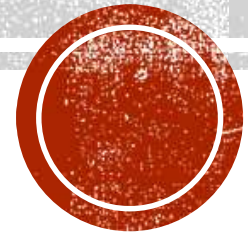
COMPOST: FROM THE GROUND DOWN

Insight into the small world where life ends and begins

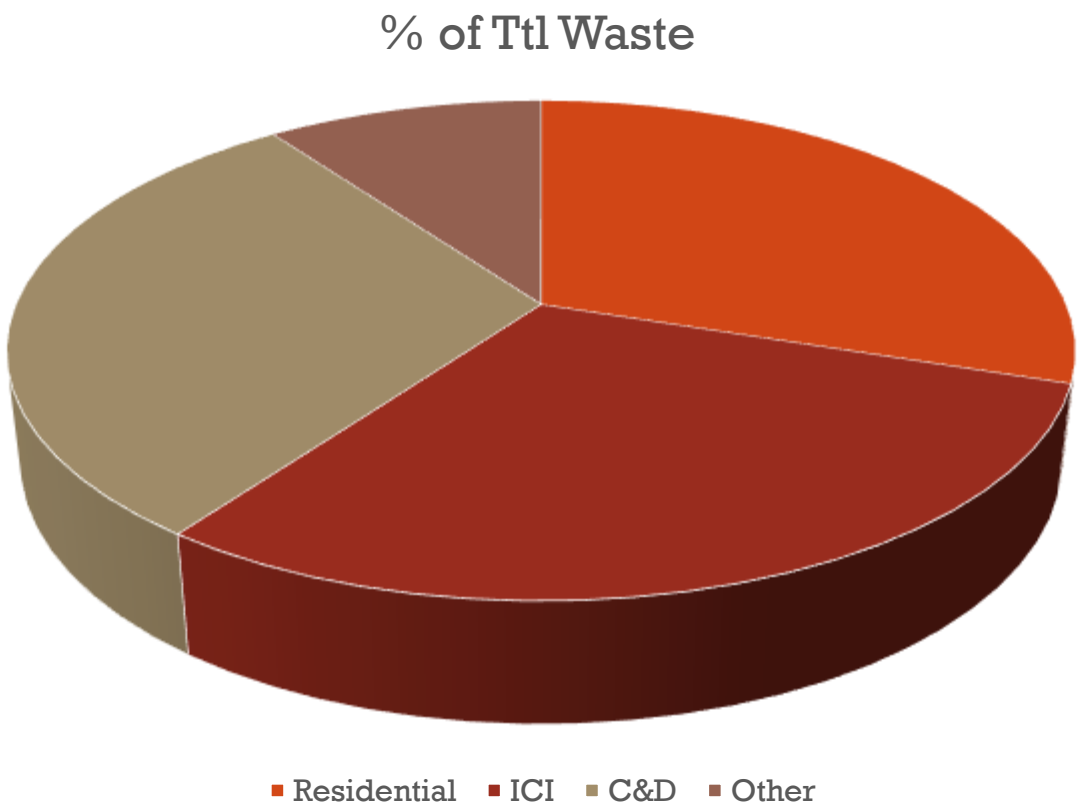


WASTE HIERARCHY

Most Desirable Least Energy

Least Desirable Most Energy

WASTE CHARACTERIZATION



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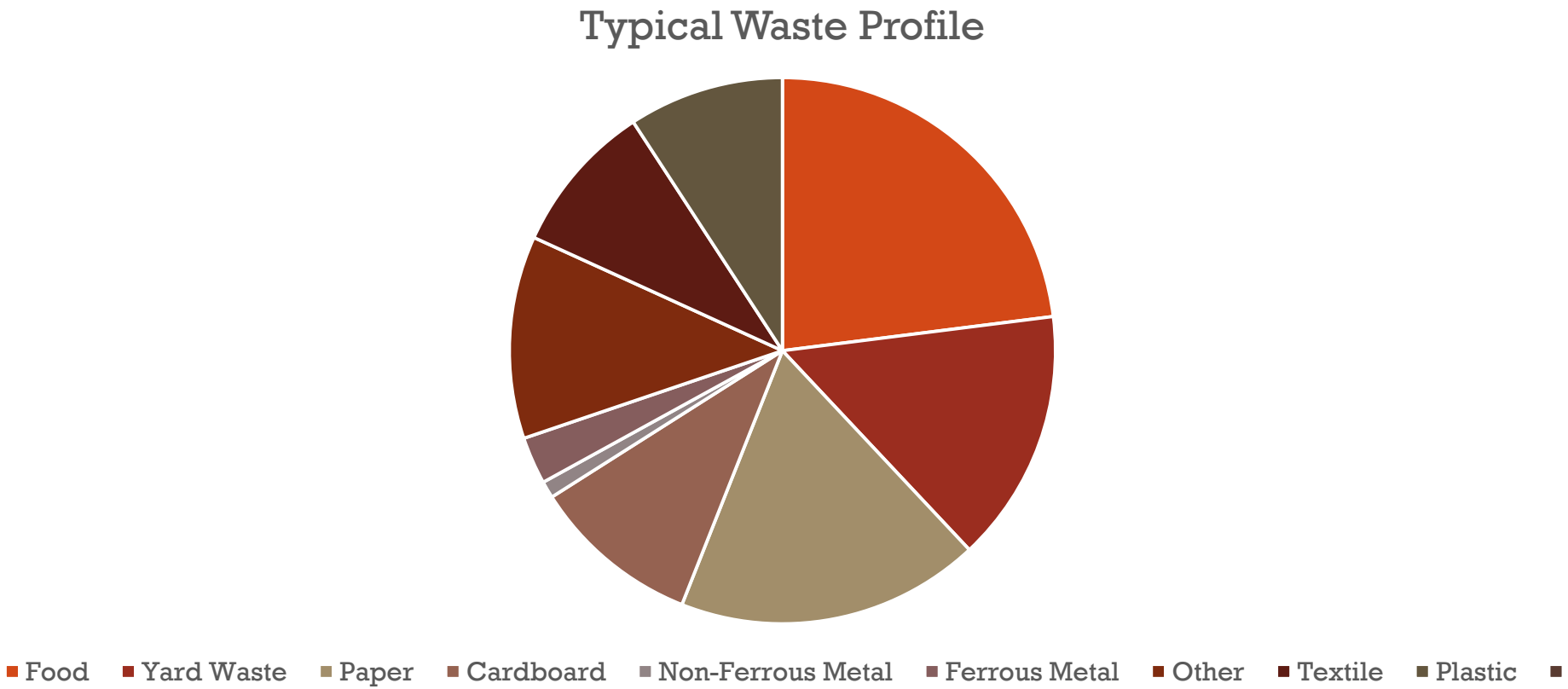

