

A DIY GUIDE
TO
PHYTOREMEDIATION
GARDENS



PARTNERS, COLLABORATORS & SPONSORS



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GUIDE

OVERVIEW

A Do It Yourself (DIY) Guide to Phytoremediation Gardens provides a step by step manual illustrating the process of creating a Phytoremediation garden at home to remove and reduce toxins in contaminated soils. The guide demonstrates the process of planting, monitoring, caring, testing, harvesting and disposal.

The purpose of this guide is to step you through each stage of the process, allowing you to learn, educate and create your own Phytoremediation Garden in the hope of greater restoration and awareness.

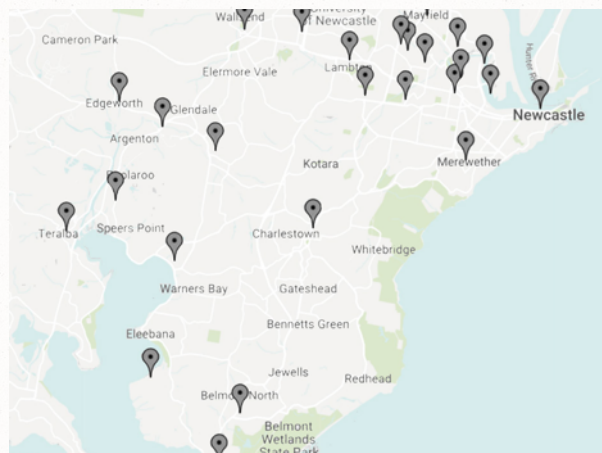


The Importance of

PHYTOREMEDIATION

In 2020 there were 1,805 notified sites in NSW found to have toxic soil (Epa, n.d.). Approximately 10% of these contaminated sites are in the Hunter Region and around Newcastle's older suburbs (Kelly, 2012). Contaminants do not degrade, posing long-term threats to the environment and our health. Current remediation techniques are not sustainable and are a short-term fix to this issue.

Phytoremediation is a term used to describe the process of using plants to remove pollutants from the environment. Phytoremediation is a passive remediation technique that involves growing plants in a contaminated matrix to remove, stabilise or break down environmental contaminants within a plants tissue (Alberto, 2013). This technique provides a sustainable solution to remediating and improving soil quality.



Map of toxic sites Newcastle, NSW

SOIL SAMPLE

Firstly, your garden soil will need to be tested, allowing you to identify specific toxins on your site. A variety of toxins may be present in the soil.

TOOLS REQUIRED:

5 x ZIP-LOCK BAG



MARKER



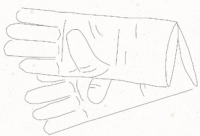
TROWEL



1

Locate a soil testing service. Below is a list of some recommended services:

- The PhytoLab, Broadway, NSW. UTS: School of Life Sciences
<https://thephytolab.com/what-we-do/>
- Macquarie University, Sydney NSW. - VegeSafe Program
<https://research.science.mq.edu.au/vegesafe/how-to-participate/>



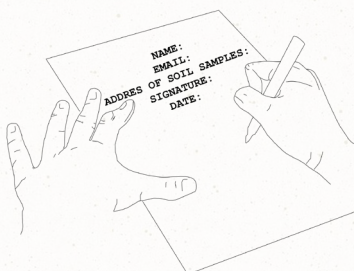
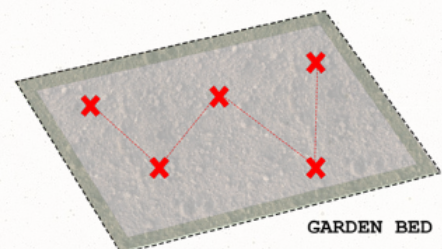
2

Wear gloves, dusk mask, long pants, and a long sleeve to protect yourself from possible toxins.

3

Select approximately five areas to take samples from. Taking multiple soil samples allows for variations in the data.

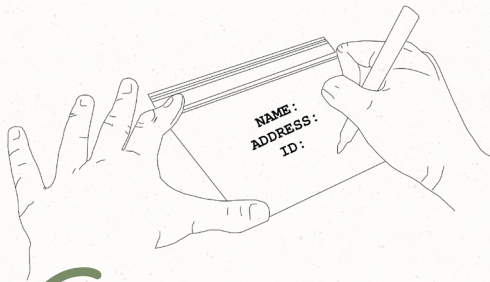
Sample areas should be spread evenly across your garden and in a zig-zag formation.



