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Protecting Tree Roots at the Morris Arboretum

Title: Protecting Tree Roots at the Morris Arboretum

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Abstract:

Trees need healthy roots to grow and thrive. Keeping them in good condition is necessary. The health of the specimen is directly linked to the soil conditions in which the roots of the tree are growing. Ensuring that a set of guidelines is in place with the goals of preventing damage from occurring in the first place is necessary and exploring methods to undo any root damage that has already occurred will help protect the Arboretum's trees in the future. Creating educational material that can be distributed online to Arboretum staff and the public will help educate a wide range of people on how they can prevent root damage. Additionally, performing and documenting work done, such as using air tools to de-compact soil and expanding mulch rings to prevent soil compaction, will demonstrate methods that improve root growing conditions and can be easily implemented. Allowing tree roots to grow properly is essential to keeping the specimens in the Arboretum beautiful and healthy for years to come.

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INTRODUCTION

The Morris Arboretum has one of the best and most expansive collections of plants in the area and maintaining the health of the specimens is a matter of utmost importance. The roots of a tree are its connection to the world around it, anchoring it in place and allowing the plant to take in all the water and nutrients needed to grow so it can be enjoyed by the Arboretum's visitors and employees alike. Over time, areas of the landscape have become sites where tree roots do not exist in optimal growing conditions due to soil issues such as compaction and erosion. Working with the goals of improving soil conditions and preventing any more damage will help ensure that all Arboretum specimens remain in excellent condition. Methods such as using an air tool to de-compact soils and increasing the size of mulch rings must be implemented to reverse any damage that has already occurred and to prevent any more from happening. An important step in avoiding more damage is creating easy to understand informational material that can be used by members of the public as well as members of the Arboretum staff. A great way to ensure that staff members are better educated on root health is to show a short slideshow presentation once a year to all employees that emphasizes preventative measures so fewer issues arise in the first place. In addition to a presentation for staff members, publicly available information that illustrates the importance of tree roots and how to protect them will help teach people ways to shield roots from harm. As one of the premier horticultural institutions in the world the Morris Arboretum must be a place where trees, shrubs, and herbaceous specimens can grow in an ideal environment to be used as an example of how plants look when properly cared for.

PROJECT GOALS

There are two primary goals of this project: to improve the health of the trees and shrubs in the Morris Arboretum by focusing on the conditions in which root systems exist, and to create informational material that can be used to educate any person, regardless of horticultural or arboricultural knowledge, on how to avoid damaging tree roots and how to help improve root growing conditions. Using equipment such as an air tool to de-compact soil and increasing the amount of mulch used around trees, either expanding the existing ring or adding a ring to trees without one, are examples of how improving conditions will be achieved. To accomplish the goal of providing educational material that emphasizes root health and protection, a short slideshow presentation will be made for staff use, and online informational pages as well as an article in the Arboretum's *Seasons* magazine will be publicly available to anyone that wants to learn more about the importance of roots. Addressing root growth issues in the Arboretum is an important step in keeping the specimens healthy and creating informational materials for public and staff use on how to prevent root damage will ensure that trees and shrubs anywhere thrive for years to come.

BACKGROUND

Soil is a living ecosystem that provides all the nutrients plants need to complete their lifecycle and must be managed to ensure that it is usable in the future so plants can continue to grow well. Each different nutrient helps plants grow in a specific way: Nitrogen (N) helps with vegetative growth and chlorophyll production, Phosphorus (P) benefits root growth and disease resistance, and Potassium (K) helps plants with flowering and fruit production. Nutrients in the soil must be in an available form for plants to use as many of the chemicals needed to sustain plant life are scarcely available due to the chemical interactions between the soil and nutrient particles. Due to the three major nutrients plants require (N, P, K) being strongly bonded to soil particles symbiotic relationships between roots and other organisms, such as a fungus called mycorrhizae, are important factors in making soil nutrients more readily available. Soil nutrients are very hard for plants to acquire “phosphate is often immobile in soils, and mycorrhizae are able to make phosphate soluble in their immediate environment (Badawi 2010). Phosphate, other nutrients, and water are shared with the plant through the mycorrhizal relationship” (Chalker-Scott).