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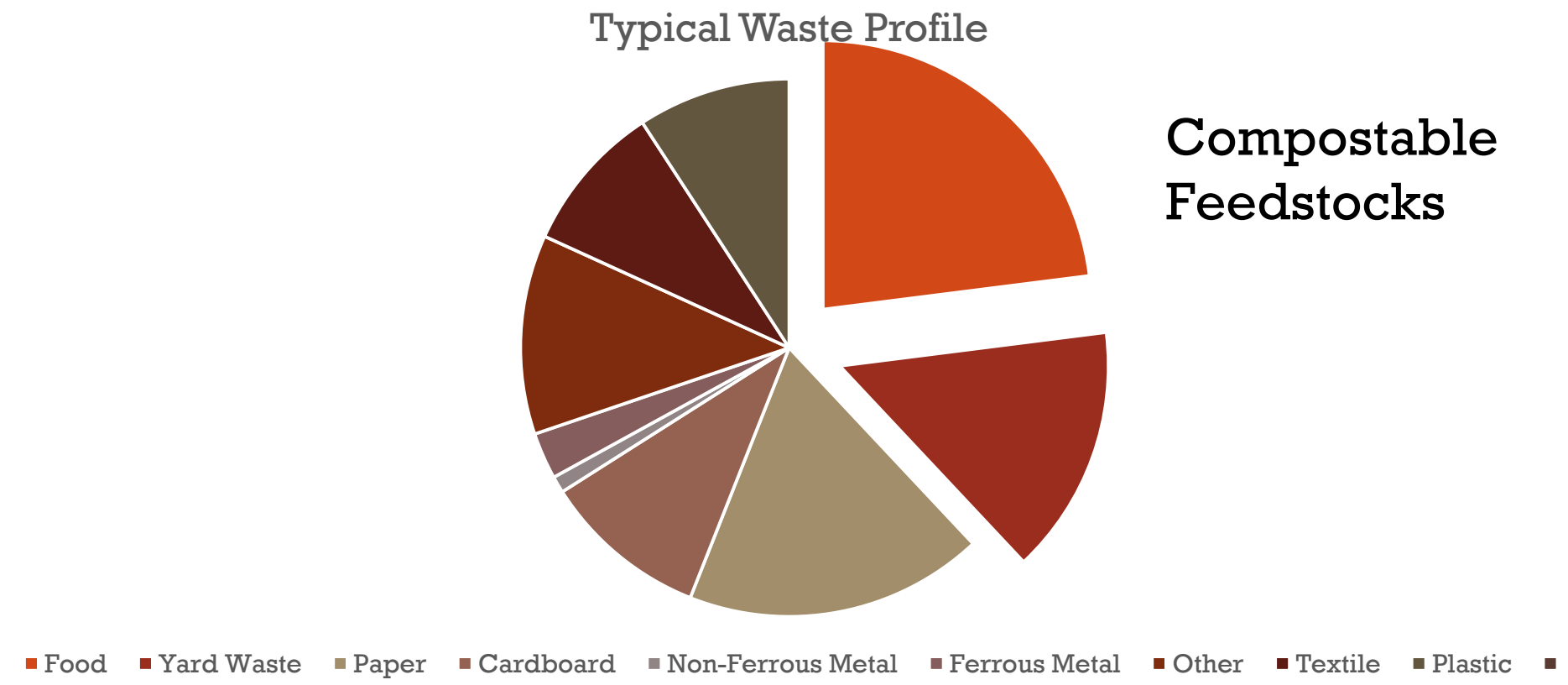


Compostable Feedstocks

WASTE CHARACTERIZATION

- In 2010 Saskatchewan municipal solid waste for disposal was 937,268 tonnes of which 283,726 was from residential sources
- National diversion rates in 2010 are at 24.5% however SK is lagging at 13.2%
- In Saskatchewan 47% of households are composting kitchen and/or yard organics via curbside or backyard
- >40% of waste disposed in SK landfills in urban areas is compostable food and yard waste

- -source *State of Waste Management in Canada*, Giroux Environmental Consulting, for the Canadian Council of Ministers of Environment, 2014

COMPOST DEFINED

- 1926 Funk & Wagnall's: com'post, *n*. **1.***Agric.* A fertilizing mixture, as of peat, stable-manure, lime, etc., decomposed and combined in a heap
  - Comes smack in between com-pos'si-ble *(capable of coexisting)* and com-po'sure *(tranquility, as of feelings, thoughts, manner or appearance)*
- 1998 Canadian Oxford: compost, *n.* a mixture of decomposing vegetable matter, table scraps, manure, etc., used to fertilize soil. *v.* **1.**treat (soil) with compost, **2.** make (make manure, vegetable matter, etc.) into compost, **3.** degrade into compost
  - Comes in between compos mentis *(having control of one's mind)* and composure *(a tranquil manner)*

CANADIAN COMPOST COUNCIL

- Composting is a natural biological process, carried out under controlled conditions, which converts organic material into a stable humus-like product called compost. During the composting process, various microorganisms, including bacteria and fungi, break down organic material into simpler substances. Composting is an aerobic process, meaning that the microorganisms require oxygen to do their work.

COMPOST BASICS

- Five Dubyas and an H
- The Quick Dirt on Compost
- Making it work-your bugs become your best friends.
- Getting it together. Mix ratios
- Sustainable populations. What goes up must come down.
- Should have stayed in school-sciences explained.
- K.I.S.S.

W5+1

- Who is going to do the task? Who will benefit? Who will it cost?
- What work will be done? What products will be addressed? What resources are available? What are the expectations from all the 'Who's?
- Where will the work be done?
- When will it start?
- Why bother? The 'right' thing to do? Cost of disposal of waste? Different community culture? Why are you here?
- How will we do this? You will be relieved to know that if you have the answers to the W5 questions, the 'how' will be taken care of.