4

Fill out the consent form from the company that is testing your soil.

SOIL SAMPLE

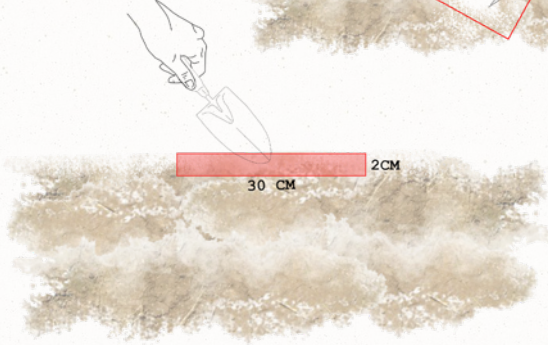
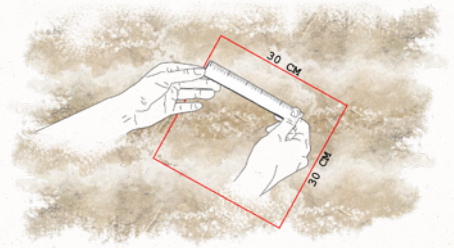


5

Label the five plastic bags with your name, address, date, and sample ID (matching the consent form: "Front Yard, Back Yard, Veggie Patch 1" etc.

6

Dig into your first location and collect the top 2cm of soil over a 30 x 30 cm area. The samples need to be clean from gravel, rubbish, grass, etc.

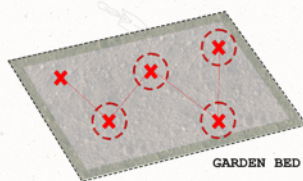


7

Place soil samples of approximately the size of a cricket ball into the correctly labelled sealable plastic bag.

8

Clean tools before next sample to stop cross-contamination.

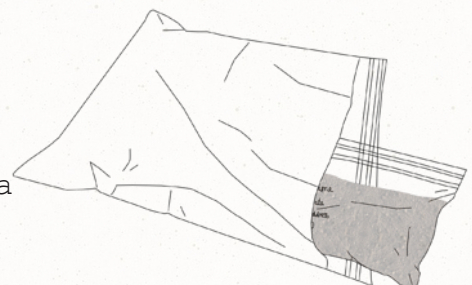


9

Repeat for the remaining four locations

10

Place your form and samples into a mailing satchel or small box and post. Reports can take up to five-weeks.



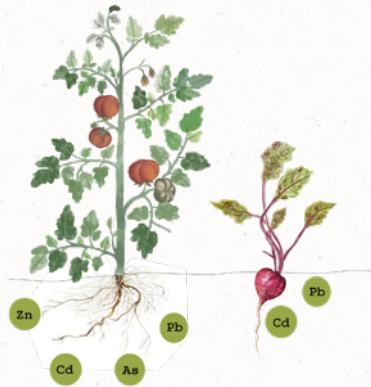
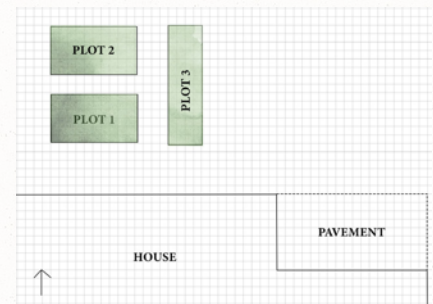
DIY DESIGN

GARDEN PLAN

After receiving the test results a remediation plan can be created based specifically on the toxins identified on your site. The toxins being drawn out is specific to the plant, therefore, plants should be chosen that can take out toxins that have been identified in your lab report. Below is a list of Phytoremediation plant species and what toxins they absorb, allowing you to identify suitable plants and how many are required.
(PROVIDE WEBSITE LINK)

1

Create a rough plan highlighting where your garden will go. Include where your home sits and any existing structures. Also mark the direction of the sun, allowing you to determine the sunny and shady areas of your garden.



2

Identify plants from the website that will absorb the toxins present in your soil.

