Case Study - Cooks Landfill Antigua
Landfill disposal of green waste and impact on uPOPs emissions

With no alternative to landfill for the environmentally sound management of green waste, this waste stream is being deposited in Cooks Landfill in Antigua and within the debris waste area adjacent to Plantation Landfill in Barbuda. Although not specifically recorded as a homogenous waste stream, 45 % of waste deposited at Cooks Landfill in 2017 was found to be organic waste (green and food waste). An estimated 21,000 tonnes of parks and gardens green waste were deposited in Cooks Landfill in 2018, representing 15% of all waste disposed in that year. The key problems with green waste on the landfill can be summarised as follows:

- Low density, high volume nature (particularly tree cuttings) prevents efficient and effective waste mass compaction – green waste has a tendency to "rebound" leaving air pockets in the waste and preventing effective daily cover application which leaves the waste mass susceptible to fire (and consequently UPOPs emissions) and provides breeding ground for disease vectors.
- Provides a fuel source – wood dry organic matter represents a good fuel source to sustain any potential landfill fires (or existing fires as is the case at Cooks Landfill), particularly when combined with air pockets are described above.
- Hazard to landfill compactor and other vehicle operations – large items of green waste, particularly tree stumps and branches can become entangled in vehicle tracks/wheels, puncture tyres, rip hose lines, causing vehicle down-time for repair.
- High volumes of large deliveries impact effective tipping face control – green waste requires careful management on site due to all points listed above. Therefore, landfill site staff must take additional time and effort to direct and manage green waste loads detracting from the focus of managing the municipal and other general active waste loads.
- Consumes valuable landfill space – green waste has nutrient value that can be returned to land, it is not toxic or harmful to health or environment if managed correctly and therefore does not require to be landfilled. Once in the landfill green wastes costs more than municipal waste to compact (due to machine passes required) and shortens the lifespan of the landfill site resulting in the need to invest in finding and constructing the next landfill much sooner.
- Contributes to landfill gas and leachate production - The anaerobic decomposition of cellulosic biomass (green waste) results in methane and other Greenhouse Gas generation which contributes to global warming. This decomposition also contributes to other gas and leachate production in the landfill which can result in the leaching of toxic materials from other wastes such as heavy metals from waste electronic equipment.

For the reasons listed, it is environmentally and economically advisable to divert green waste from the landfill to an alternate waste treatment method. The following photo case study illustrates the issues and potential solution by way of pilot composting project.

Cooks landfill on fire with smoke, including unintentional Persistent Organic Pollutant (uPOPs), emissions visible along the edge of the landfilled waste mass.

Upto 38,000 tonnes per year (100+ tonnes/day) of bulky green waste mixed with all other waste goes into Cooks Landfill. This presents an insurmountable challenge for the small bulldozer operating on site to compact the waste, an essential operation to minimise the oxygen in the landfill and enable good, uniform, cover material application, which are operational techniques that minimises the occurance and spread of fires. Disposing of green waste at Cooks Landfill is currently free and therefore an easy and cheap way for developers and landscape gardeners to quickly discard their waste.

Pockets of air within green waste (which “springs” back after compaction, creating the air pockets) in the landfill, assist decomposition of the vegetation, creating heat and gasses that can lead to spontanious combustion, and provides fuel and oxygen to sustain or reinvigorate existing fires.

Large volumes of green waste also hinder the correct layering of waste leading to overly steep side slopes that aren’t compacted, can’t hold cover material that would supress fires, and are unstable.

The large volumes of bulky branches in green waste disposed of in Cooks landfill and the impact this has on site operations are one of the leading contributors to the current perisitant fires and associated smokle emissions at the site.

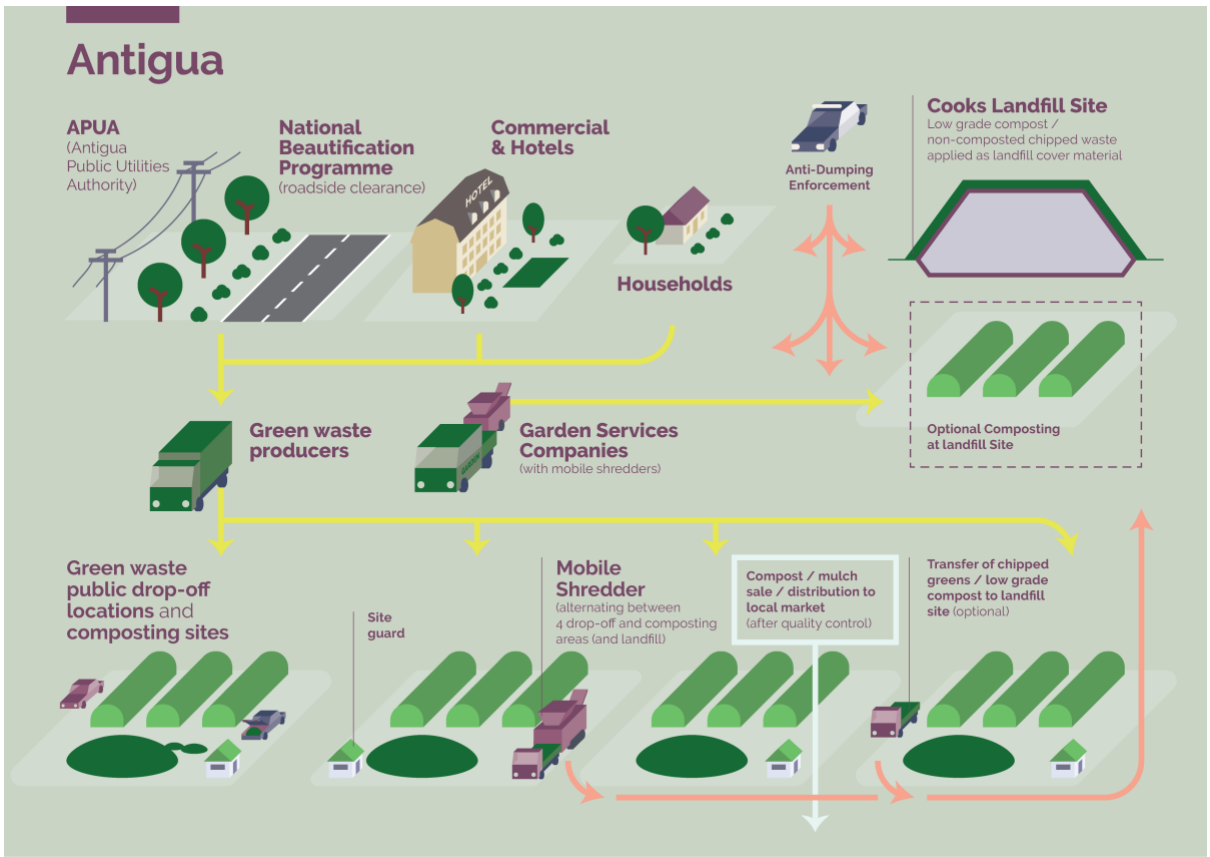
As fires spread and heat the cover material, the cover dries out, cracking and causing additional fissures where oxygen and rain can enter, and gasses can develop and escape. Dry cover material also becomes friable, being even less able to hold to steeper side slopes.