THE FIRST THING TO KNOW

- Your Products
- It is a Natural Process
- Requires Additional Air and Water (usually)
- As well as some level of Commitment

PRODUCTS

- What are you willing to accept?
- Leaves and grass are simplest
  - No pre-processing required
  - If it gets abandoned, it will still do its thing
- Branches need to be chipped
- Logs and stumps require very expensive shredding to process
- Food can cause problems if there is too much at a time

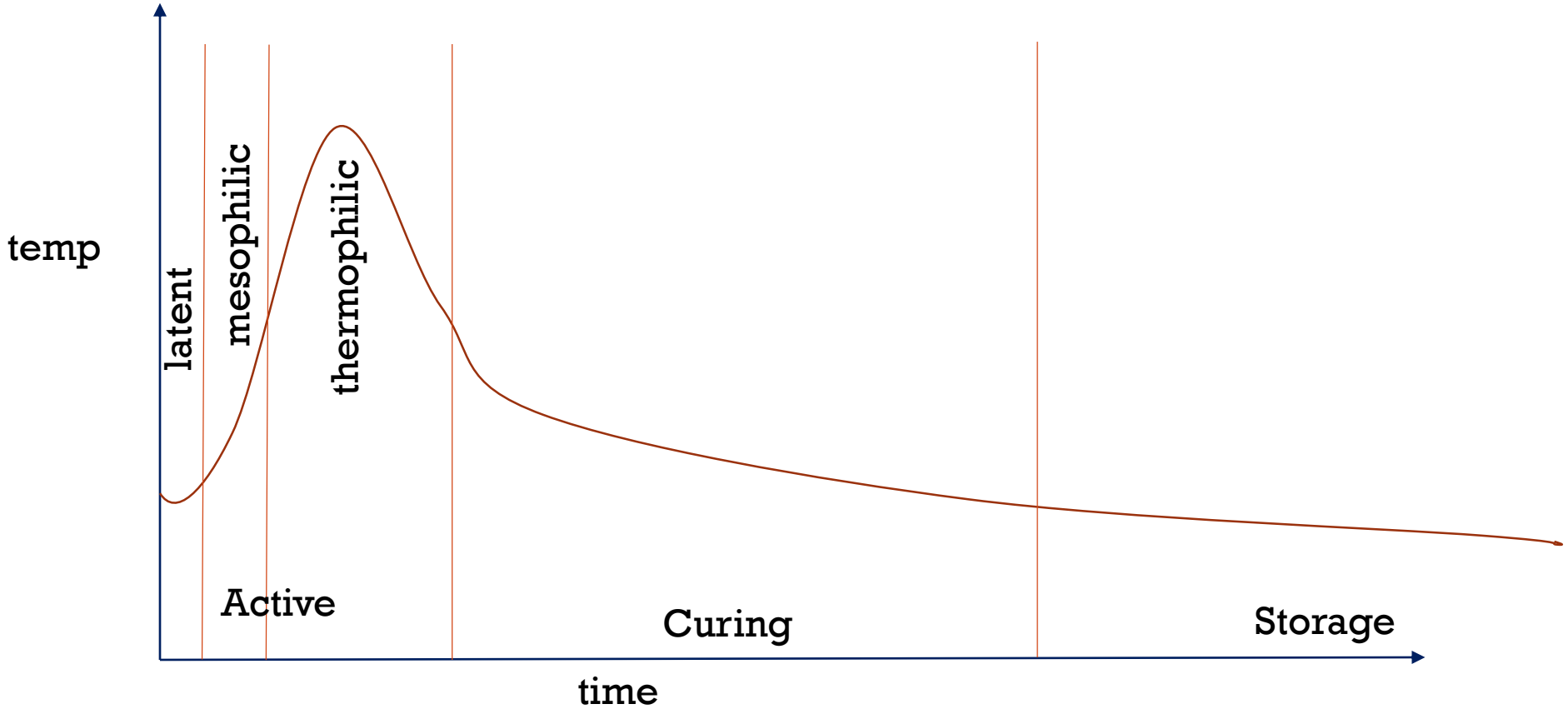
ITS ALL NATURAL

- There is no groundskeeper raking leaves in the treed valleys and bluffs of the province where every year all the trees shed their foliage
- Nature has a way of dealing with its ‘litter’
- Leaves, and all living organisms undergo decay which begins at the moment the life ends.
- Microscopic bacteria and fungi and insects go to town on the leaves and deadfall and detritus which breaks the plant material into smaller more manageable pieces until it isn’t even recognizable
- Work happens consistently over time

WHAT WE DO

- Give nature a little boost and a kick start
- While nature deals with a little over a long period of time, we concentrate the organics then try to minimize the time that we have to work it through the same process
- We have an understanding about what the role of different organisms play in the decay process, so we try to enhance that part
  - Maintain optimum temperature, water content and air supply
  - Thermophillic phase is really the rock'n'roll part of the process where a lot of food, air and fuel is used up in a relatively short period of time

PHASES OF COMPOST ACTIVITY



WHAT IS HAPPENING IN THERE?

- On a very small scale a lot is going on
- The image is the Compost Food Web developed by D.L. Dindal in 1978
- The arrows indicate the direction of energy flow