3

Research plant species selected, allowing you to understand the growing conditions of each plant. It is also recommended to take your plant list and sketch design to a local plant nursery to identify suitable plants and advice on appropriate spacing and placement.

Thyme x6	Sweet potato x7	Basil x10	Tomatoes x10
Spring onion x30	Sunflower x8	Chives x30	Silverbeet x20

4

Map your final plant species onto your garden plan.

5

Purchase seedlings and plants.



DIY DESIGN

GARDEN PREPARATION

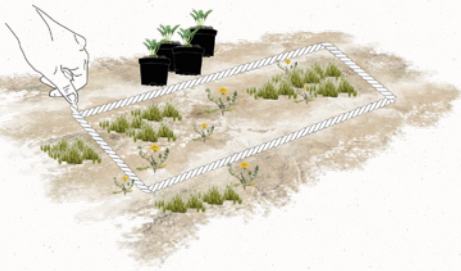
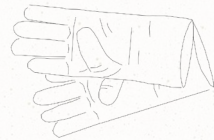
The aim of a Phytoremediation garden is to remove toxins, please do not add or remove soil from your site.

TOOLS REQUIRED:



1

Wear gloves, dust mask, long pants, and a long sleeve to protect yourself from possible toxins.

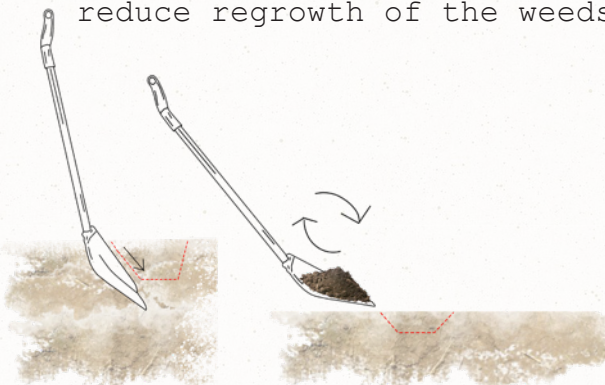
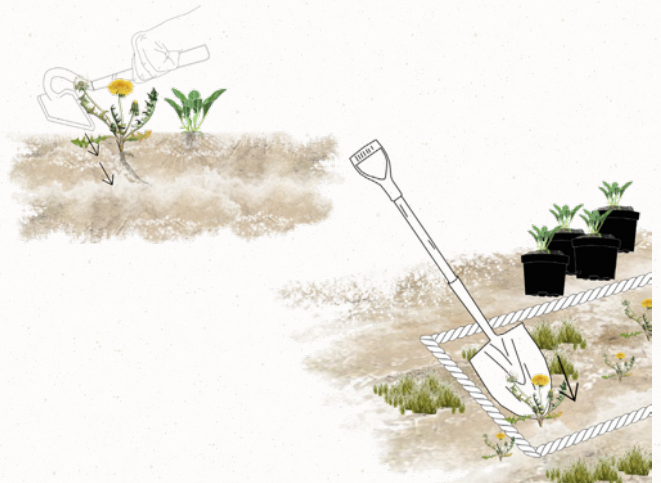


2

Mark out your garden beds with a flexible material.

3

If your beds have existing lawn or weeds remove them by digging up the garden beds with a shovel or garden hoe. Ensure you clear the soil to reduce regrowth of the weeds.



4

Work the soil to improve water and air penetration, digging it up at approximately half a shovel in depth.

5

Form the soil into beds by building it up and raking the soil evenly across the surface.

Beds can be raised using a shovel to form natural mounds or garden edging can be applied.



PLANTING

To ensure your Phytoremediation garden thrives make sure to plant in the correct season. To start planting follow the steps below:

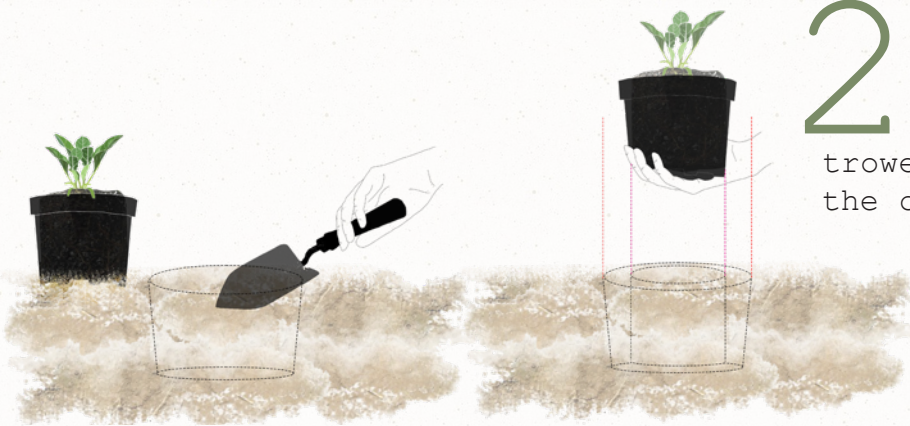
TOOLS REQUIRED FOR PLANTING:



1 Roughly map out where each plant will go by placing them on top of the soil, this will also allow for more accurate placement. To undergo toxin testing plants are removed, therefore, plants can be placed more densely.



2 Loosen up the soil with a trowel. Dig a hole as deep as the container the plant is in and twice as wide.



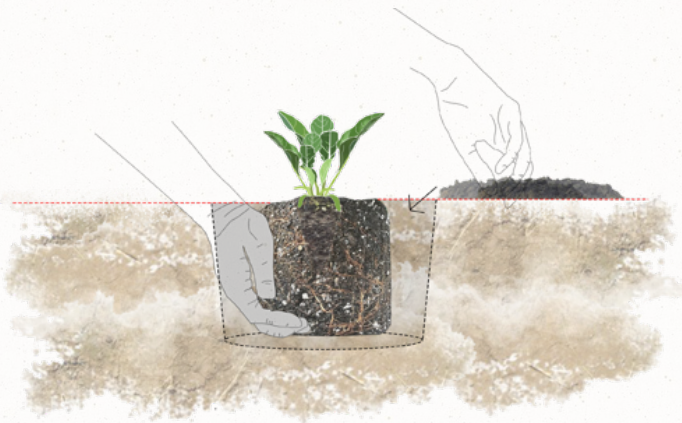
3 Remove the plant from the container by turning the pot upside down and gently tapping the bottom of the container. If the plant does not slide out gently squeeze the sides to loosen the soil from the pot. Gently hold the base of the stem in one hand and the other around the roots, try to keep as much potting mix around the roots.



PLANTING

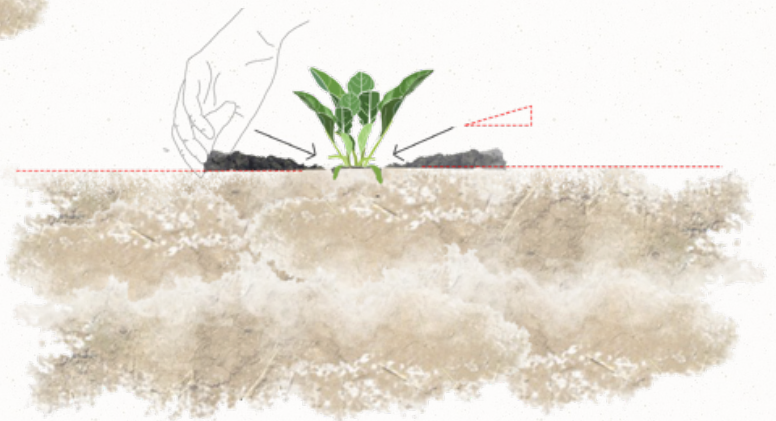
4

Place the plant into the hole, use one hand to hold the plant into an upright position. Check the depth of the hole is correct by lining up the plant soil with the existing soil.



5

Holding the plant in one hand gently move the soil backfill into the hole. Make sure the top of the potting mix is level with the surrounding soil.



6

With hands create a small slope with the soil forming towards the plant, this allows water to flow towards the plant not away.

7

Continue steps for each plant.

PLANTING

SEEDS

Depending on the plant selected some may be purchased as seeds.
Below lists the steps to sow seeds:

1

Most seed packets will come with steps stating planting depth. Follow the instructions listed. A general rule is to plant at a depth equal to three times the seed diameter.



2

Once depth is determined use your index finger to create a hole of the required depth. If the soil is hard you may use a bamboo stake or dibber to form individual holes.

3

Drop the seed in the hole. Use hands to gently move soil over the hole.