Garden waste and bulky branches burning is evident across the site, particularly on the side slopes.

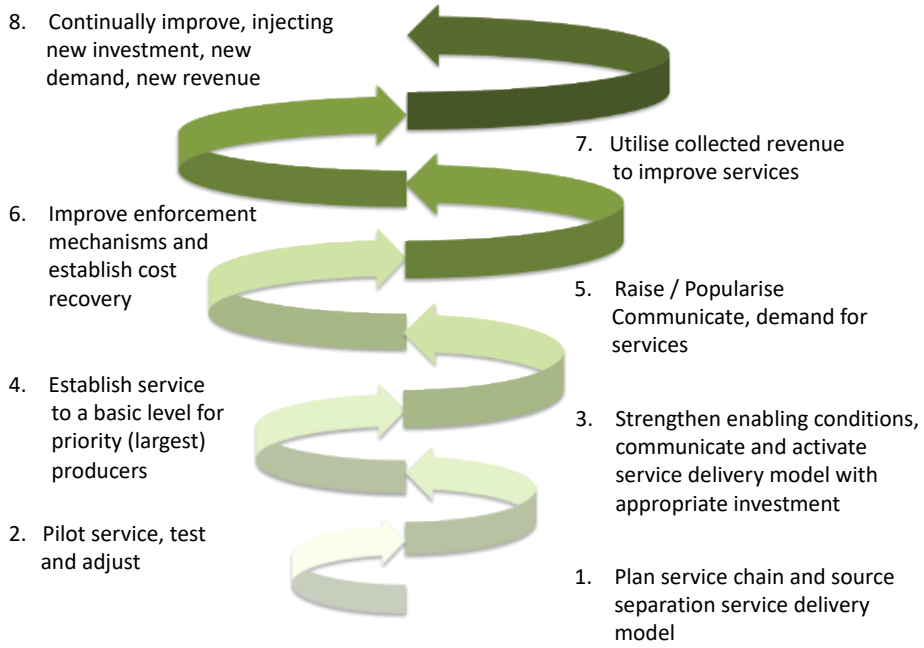
To mitigate this situation and enable improved operations that reduce fires on the landfill and associated emissions of uPOPs, the green waste needs to be diverted from landfill disposal to an alternative treatment solution, e.g. composting.

Green Waste diversion from landfill to composting

To divert green waste from landfill, a suitable and sustainable alternative is required. Composting offers this, however, requires a source segregated organic material free of contaminants. Several operational options are available, the following diagram illustrates NSWMA's desired approach.