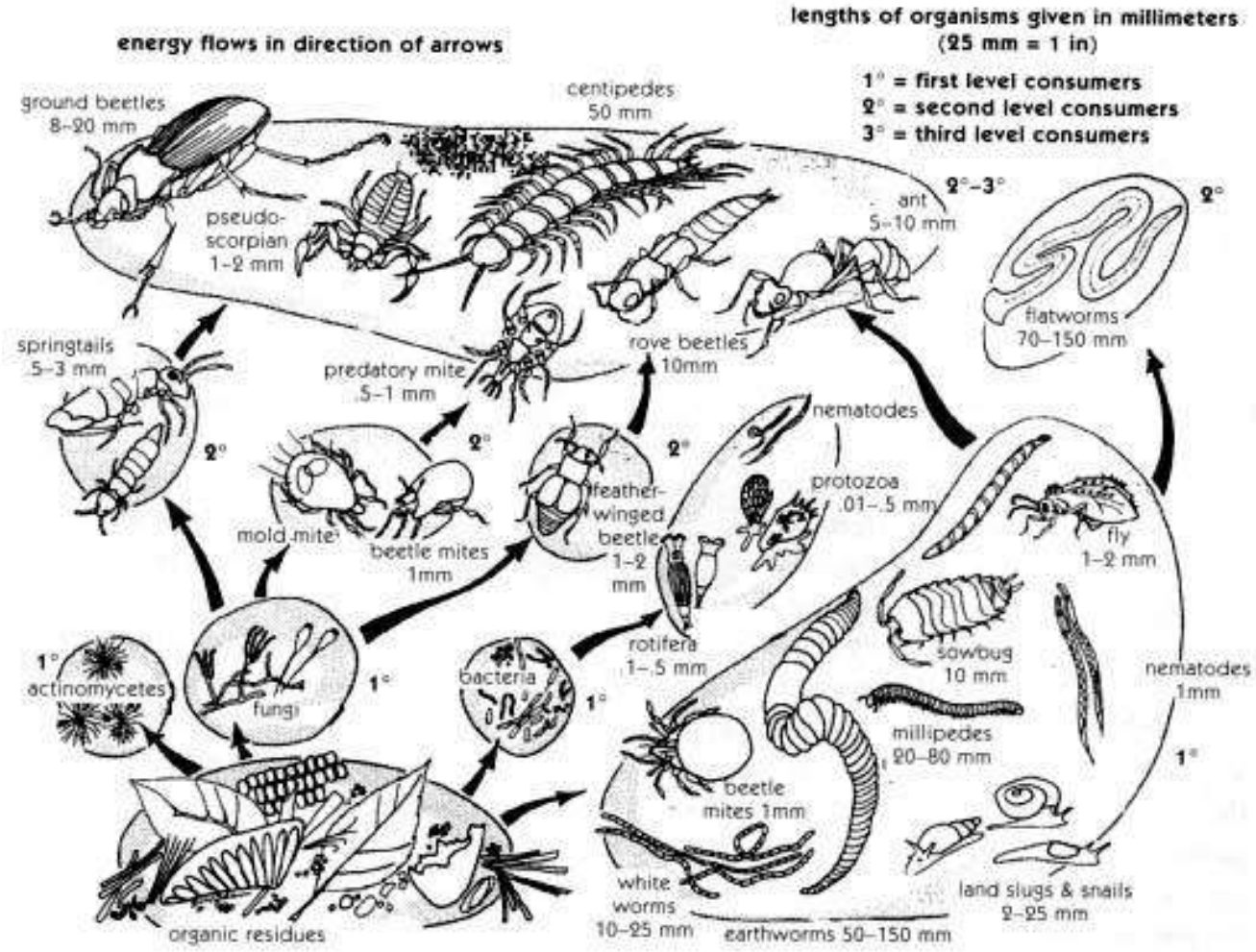
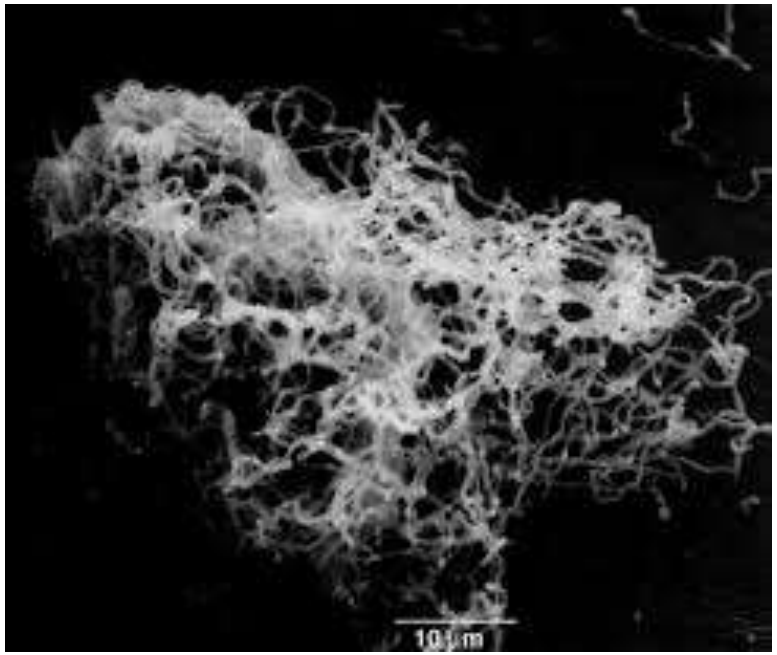


Figure 3.1 Soil organisms and their role in decomposing residues. Modified from D.L.Dindal, 1978.

IT'S A SMALL SMALL WORLD

- Activia yogurt has billions of bacteria in every spoon full; just like compost!
- Trust the numbers- scientists assure us of this and if we want to call them out on it, we have to become scientists. Its really just a vicious circle that stops right here.
- This fungi is massive compared to a bacteria