4

Repeat the process for all seeds.

PLANT CARE

WATERING

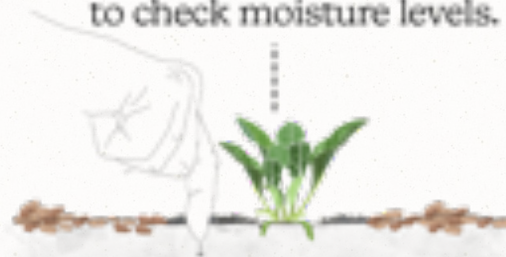


HOW DO I KNOW IF MY PLANTS NEED WATERING?

Pull back mulch until the soil is exposed.



Insert index finger into the soil to check moisture levels.



Does the soil have moisture?

YES

Your plants don't require watering.

NO

Your plants need water !

Follow the 'How To' Guide

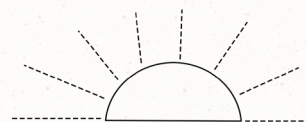
PLANT CARE

WATERING

1

HOW?

The best time to water your plants is in the early morning, while it is cool. This allows water to reach the roots of the plants without water lost to evaporation.



ROOT ZONE

2

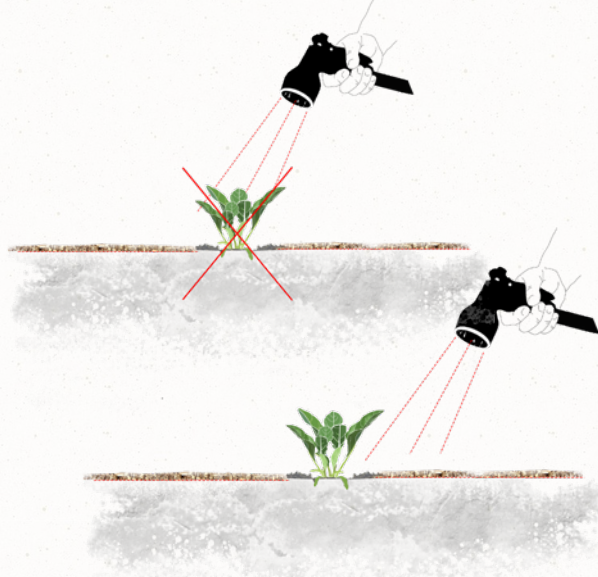
HOW MUCH WATER DO MY PLANTS NEED?

Plants with larger root zones require more water. Your plants will be healthy if you completely wet the root zone each time you water. The root zone falls beneath the outer edge of the plant's canopy. As a general rule water each plant for 20-30 seconds. The soil should be damp not soggy.

3

HOW DO I WATER MY PLANTS?

Set your hose to a gentle setting such as 'shower'. Do not stand directly over the plant as direct watering can cause damage. Ensure you are directing the water towards the root zone of the plant.



4

HOW DO I KNOW IF I HAVE WATERED ENOUGH?

An easy way to test the soil moisture is by pushing a soil probe into the soil an hour after watering. The probe should be able to slide through the soil. If it is difficult to push through your plants require more water. Water your plants until you can easily slide the probe into the soil.



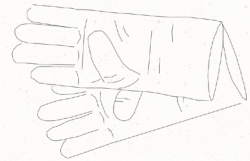
PLANT CARE

WEEDING

Weeding is important to ensure a healthy garden, it is crucial to weed in the early stage as weeds compete with seedlings for nutrients and water.

1

Apply gloves, long pants, and a long sleeve shirt. If possible weed when soil is damp, as soils are loose, making removal easier.



2

EARLY STAGE: Weed by hand by gently pulling the weed near the soil. It is important to gently pull the weed from the soil to ensure the plants roots around the weed remain undisturbed. If you are unsure if it is a weed or not let it remain until you can clearly determine the plant.



3

LATE STAGE: Mature weeds will form as the garden develops overtime. They can be removed placing the blade of the garden hoe next to the stem. Press down on the tool vertically and tilt the tool, until you can pull the whole weed out. Less precaution is required at this stage as there is a low chance of damage to the plants root system. Ensure you dig out the whole root to stop regrowth.



4

Dispose of all weeds to stop regrowth.