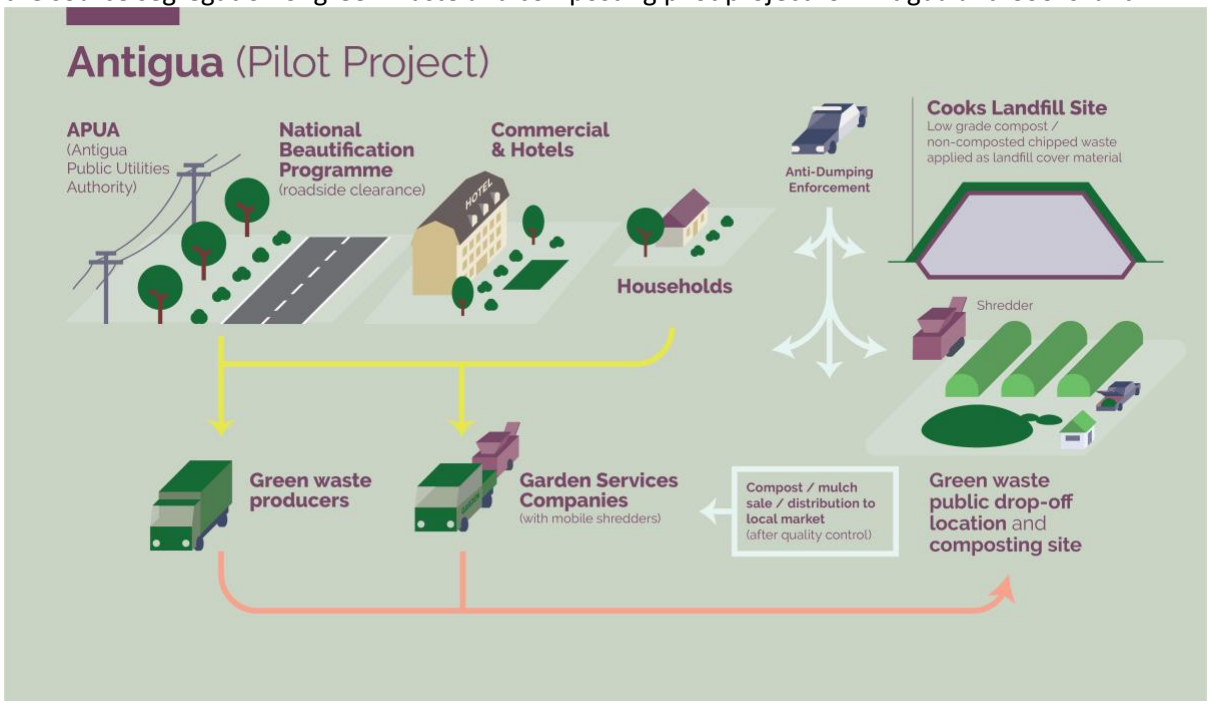


It must be recognised that transitioning from disposing of over 100 tonnes of green waste a day, to establishing a viable green waste sorting, collection, composting treatment, and compost market cannot just happen immediately. Several steps require to be taken as illustrated in the following service delivery growth spiral, which indicates the main steps from concept to self-sustaining business model. Recommended steps for the Government of Antigua / NSWMA to take to achieve this are presented at the end of this document.



Source Segregation of Green Waste pilot project

The first steps to establishing the composting service is to plan the source separation service and pilot it. This has been conducted as part of the consultancy project with the following diagram illustrating the source segregation of green waste and composting pilot project for Antigua and Cooks landfill.



To this end, a pilot green waste source segregation and composting project has been established within the Cooks Landfill and waste management facility.

KEEPING ANTIGUA LOVELY
RECYCLING • REUSING • REDUCING WASTE

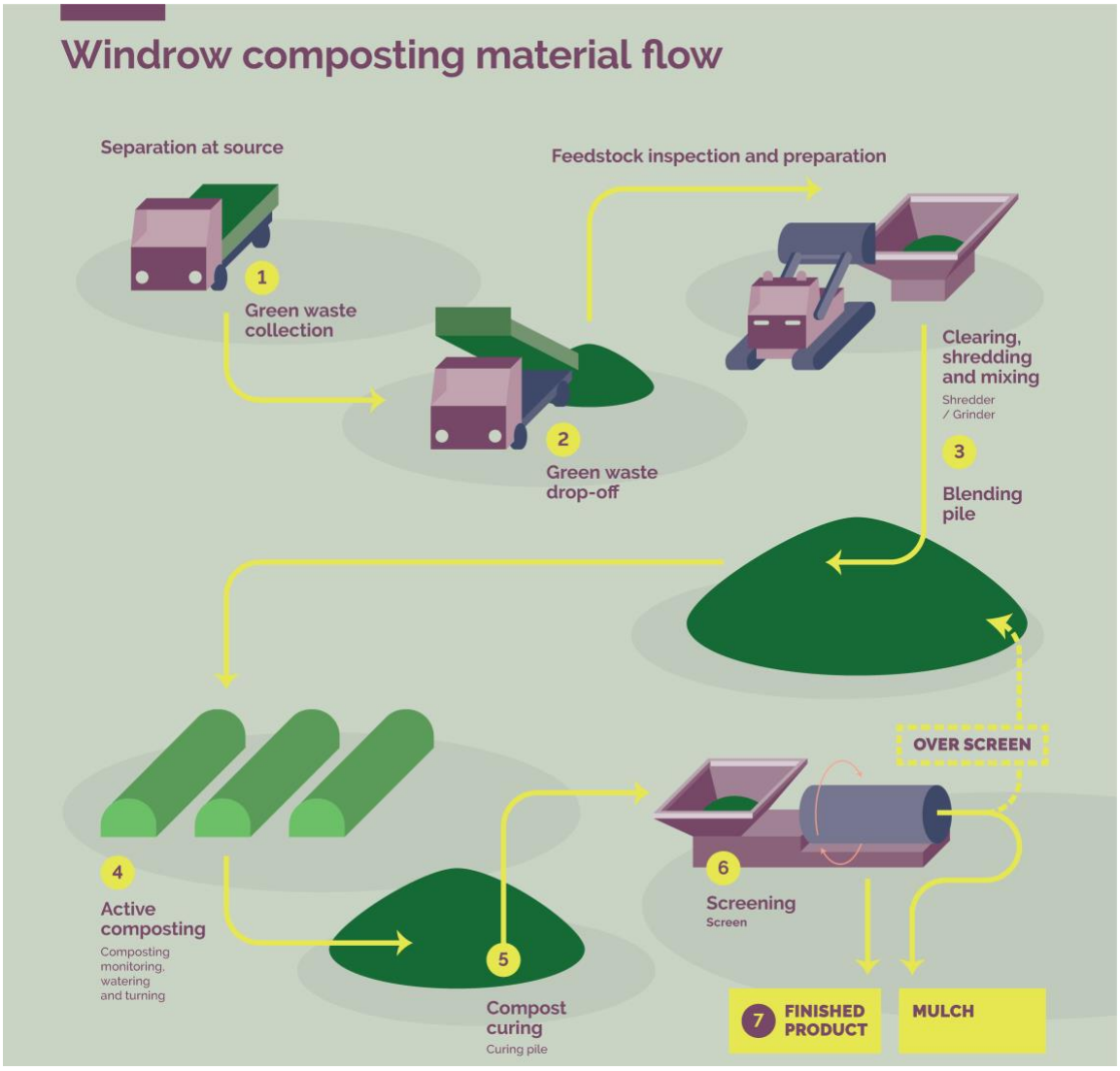
GREEN WASTE DROP OFF

Information, Education and Communication regarding the need to source segregate materials and where to take them is critical. To promote this, specific campaign branding (above and below images) were designed and utilised in campaign leaflets, signage and communications through local and social media.

A green waste drop-off and composting area was established at Cooks Landfill after vehicles pass over the weighbridge and before the waste disposal cell. This enables vehicles transporting green waste to be easily diverted from taking waste onto the active waste mass of the landfill.