Having healthy soil is incredibly beneficial for plants as there will already be a large population of mycorrhizae, decreasing the likelihood of nutrient deficiencies occurring and ensuring that an outside source of mycorrhizal fungi is not needed. In addition to healthy soils having higher levels of usable nutrients due to fungal activity, certain plants like those in the genus *Carex* can improve nutrient availability for everything in the area with specialized roots that help make essential nutrients more available for use, making these plants incredibly beneficial to everything in the immediate area. ‘Cluster roots’ were first described in Cyperaceae by Renner (1935). The production of these specialized root structures in *Carex* is documented by Selivanov and Utemova (1969) who confused them for mycorrhizal structures. Lamont (1974, 1981, 1982, 1983, 1984) further defined the root type as ‘dauciform roots’ and characterized their ability to enhance nutrient uptake... Production of dauciform roots in *Lepidosperma* is induced by low availability of phosphorus and results in the production of elongated cells that release carboxylates in an exudative burst (Shane *et al.*, 2006). Carboxylates promote the release of soil-bound phosphorus (Shane *et al.*, 2005; Watt and Weston, 2009)” (Barrett). Soil needs to be cared for and treated properly to allow for the natural replenishment of nutrients that are necessary for tree roots to be able to grow well in the area.

Trees have different types of roots that serve distinct functions, providing physical support as well as taking in the water and nutrients necessary for growth. There are two major kinds of roots, woody structural roots and non-woody feeder roots, both of which are located in the top 6-24 inches of the soil and can extend two to four times the size of the tree’s crown (Sillick & Jacobi). Structural roots are large roots that increase in size annually, growing laterally out from the trunk of the tree and typically are found in the top 18 inches of soil sometimes growing deeper into the soil. Structural roots transport water and nutrients through the plant and anchor the tree in place, supporting it through all kinds of environmental stresses like windstorms and snowstorms. Feeder roots are small, fine roots that emerge from larger woody

roots, and have a very large surface area relative to their size, which allows them to take up the maximum amount water and nutrients from the soil immediately around them. These feeder roots are usually found within the top 12 inches of soil where they provide the tree with all it needs to grow. With adequate space and soil volume the root system of a tree can extend far out in the soil in search of all it needs to sustain itself in the future. All roots are crucial to the proper development of the tree, and any damage to roots within a certain area would be extremely detrimental to the health of the plant.

The critical root zone (CRZ) is a circle around the trunk of tree that corresponds to the dripline of the tree, where the most important structural and feeder roots are located and can be defined as one foot + one foot per inch of trunk diameter measured at four feet from the soil surface. Avoiding activities that cause soil damage in the CRZ is an extremely important concept that must be understood by all members of the Arboretum staff. Repeated pedestrian traffic, driving, and parking vehicles within the dripline of the tree causes soil compaction reducing the ability for the roots to take up water and nutrients and can even lead to death. “Soil compaction increases soil density. Roots are less able to penetrate the soil and are generally shallow and malformed. Because their growth is restricted, they are less able to exploit the soil for nutrients and moisture. Nitrogen and potassium deficiencies are the most common. This leads to additional fertilizer requirement and increases production costs.” (“Soil Compaction” 2020). Both financial and environmental costs will be decreased when improving and maintaining soil health are high priorities as it reduces the need for future work to restore growing conditions and reduces the amount of chemical fertilizer needed for proper plant growth. Damaging soil within the CRZ of a tree must be avoided by all employees and visitors to the Arboretum as it will ensure that no specimens are harmed while simultaneously reducing the Arboretum’s operating costs and climate footprint.

Soil compaction and erosion are issues impacting many places across the Morris Arboretum causing serious damage to the trees and shrubs and must be managed. Soil is a collection of particles varying in size with clay being the smallest diameter, sand with the largest size, and silt particles being between sand and clay. Together with organic and inorganic matter these aggregated particles make up the soil. In the soil there are pores, voids ranging in size filled with either air or water, that control drainage as well as the availability of oxygen and water. Erosion harms soil and is very detrimental to the land as well as any plants in the area. “Because most of the organic matter is close to the soil surface in the form of decaying leaves and stems, erosion of the topsoil significantly decreases soil organic matter. Several studies have demonstrated that the soil removed by either wind or water erosion is 1.3–5.0 times richer in organic matter than the soil left behind” (Zuazo & Pleguezuelo). Soil erosion strips the area of nutrient-rich topsoil and removes the medium that plants need for support during growth. When soil is harmed by erosion or compaction these incredibly important pore spaces are reduced in size or destroyed entirely, negatively affecting the soils ability to hold oxygen as well as its ability to retain and drain water. Activities that damage soil structure must be avoided whenever possible for the specimens located throughout the Arboretum to thrive now and in the future.