PLANT CARE

GENERAL HEALTH

Below identifies steps to maintain a healthy garden:

1

DISEASES: To maintain a healthy garden requires understanding of possible diseases that may occur and why. GrowVeg provides detailed information about identification, symptoms, management and prevention of plant diseases. It is recommended to follow this guide if you see concerning changes in your plants.

Click on the link for more information:

<https://www.growveg.com.au/plant-diseases/australia-and-nz/>

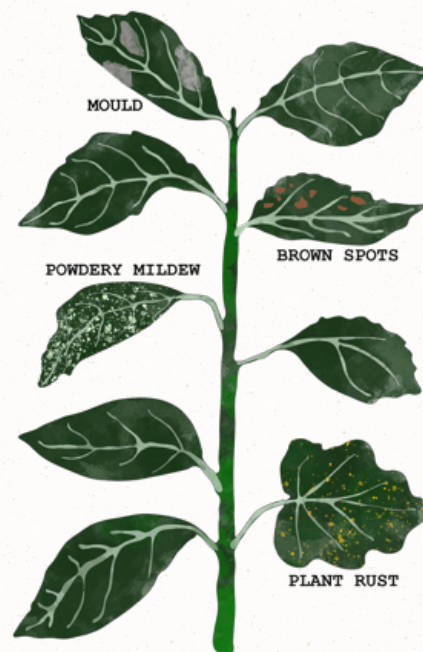
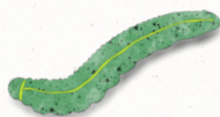


Diagram of possible disease symptoms



2

PESTS: Pests can impact your garden by damaging foliage and the overall health of your plants. GrowVeg also provides a guide to help you identify pests and how to prevent them naturally. In addition, this website supplies an identification guide of beneficial insects and how to encourage them into your garden.



Diagram of Caterpillar damaged foliage.

Click the links for more information:

<https://www.growveg.com.au/pests/australia-and-nz/>

<https://www.growveg.com.au/beneficial-insects/australia-and-nz/>



Caterpillar prevention example:
Planting blooming herbs

TOXIN UPTAKE

How do I know if my plants are cleaning the soil?

Your plants require testing to know if they are absorbing contaminants, as most plants concentrate contaminants within their roots, therefore, signs of contaminant uptake cannot be visually seen.

However, high contamination uptake can be associated with signs of plant distress, such as, leaf edge death or darker patches.

If in doubt, always send your plants for testing (Murray, n.d.).

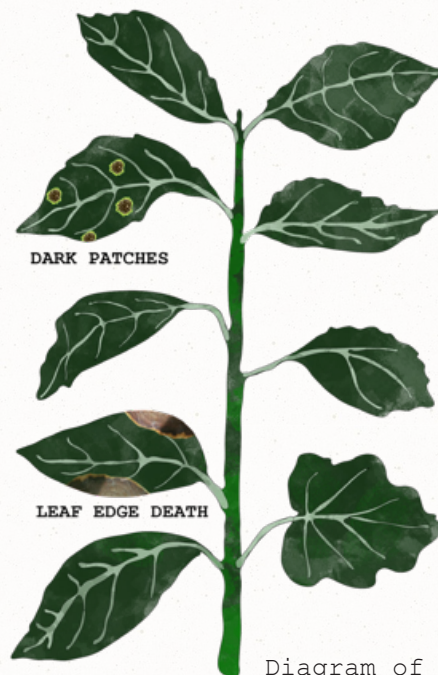


Diagram of contamination uptake signs

Your plants can be harvested at any time to be tested. As a general rule, it takes approximately a month of growing in contaminated soil for plants to absorb contaminants.

Follow the instructions in 'Sampling' to prepare your plants for testing.



SAMPLING

Sampling provides data on plant toxin uptake. The following steps are based upon small to medium shrubs and will vary if sampling large plant species.

TOOLS REQUIRED:

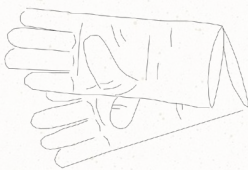
ZIPLOCK BAGS + MARKER
PAPER BAGS



1

Locate a laboratory that tests for heavy metal contamination. Below is a list of recommended testing services. The steps below may vary depending on the testing service you select.