A green waste drop-off area, green waste processing and chipping area, and windrow composting operational area has been established on site.

Additional area has been cleared and made available to expand composting operations and ensure sufficient area is available for material curing with sufficient quality control. The aim is to establish a green waste processing by composting process that follows that depicted in the below illustration.



The major challenge is ensuring green garden waste is delivered to site in a condition that enable fast processing of materials, that means free from non-biodegradable contaminants. The below picture illustrates how most of the green waste currently arrives on site. With this level of contamination, it would take far too many resources to sort through each load to make it clean enough to then chip and load into composting piles. A targeted and concerted communication and behavioural change campaign is required. All garden services providers, developers, hotel owners, garden owners, public bodies involved in green waste management must be consistently and continuously made aware of the drop off facility location and the need to have no contamination.

The green waste should be dropped off in this condition as a minimum (and pre-chipped as a preference).

The larger material will then be processed through the on-site chipper. This is manually loaded and is therefore a slow operation, future investment is required into a machine loadable large shredder.

Once cleared of contaminants and, where required, chipped, the material is then layered into windrow compost piles, 20m long, 3.5m wide and up to 2m high.

Material will be layered with alternating layers of nitrogen rich greens, and carbon rich wood chips. Each layer must be watered down heavily as the pile is constructed, water pumps are provided.

Machines can mix the materials as the pile is built and gently press it down into shape.

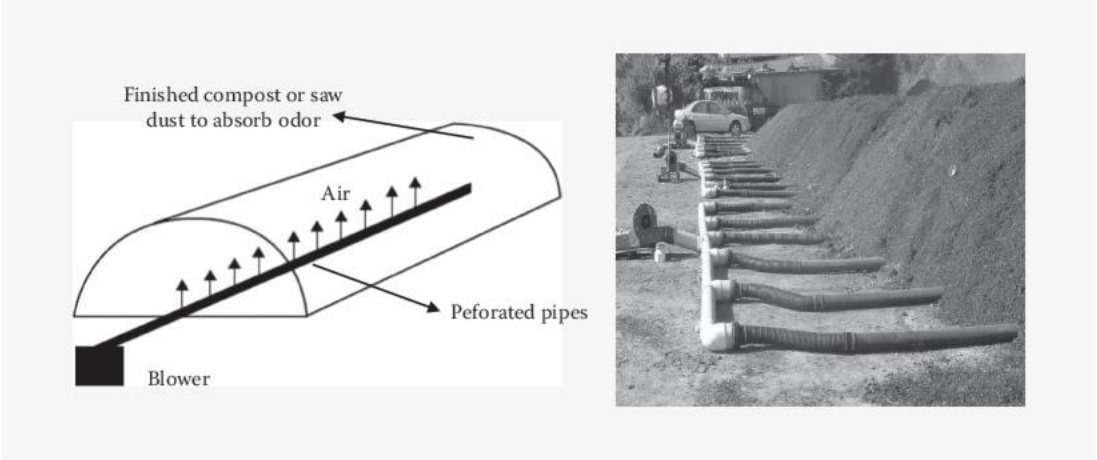
Continuously apply water as the layers are placed and the pile are built up.

Ensure the pile size and shape is maintained, as the cover fabric needs to cover the whole pile (top and sides), the cover size (20m x 5m) is what dictates the dimensions of the pile. Future uncovered maturation piles can be larger to assist retain moisture within the centre of the material.

The final windrow pile shall be trapezoidal in shape to assist airflow through the pile.

Once the pile is constructed and wetted, immediately roll the cover material over it. The text on the cover material must be visible on the outside, as this material is directional, allowing air in and preventing moisture loss out. 7 rolls of 20m x 5m cover material have been provided.

Composting thermometers have been supplied to monitor and record temperature daily. The internal pile temperature will gradually heat up and should remain between 45 and 65 Celsius for several weeks. If too hot (above 65 Celsius), remove the cover for a short period (preferably in the shade of the night to prevent excessive moisture loss), if temperature remains high, then turning the pile to release heat is required. If too cold, turn pile and add water and possibly nitrogen if required.



An alternative to turning the pile is to install perforated pipes under the pile as it is built with an air blower providing air into the pile (see separate section detailing potential simple aeration system suitable for the windrows established at Cooks). This should reduce the need for mechanical turning and therefore reduce equipment needs. But this might also speed up moisture use within the pile and so frequent additions of water may be required. Aerated Static Pile would be suitable for food waste processing within the windrow too or in containers on site if desired to reduce chance of vermin. A FOGO (Food Organics, Garden Organics) segregated collection system would then be desirable, but higher quality (more nutritious and faster breakdown) would be produced.