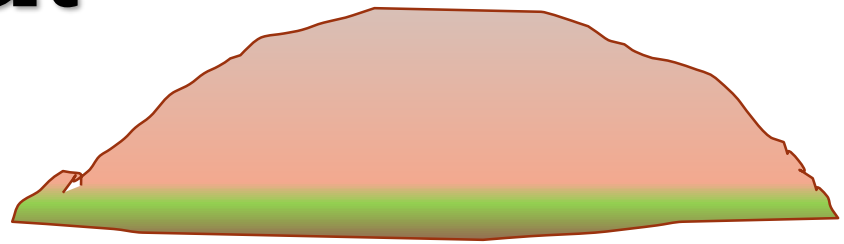


EMISSIONS

Water Vapour

Heat

CO_2

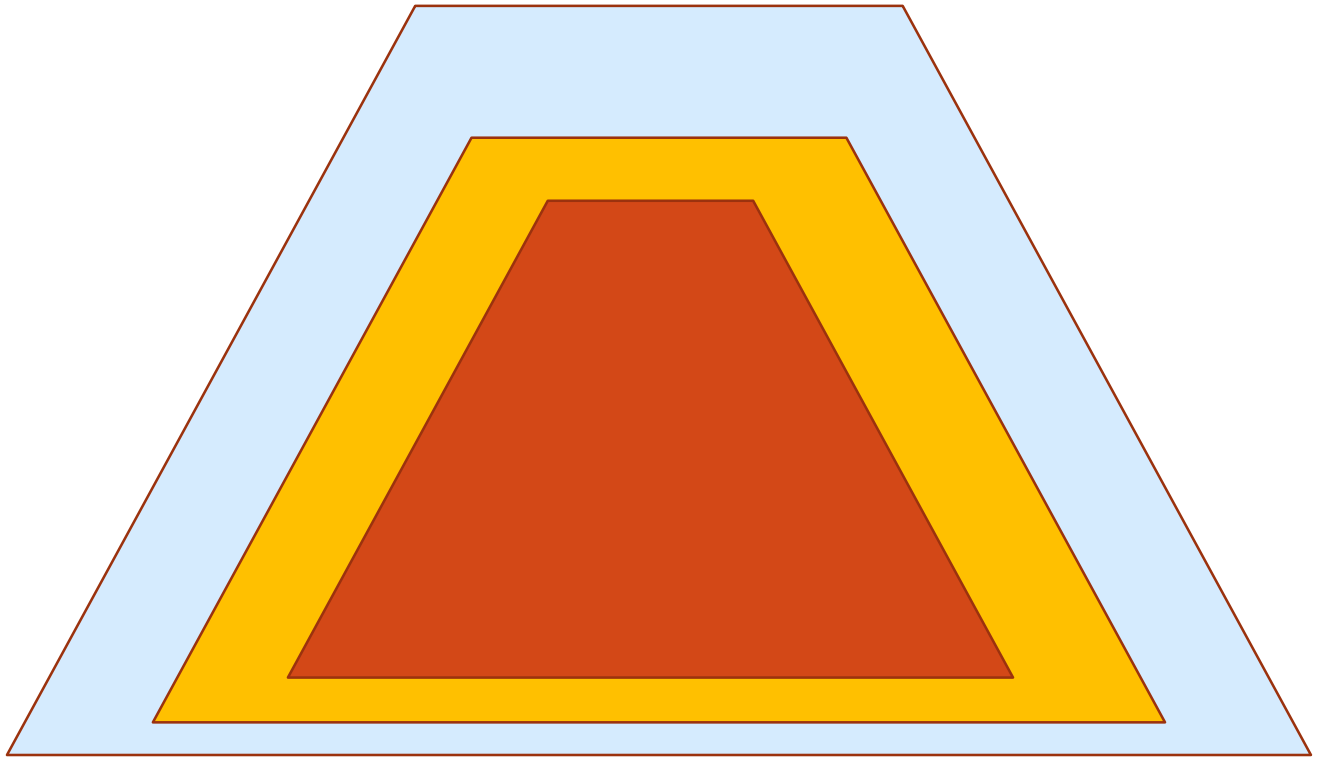


WHERE DOES THE HEAT COME FROM?

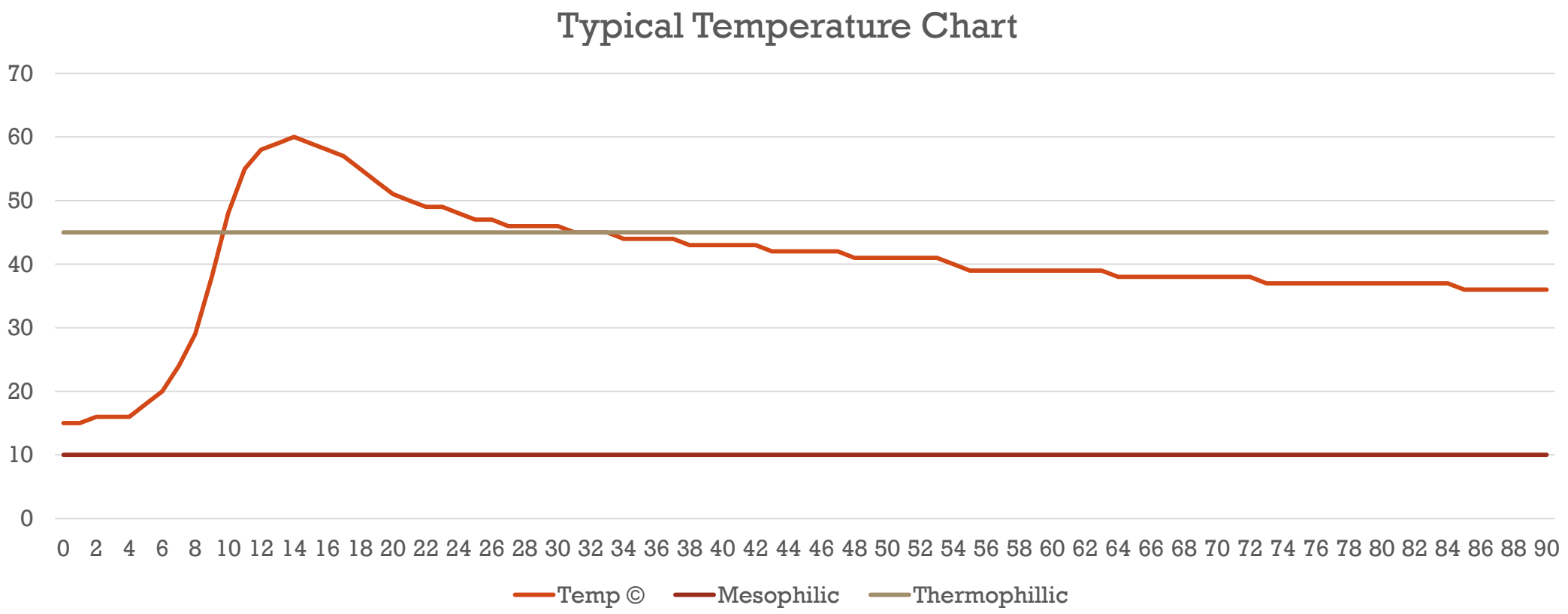
- The little bugs in the mix are working at a feverish pace
- There is usually a lot of insulation in the external wall which prevents heat from dissipating
- The heat continues to build and can reach very high temperatures (>60°C)
- We need to measure temperature; we can cool the windrow by aerating it. Bring the hot internal material to the outside and let the cool product gain some heat.