- The PhytoLab, Broadway, NSW. UTS: School of Life Sciences
<https://thephytolab.com/what-we-do/>
- EnviroLab Services, multiple branches across Australia
<https://www.envirolab.com.au/>



2

Wear gloves, dust mask, long pants, and a long sleeve to protect yourself from possible toxins.

3

Determine what plants and how many you are going to sample.

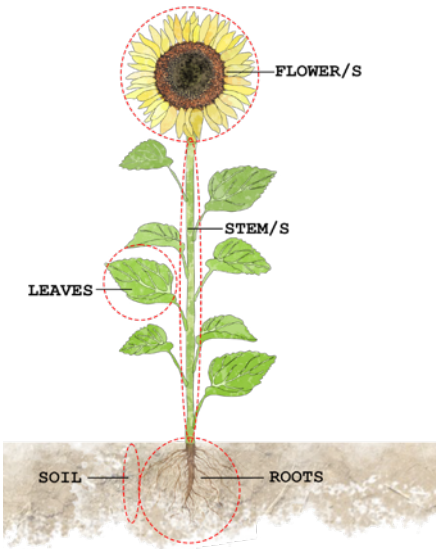
As a general rule aim for 3-5 plants from each species. Testing is determined on plant mass, therefore, the smaller the plant, the more samples required. For small shrubs and herbs aim for 5 plant samples.



SAMPLING

4

Create a document/spreadsheet to list plant features. Include plant height, leaf count, leaf thickness, number of flowers, and other observations.



5

Label paper bags and plastic bag (for soil) with your name, address, date, plant number and sample ID. A sample ID is the section of the plant. You should have a stem, leaves, roots, soil and possible flowers or fruit.

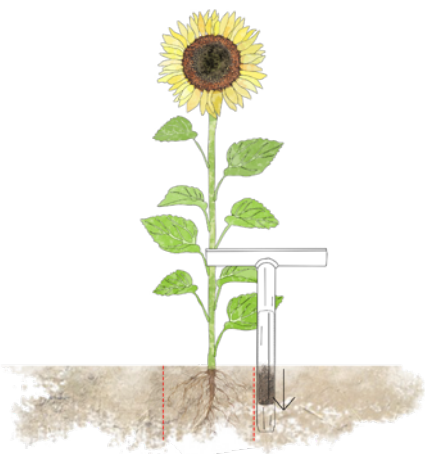
6

Measure the height of the plant using a tape measure. Write this down in your spreadsheet under "Height".



7

Using a soil probe or trowel, take a soil sample of your first plant. Collect soil in the root zone of the plant. The soil should fill a quarter of a standard zip-lock bag. Always collect more soil if you are unsure.



8

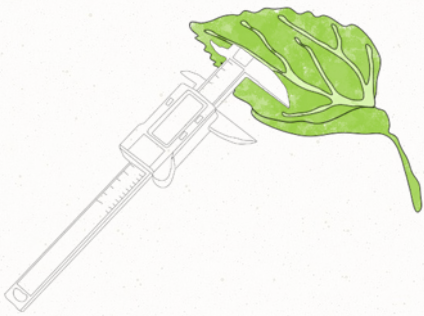
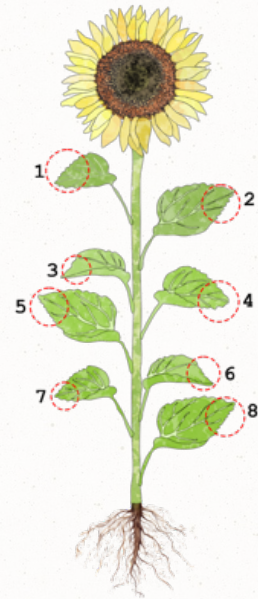
Hold towards the bottom of the plant and gently pull it from the ground. Be careful with this process as you want to ensure the roots stay attached to the plant.



SAMPLING

9

Count how many leaves the plant has and note them on a document or spreadsheet under "Leaf Count".



10

Measure the thickness of any four leaves using a Caliper. Slide the caliper onto the leaf diagonally and close the teeth. Note this down under 'Leaf Thickness'

11

Pull the leaves from the plant and put them in the paper bag with the sample ID labelled 'Leaves'. Fold the top of the paper bag to secure the leaves.