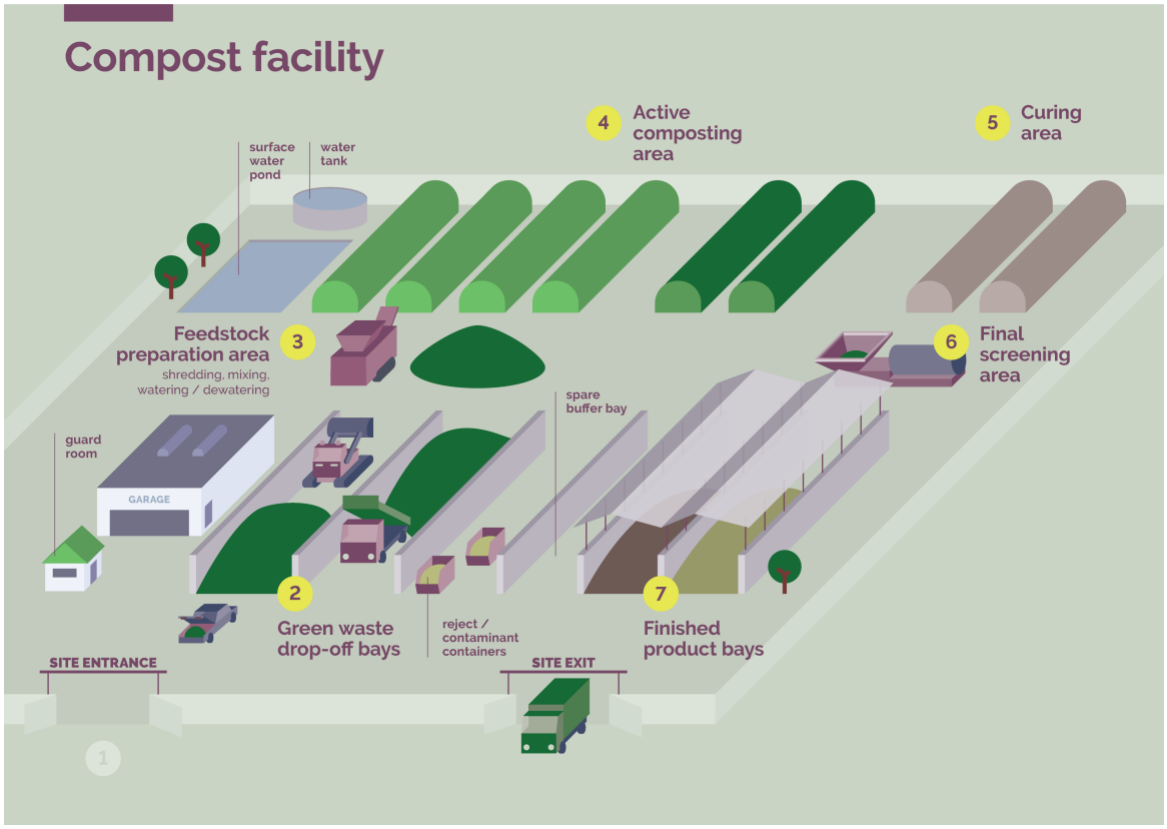
Composting time will depend on the mix of material (Carbon to Nitrogen ratio, use compost calculator provided by the project to assist, nitrogen will be the limiting factor and so addition of animal manures or food waste would be beneficial), size of the material in the pile (the larger the green waste size, the longer it will take to break down, there is a need for a larger shredder to reduce all materials quickly), the moisture content, and the mixing / turning action to assist break up material. Primary composting under the cover will likely be approximately 8 weeks, if moisture levels are managed well. During this time the pile will reduce in volume by approximately half. After this period, two or more windrow piles can be mixed together and left for a further three to four months, with moisture levels continuing to be monitored and maintained.

Prior to screening the course and fine materials through the screen provided, the pile will be left to dry a little, so the particles are not holding together in a ball. This will aid screening and extraction of good quality fine compost, which should be left to cure for a further few months under cover. The larger particles falling over the screen can be used in creating future windrow piles, returning the microbes to the piles, or used directly as mulch material.

Once screened the fine screen material can be marketed as high value compost and the over screen can be passed through the shredder again if desired, returned to the composting windrows, sold as a mulching mix, or applied to the landfill as cover material / remediation closure material. It can also be used to line areas for septic tanker discharge to absorb the septic waste and establish a medium to encourage additional breakdown and biological treatment.

A potential desired composting operation is depicted in the following diagrams. But piloting a simple system first to establish the operator models, identifying the best operator (business model), and establishing the market for compost materials is the critical exercise at this early stage.


Green waste drop-off
Surface water pond / swale
Reject / contaminant containers
Shredded feedstock bay
Feedstock preparation area (shredding)
3
guard room
2
SITE ENTRANCE
SITE EXIT
1
4 - 7

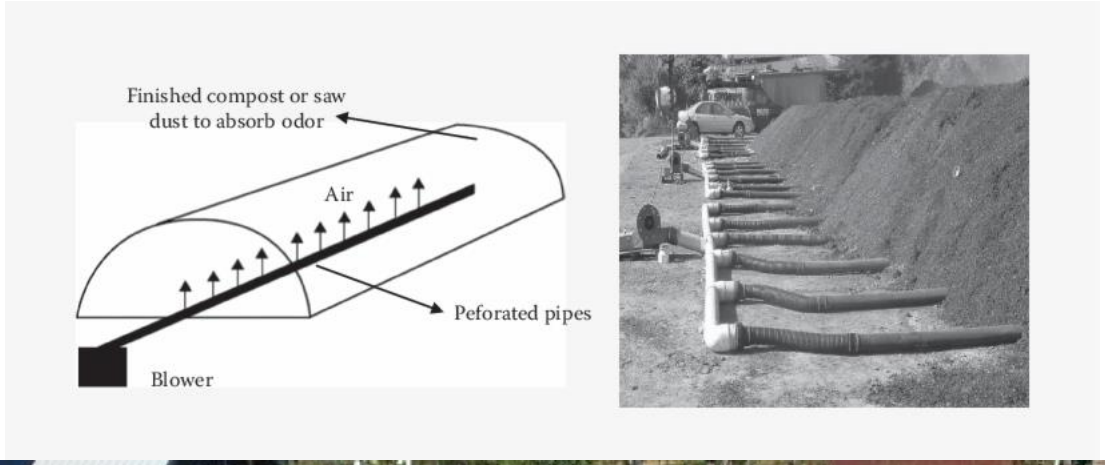

Compost facility
4 Active composting area
5 Curing area
surface water pond
water tank
Feedstock preparation area
3
shredding, mixing, watering / dewatering
6 Final screening area
spare buffer bay
guard room
GARAGE
2
Green waste drop-off bays
reject / contaminant containers
7
Finished product bays
SITE ENTRANCE
SITE EXIT
1

Cooks Landfill Antigua
Source Segregation of Green Waste pilot project
Aerated Static Pile Composting - Equipment and installation example

Aerated static pile composting is a method of delivering oxygen into the composting pile via a blower connected to perforated pipes running through the base of the pile. This reduces the need for mechanical turning of the pile and, if moisture levels are properly regulated, can speed up microbial decomposition. This is suggested for Antigua given the shortage of mechanical equipment / absence of windrow turner. The system is also very compatible with the windrow covers provided to NSWMA by the project.