65°C max

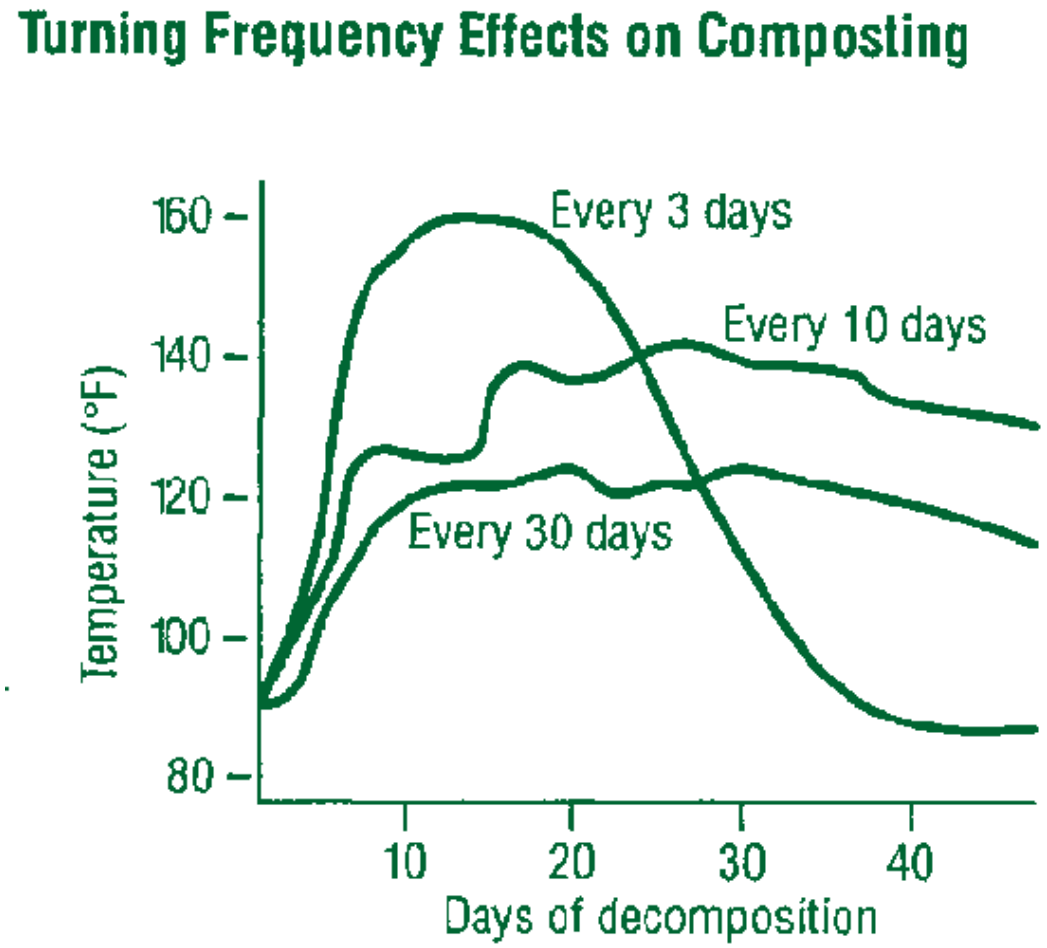
WINDROW TEMPERATURE DISTRIBUTION



TEMPERATURE PROFILE



WHEN SHOULD I TURN IT OVER



OPTIMAL TEMPS FOR EACH STAGE

Active Phase	Curing	Storage
55-60℃	Below 50℃	Near ambientt

CHEMICAL CHANGES

- pH is a measure of alkalinity or acidity (from 0-14)
- 7 is neutral
- Will vary slightly throughout the process
- Will generally be alkalyne (>7) but good range between 6.5 and 8
- Low O2 can contribute to reduced pH
- Organisms will seek balance, or die trying
- Our job is to make the bugs happy

YOU CAN HAVE ANY COLOUR YOU WANT: AS LONG AS ITS GREEN OR BROWN

- Colour reflects the amount of nitrogen that is in the product.
  - 'Green' generally denotes higher nitrogen content
  - 'Brown' denotes higher carbon content
- Ideal CARBON:NITROGEN ratio is between 25:1 and 30:1
- Typical values for C:N can be found
- Blend the feedstocks to meet target

C:N TYPICAL RATIOS

Material	Ratio
Fish waste	5:1
Manure	15:1
Food	15:1
Green Grass	20:1
TARGET	25:1 to 30:1
Just Fallen Leaves	40:1
Dry Leaves	90:1
Field Straw	100:1
Sawdust	200:1
Woodchips	300:1
Newsprint	400:1
Cardboard	560:1

BLENDING RULES OF THUMB

- Most smaller municipalities are getting their leaves in the spring and fall, then grass during mid-spring through to end of summer
- You may need to stockpile leaves to have them to blend with the grass that comes in
- Use loader buckets as your measure and start with a 1 leaf to 1grass ratio
- Put up enough so your pile is about 2 m high
- As you get more material, keep blending it then adding to your pile to make it longer
- If the pile is smelly after the first few days when you dig into it, spread it out and add enough leaves to get the ratio to 2:1 leaves to grass
- Mix and re-pile it