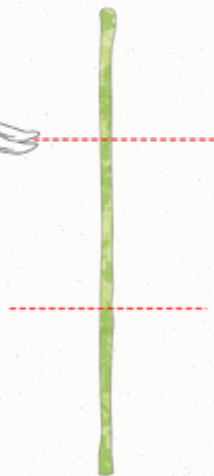
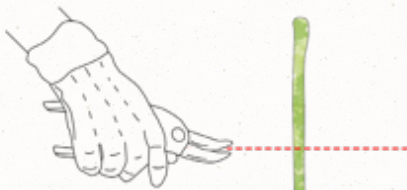
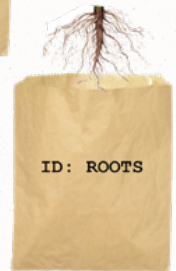
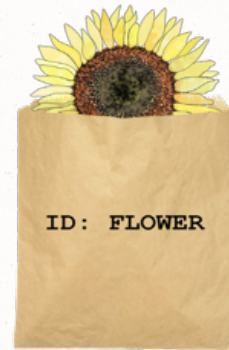
12

Using secateurs cut the plant into parts. If the plant has flower/s cut where the flower joins to the stem. Following the same process cut where the roots join the stem.

SAMPLING

13

Place the flower/s into the paper bag labelled 'Flower' and the roots into the bag labelled 'Roots'. Fold the tops of the bags.



14

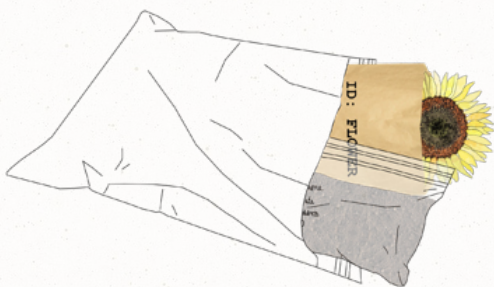
If the plant is tall the stem may not fit into the sample bag.

Depending on the stem size use secateurs to cut it into even sections and place into the bag labelled 'Stem'.

Fold over the top of the bag.

15

Repeat steps for all plants being sampled.



16

Place the samples into a mail satchel or box and post. Reports

can take up to five weeks.

HARVESTING AND DISPOSAL

After the remediation process the plants become saturated and cannot absorb anymore toxins. As some plants may hold the toxins in their tissue they require removal and disposal. If the plants are left to die in situ the contaminants will return to the soil. Therefore, plants must be harvested and disposed of as they begin to wilt and finish their growth period.

Contact a hazardous waste disposal contractor to test the plants. They will undergo a toxicity characteristic leaching procedure (TCLP) to identify toxin levels within the plant. If the test is positive you will have to dispose of the plants through hazardous waste services. If the test is negative your plants can be composted safely (Brownfields to Greenfields, n.d.).

Below is a list of services around Newcastle that dispose of hazardous waste:

Cleanaway Waste Management, Kooragang NSW

<https://www.cleanaway.com.au/waste/contaminated-soil-pollution-remediation/>

SEUZ Hunter, Mayfield Nsw

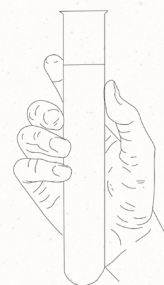
https://www.suez.com.au/en-au/who-we-are/suez-in-australia-and-new-zealand/our-locations/nsw/hunter?utm_source=Google&utm_medium=Business&utm_campaign=BG-Listings



Perennial plants continue to grow



Harvest wilted plants



TCLP Test

BIBLIOGRAPHY

Alberto, A. (2013, March). Phytoremediation: A Green Technology to Remove Environmental Pollutants. Retrieved from: <https://www.scirp.org/journal/paperinformation.aspx?paperid=29110>

Brownfields to Greenfields. (n.d.). Retrieved from: https://www.youarethecity.com/pdf/fieldguide_youarethecity.pdf

Epa, NSW. (N.d.). List of Notified Sites. Retrieved from: <https://www.epa.nsw.gov.au/your-environment/contaminated-land/notified-and-regulated-contaminated-land/list-of-notified-sites>

Kelly, M. (2012, January 8). Hunter's Toxic Hot Spots. Retrieved from: <https://www.newcastleherald.com.au/story/441723/hunters-toxic-hot-spots/>