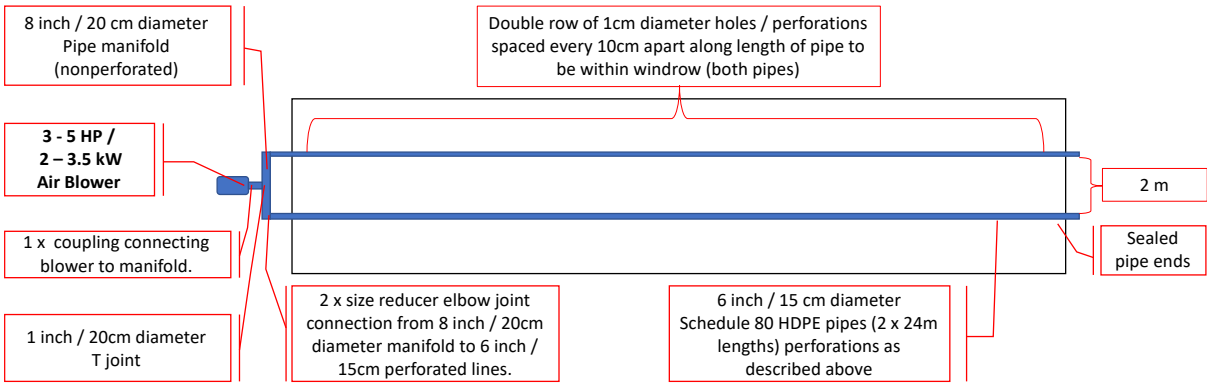
The concept is to build the windrow over a perforated pipe attached to which an air blower pushes air (oxygen) through the pipe and into the pile periodically (typically a few minutes of air flow every few hours is sufficient). The following videos and diagrams illustrate the basic concept.

Covered Aerated Static Pile Composting (India): https://youtu.be/1LHgDW4jeSc
Introduction to Aerated Static Pile Composting (USA): https://youtu.be/UjsAXYbNgxY

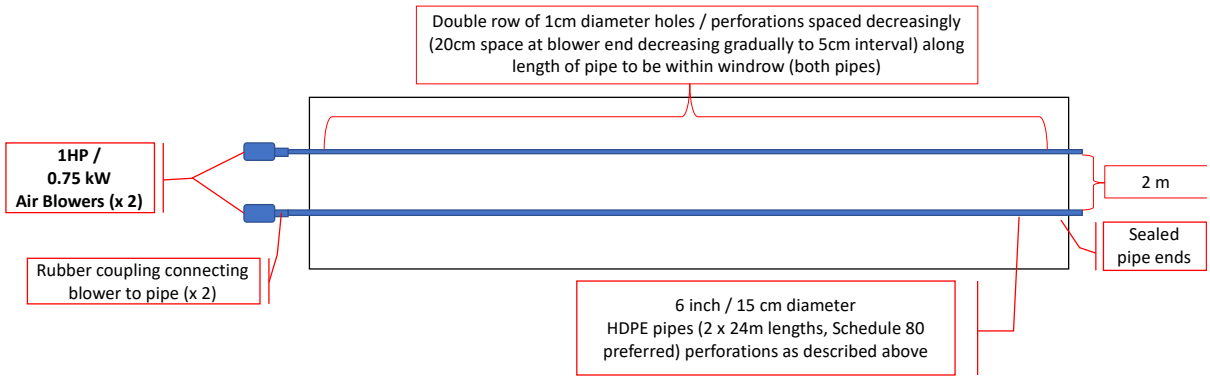


The windrow piles in Antigua are built to 20m long by 4 to 5m wide. This size is dictated by the size of windrow covers provided. The aeration setup should be constructed to fit the same size.

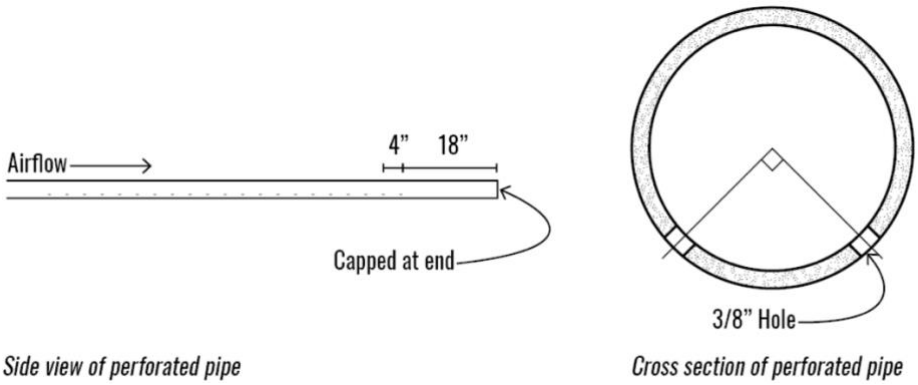
Several options exist, but the capacity of air blower is the ultimate deciding factor. Due to the length of the windrow (20m) and the drop in air pressure within a perforated pipe of that length, the options are to have one larger blower (up to 3.5 kW / 5HP) feeding two 24m long pipes from one end of the windrow, or to have two smaller blowers (750 watt / 1HP) feeding one 24 m long pipe each. The following diagram illustrate these two options. **Note**: that larger air blowers of 3 to 5 HP will require 3 phase industrial power and associated timer and electrical infrastructure. 1 to 2.5 HP air blowers are more common and run off domestic power supply.



Option A: One larger blower feeding 2 x 24m long perforated pipes. Benefit being only one blower.



Option B: Two smaller blowers, located at one end of the windrow feeding 2 x 24m long pipes each. Benefit being cheaper capital cost and more readily available, lower powered blowers.