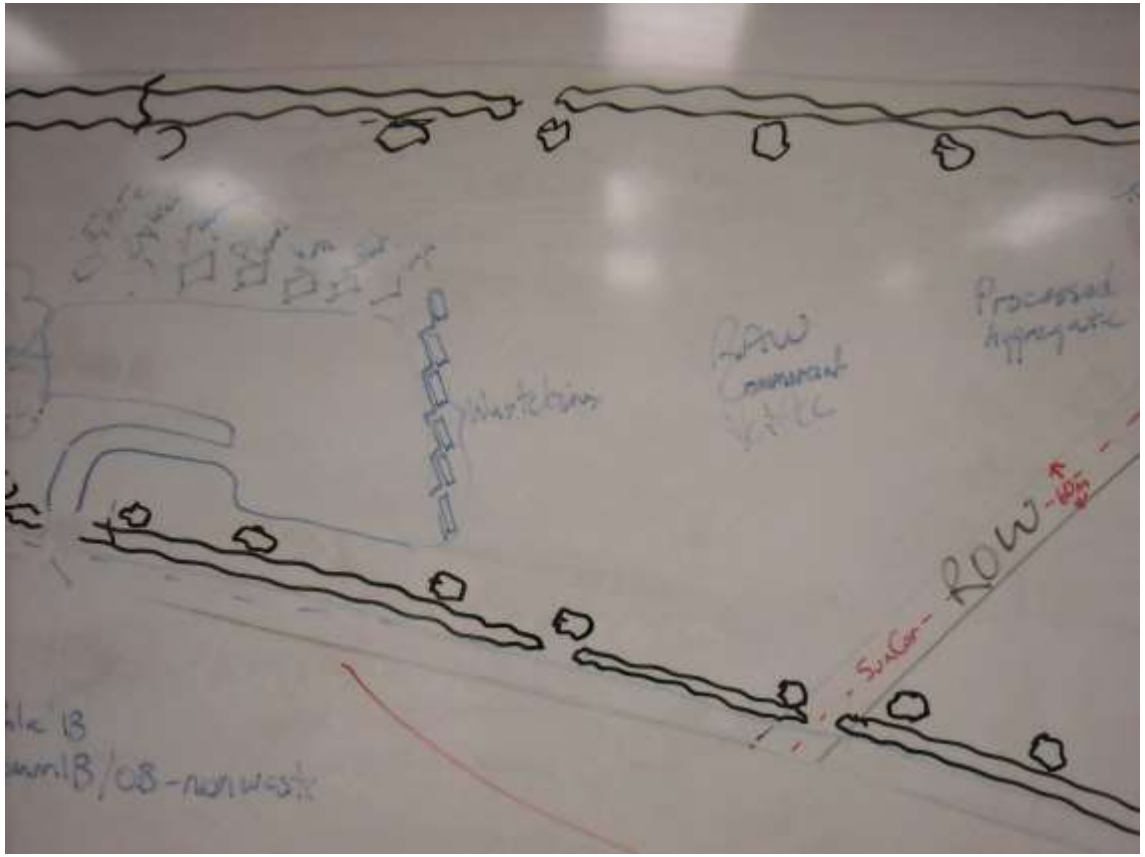
AIR AND WATER ADDITION

- If possible the compost materials should be brought up to a moisture level consistent with that of a damp sponge (55%). Essentially you want enough water available to give the insects and microorganisms a happy place to go forth and multiply
- As these organisms process the food they use up available oxygen so more air must be added. This is done usually by turning over the pile.
- As the moisture and food depletes, the pile will lose volume. It is important to continue to add air and water through the process if possible to maintain ideal conditions.
- In Sask it can be very difficult to keep water content high enough – for curing the water content may be around 40% or slightly less

WHO LOVES MATH?

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Y=mx+b2

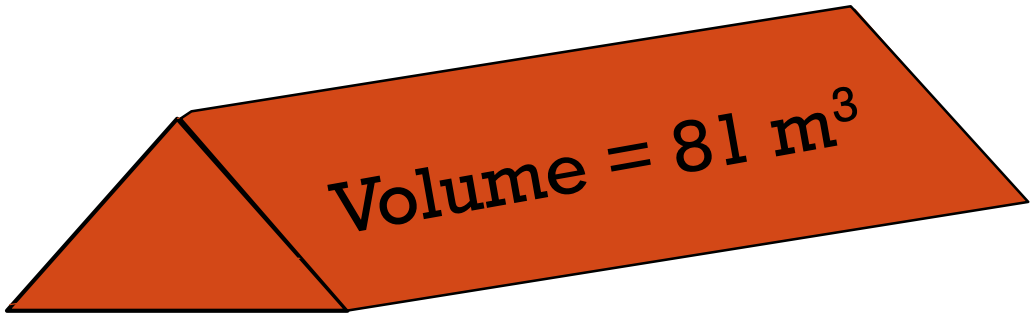


$$\sqrt{a^2 + b^2}$$

$$\cos\alpha + \cos\beta = 2\cos\frac{1}{2}(\alpha + \beta)\cos\frac{1}{2}(\alpha - \beta)$$

ESTIMATE COMPOST VOLUME

- So if your windrow is 36 m long and 3 m wide and 1.5 m high the volume is found using the formula:
  - V=1/2 base x height x length = ½ x base x height x length = 0.5 x 3.0 x 1.5 x 36
  - =81cubic metres



HOW MUCH WATER DO I NEED

- Simple test for water content:
  - Get a pail of representative sample – nobody will judge you on this but you want to get an average part of the material
  - Weigh a microwave safe bowl on a digital food scale
  - Mix the sample in the pail, grab a hand-full or two and put into a microwave safe bowl. Weigh the bowl plus moist sample
  - Dry on low to medium heat in a microwave for only a minute or two at a time. You do not want to burn any sample
  - Weigh between heating cycles. When it appears dry and is no longer losing weight take a final measurement.
- Wet weight – dry weight = water weight
- Water content is water weight/wet weight x 100 to get percent moisture

WHAT IS THE WEIGHT OF MY MIXTURE

- Do a bucket test to estimate the weight per unit volume
- Get a 5 gallon pail, an old bathroom scale, a piece of ¾' plywood
- Weigh the clean empty pail
- Put sample in the pail up to a line that indicates a known volume
- Drop the pail on the plywood several times to consolidate the material.
- Top it off to the full line with compost
- Weigh it then subtract the weight of the empty bucket from the entire weight
- Full weight-empty weight = sample weight 12kg – 2 kg = 10 kg
- Sample volume = 22 litres so 10kg/22 l = 0.454 kg/litre or 454 kg/m^3

WATER TO ADD

- Your water content is 35% and you want 45%
- Your density is 454 kg/m^3
- Pile volume is 80 cubic metres
- Weight of pile is 80 m^3 x 454 kg/m^3 = 36,320 kg
- Need to add 10% water to the mix. 10% of 36,320kg = 3,632kg or 3,600 litres
- Test your theory by adding 10% water to your pail sample; mix it well then check the consistency. Is it too wet or just right?

KEEP THE DUST DOWN

- It is important to remember that the piles consist of very active biology
- When we let it dry to the point where dust is blowing we can end up breathing in the dust
- Some people may be sensitive to this; provide N95 dust masks for workers
- Try to manage blowing dust by keeping some minimum water content
- EASIER SAID THAN DONE!!