Side view of perforated pipe *Cross section of perforated pipe*

A double row of 1cm holes are drilled in the Schedule 80 HDPE pipe to be located under the composting material. Holes are located on the underside of the pipe as illustrated in above diagram. Holes are spaced 10cm apart along the length of pipe to be located under the composting material. Alternatively spacing can start at 15 to 20 cm intervals nearest the blower (where pressure is greatest) and reduce gradually to 5 to 10 cm intervals furthest from the blower (where pressure is lowest). This is particularly recommended if Option A (24m pipe length) is used with a medium sized blower (3 to 4 HP).

All pipe connections must be sealed to prevent air loss and strong enough to maintain air pressure within pipes without the seal blowing out.

Any reasonable quality air blower as used to inflate bouncy castles or in swimming pool / hot tubs will provide sufficient air. In addition, a suitable rubber coupling (size reducing or increasing) is required to provide flexible connection of the blower to the manifold pipes. A timer is also required to automate blower timing. Timing will depend on the ambient humidity and temperature, type and size of materials, moisture level in compost etc and will require to be adjusted to optimise. However, typically between 1 and 5 minutes per hour or 15 minutes twice per day is sufficient.

Example air blower, rubber coupling, and digital timer.

The following are example products that would be typical for a basic aerated static pile composting system.

1.2 HP Air Blower: https://www.amazon.com/dp/B095PNQ35Z

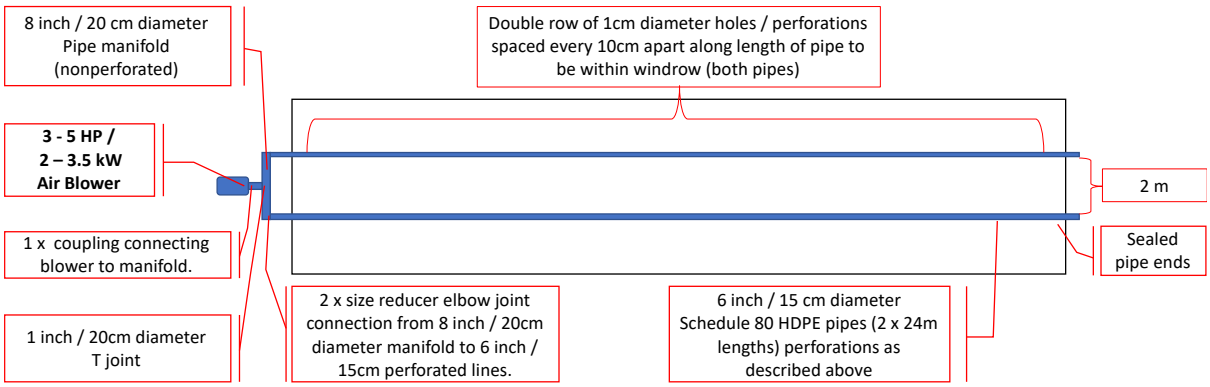
3 HP Air Blowers:
https://www.amazon.com/dp/B07VPW9TKQ
https://www.amazon.com/Air-Supply-41281002-Cyclone-Horsepower/dp/B004BNR5DC

Outdoor timer https://www.amazon.com/dp/B08GQGM6CR

Alternatively, Pre-engineered aerated static pile kits are available from:
https://www.compostingtechnology.com/pre-designed-asp/

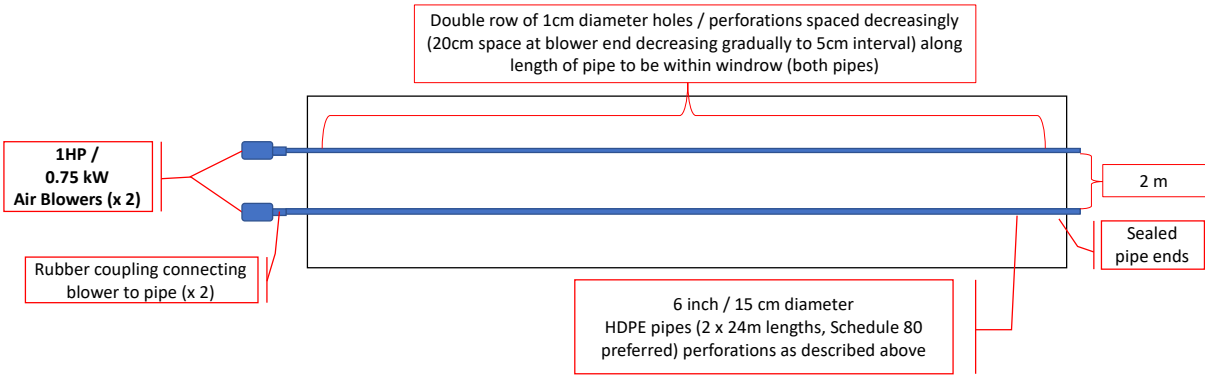
Indicative material lists and prices for converting a single windrow pile to basic Aerated Static Pile system.

Option A: (HDPE pipes can be substituted with PVC pipes, but PVC is more likely to be damaged when removing and replacing composting material)



Unit	Number of units	Typical unit price	Total price
3 – 5 HP / 2 – 3.5 kW Air Blower (appropriate electrical voltage for available supply)	1 piece	700	700
Rain cover for Blower	1 piece	50	50
Outdoor Heavy Duty Digital Programmable Timer (appropriate electrical voltage for supply and blower)	1 piece	50	50
Rubber coupling (sized specific to connect air blower outlet to manifold T junction pipe)	1 piece	10	10
Manifold T junction (sized to connect blower rubber coupling and manifold 8-inch pipe)	1 piece	10	10
Manifold HDPE pipe (8-inch diameter)	2 m length	25	40
Manifold elbow joints (with size reducer from 8-inch diameter manifold pipe to 6 inch air distribution pipe diameter)	2 pieces	15	30
Air distribution pipes (**6-inch diameter,** HDPE pipe (preference schedule 80, not DWV (drainage, waste & ventilation)) (with sealable joints)	48 m length	15	720
1cm diameter drill bit (for plastic) to drill air hole perforations along pipes as per described alignment. (Assumes drill is available)	2 pieces	5	10
Sealable **pipe end caps** for 6-inch diameter pipes)	2 pieces	15	30
TOTAL			**1,650 USD**

Option B: (HDPE pipes can be substituted with PVC pipes, but PVC is more likely to be damaged when removing and replacing composting material)



Unit	Number of units	Typical unit price	Total price
1 HP / 750 W Air Blower (appropriate electrical voltage for available supply)	2 pieces	200	400
Rain cover for Blower	2 pieces	50	100
Outdoor Heavy Duty Digital Programmable Timer (appropriate electrical voltage for supply and blower)	2 pieces	50	100
Rubber coupling (sized specific to connect air blower outlet to manifold T junction pipe)	2 pieces	10	20
Air distribution pipes (**4 or 6 inch diameter,** HDPE pipe (preference schedule 80, not DWV (drainage, waste & ventilation)) (with sealable joints)	48 m length	15	960
1cm diameter drill bit (for plastic) to drill air hole perforations along pipes as per described alignment. (Assumes drill is available).	2 pieces	5	10
Sealable **pipe end caps** for 4 or 6 inch diameter pipes)	4 pieces	15	60
TOTAL			**1,410 USD**

Recommended steps to enabling sustainable green waste diversion from landfill

1. Identify the main green waste producers to be approached in the first instance.

   Major producers to be targeted first in Antigua includes Antigua Public Utilities Authority (APUA's) vegetation clearance operations under power lines and water treatment locations. Garden services companies that currently dispose homogenous waste loads at Cooks Landfill. Hotels and resorts that don't have their own composting facility.

2. Information, Education and Communication campaign

   One of the most important aspects that requires long-term sustained activities. Sensitize the target waste producer of the need and reasons to divert green waste from landfill, the need for segregating green waste and the plans being established to impose a ban of landfilling homogenous vehicle loads of plant materials and imposition of a gate fee for mixed loads containing plant materials mixed with other wastes going to Cooks Landfill. Communicate the requirement for garden service companies to become licensed by Antigua National Solid Waste Management Authority (NSWMA) to be green waste haulers and users to only use licensed companies.

3. The Government of Antigua and Barbuda should consider establishing a small grants programme or tax relief to assist entrepreneurs (particularly garden services companies) invest in green waste shredders and equipment. Grants to be offered to companies that successfully become licensed by NSWMA as green waste haulers (optional step).

   Such assistance enables small garden services companies to offer a higher value of service which has wide reaching environmental, social as well as financial benefit to the wider society. The initial financial cost to government of supporting these grants/tax relief must be weighed up and off set against these wider societal benefits.

4. NSWMA to work with key stakeholders to identify potential service providers and composting facility locations, conducting pre-selection of sites that meet composting facility licensing and Environmental Impact Assessment criteria.

   An interim solution is to utilize an area within the Cook's landfill area for initial composting activities. However, in the long-term, it is important to establish clear licensing conditions for composting facilities to be able to operate and only license facilities that meet those standards. This prevents legitimate operators that serve the wider societal benefit and invest time and finances into their operation from being undercut and losing business to rogue companies that cut financial corners to the detriment of the environment and society.

5. NSWMA / APUA Tender and award contracts (minimum 1 year) for bush clearing / treatment services to include condition that material is shredded on site and composted in a licensed facility.

   Government and large agency procurement and contract management systems are important opportunities that enable government to clearly specify goods/services that are beneficial to society without the need for law amendments or grants. Contracts are currently awarded by the

Government of Antigua and APUA for vegetation clearance which generate large quantities of material that currently go to landfill which ultimately cost society to manage. In procuring services that mandate licensed contractors and composting of cleared vegetation, this stimulates the commercial sector to invest in composting operations and divert green waste from landfill without requiring additional regulations. Once services are established through these means, the service can be built upon by introducing landfill bans for green waste from other producers as the alternative treatment facility has been established by the service providers.

6. Assist establish compost markets through government procurement of compost.

   Similar to step 5, the establishment of the commercial composting facilities can be assisted without grant financing or additional regulatory control through guaranteed government procurement of compost materials to be used in applications that have wider societal benefit. This is in particular useful in the start-up phase when the operator requires to gain experience to produce good quality compost and mulch. NSWMA requires substantial volumes of compost material to use as cover material at Cook's Landfill, Plantation Landfill and other waste sites requiring rehabilitation. Establishing a guaranteed rate and quantity of compost procurement provides the compost operator with incentive and security to invest in producing the material. Output to be procured can include:

   1. Low grade compost (including ditch and road verge clearance with heavy metal contamination) purchased by NSWMA for landfill cover (this could be mixed with shredded tyre wastes to provide a robust and resilient cover on the landfilled waste).

   2. Medium grade for mulch, for agriculture and plant nurseries.

   3. Fine grade compost for beautification projects.

7. Apply a high gate fee on green waste (that subsidizes composting operation / contract) with a higher fee for loads containing mixed green and other wates with the eventual aim to ban green waste from going to landfill.

   Incrementally introduce fees and ban as government and large agency procurement systems assist the establishment of composting facility and facilities gain experience and capacity to accept more clients and materials. Ultimately, without a well enforced ban or fee for landfilling that is more than the cost of composting, the producers will default to the lowest financial cost option, which should not be dumping or landfill.

8. Enforce ban and illegal dumping

   To ensure item 7 has the required impact of stimulating composting facility use, there is a vital need to prevent illegal dumping and heavily punish offenders to ensure green waste producers utilize the composting service.

8. Resorts and Householders see garden services chipping service as cheaper than landfill gate fee / ban and engage service providers. NSWMA shall require and enforce resorts and households etc. to prove they manage their waste responsibly (i.e. by having contract with licensed garden service provider or evidence of on-site composting facility).