MANAGE YOUR LEACHATE

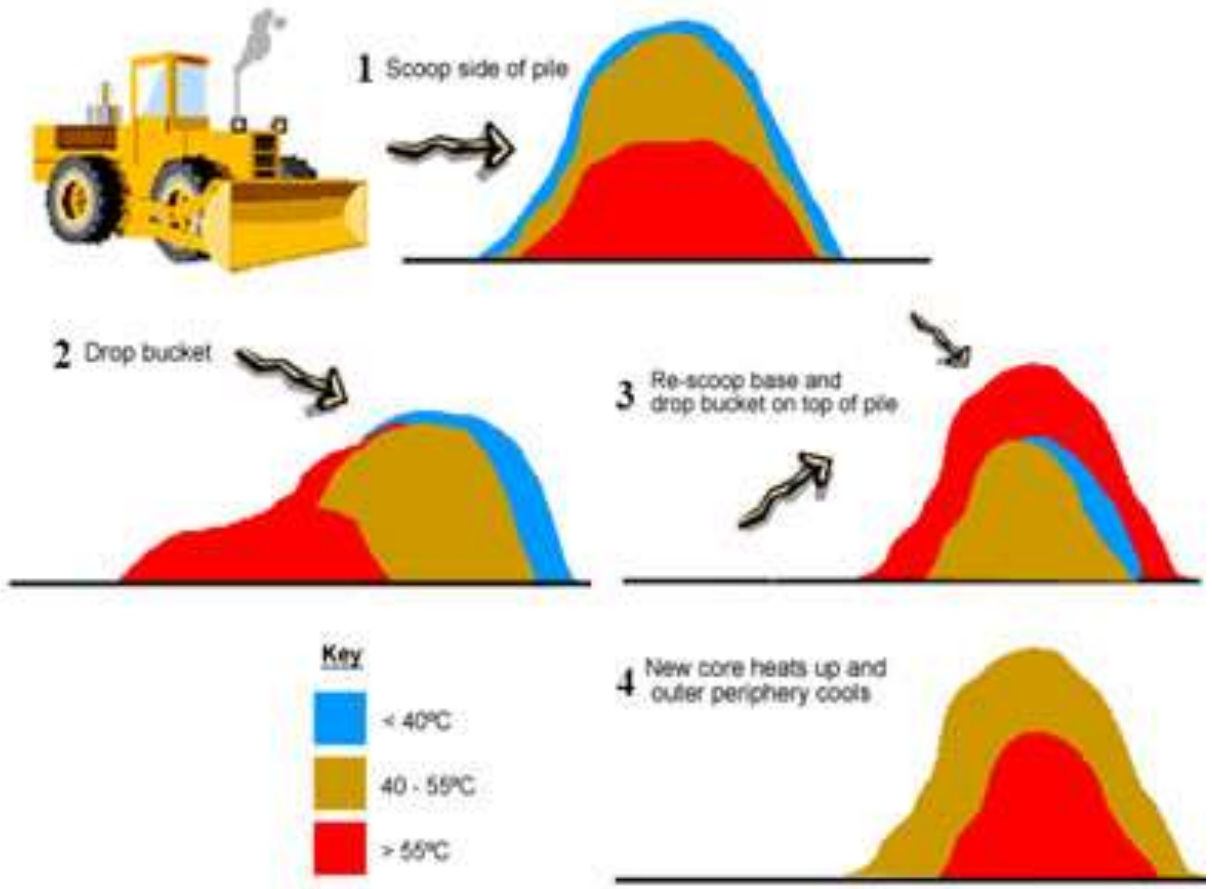
- Leachate is water that has come in contact with compost
- The Province is the regulating body for compost sites; you will need to provide evidence that you are protecting the environment around, above and below your facility.
- Write out an operating plan that discusses how leachate is going to be dealt with

FEEDSTOCK PREPARATION

COMPOST PROCESSING STYLES

- Like fashion, you can go with the latest and greatest from Europe, but making it your own will likely last longer and be far more cost effective
- Process used is dependent on:
  - Quantity of feedstock
  - Consistency of feedstock
  - Turning and mixing equipment being used
  - Availability of water
  - Time that can be committed to the work

BUCKET TURNING



ROU (2003). Information Sheet No. 2-7 Composting. Recycled Organics Unit, University of New South Wales, Sydney.

BUCKET TURNED PILE

TURNERS

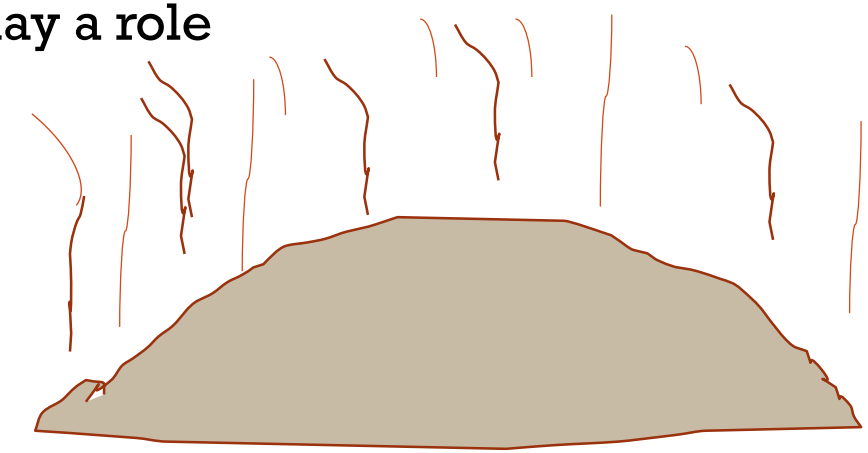
PASSIVE AERATED WINDROW

AERATED STATIC PILE

IN-VESSEL

ODOUR CONTROL

- If anything shuts your operation down, it will be odour complaints
- It doesn't have to be that way – but you need to pay attention
- Most odours occur if there is too low O2 remaining in windrows before turning
- You can manage odours with some curing compost or wood chips
- Wind will play a role



DON'T STOP LEARNING

- Read all you can
- Here are a few good resources:
  - Industrial Composting by Eliot Epstein
  - Technical Document on Municipal Waste Organics Processing by Environment Canada, enviroinfo@ec.gc.ca
  - Midscale Composting Manual, Olds College and Alberta Environment
  - The Virginia Yard-Waste Management Manual, Dept of Crop and Soil Environmental Sciences, Virginia Tech
  - The Compost Council of Canada at Compost.org
  - The Saskatchewan Waste Reduction Council
  - Many many others online, in print and just a phone call away

COMMITMENT

- The level of success is often tied to the commitment of your management team to the project
- Without buy-in from all the stakeholders the compost program can start but have a rough finish
- Staff should be encouraged to become involved so they understand the process and where they fit in. Front line workers will be a huge benefit to you.
- General public needs to be aware of what you are asking for and you will need to educate them on expectations
- Don’t forget to celebrate every success along the way

AS ALWAYS: REMEMBER