METHODS

Identifying areas around the Arboretum where soil compaction or soil erosion have occurred was done visually by identifying sites where the problems are easily observable or in areas where it is easy to determine that there is a large amount of vehicular/pedestrian traffic. In several areas of the landscape there are places where there is a combination of both erosion and compaction, these two problems typically occur together on slopes such as in an area just below the Widener parking lot. This area is a good example of how problems can escalate when one of them has been initiated.

Compacted soil formed by unnecessary repeated lawn mower traffic in an area with a small amount of sparse turf in a deeply shaded area created ruts in the soil surface. These ruts provide a channel for water, from rain or irrigation, to accelerate downhill picking up any soil particles on the surface and causing soil erosion. By washing away the surface soil in these channels, deeper ruts are subsequently formed making the depression more pronounced and creating a deeper channel that concentrates the waterflow, thereby increasing the amount of soil erosion that occurs in that area during rain/irrigation events. The soil that was washed further down the hill during the erosion process is then deposited in areas where it is unwanted, where it could be potentially smothering other plants, or up against the trunk of a tree increasing the likelihood of disease issues occurring. The tree roots where the soil has been eroded away are now exposed on the surface allowing them to be very easily damaged by pedestrians and vehicles, such as lawn mowers and golf carts. By identifying areas where there are soil compaction or erosion issues, the Arboretum can create a management plan to solve these issues that will reduce financial costs as well as environmental harm.

The most common causes of soil compaction and erosion at the Morris Arboretum are vehicle traffic and repeated pedestrian traffic. Different vehicles compress soil with different levels of severity when driven on non-paved surfaces. In general, the heavier the vehicle the higher the level of compaction that occurs. Soil compaction is commonly a precursor to erosion, initiating the process by creating ruts and channels where water from rainfall or irrigation accelerates as it flows, removing topsoil as it flows downhill. By managing compaction issues at the Arboretum, a large amount of the erosion problems will be handled, and future issues will be prevented. Across the Arboretum there are signs of compaction resulting from daily or near-daily traffic over the same area. "In order for roots to survive, oxygen must be available in the soil immediately surrounding them... This process is inhibited in fine textured (clayey), waterlogged and compacted soils because pore spaces are small and may also be filled with water" (Dobson). In several places there are visible ruts that have formed in the soil due to concentrated soil compaction from vehicles repeatedly driving over the same area. Practices such as mowing an area of turf repeatedly, and parking/driving golf carts or trucks on non-paved surfaces, especially within the CRZ, must be avoided.

Pedestrian traffic can cause just as much, if not more, soil compaction damage as vehicular traffic can. Pedestrian traffic as an issue is far more difficult to manage than vehicular

traffic as the activities of visitors do not follow predictable patterns. Places where people repeatedly walk over unpaved areas are relatively easy to find and identify as they are typically near areas of the Arboretum that have special appeal such as the swan pond or the pathways leading to the log cabin. These problem areas are identified visually by broad areas of compacted soil, such as around the *Ulmus parvifolia* near the swan pond, or by narrow strips of extremely compacted soil easily observed on the pathways to the log cabin.

Methods of actively controlling pedestrian traffic should be undertaken in certain areas of the Arboretum to allow time for work to be performed with the goal of fixing issues in problem areas. Practices that passively direct pedestrian traffic onto paved surfaces and away from vulnerable areas, or into pathways that have been created specifically to handle foot traffic should be attempted with the hope of reducing the overall amount of damage to the soil. Determining the most common causes of soil-related issues at the Morris Arboretum is an incredibly important step in determining a how to properly manage problems and keep all the plants healthy for the future.

RECOMMENDATIONS

Protecting tree roots and ensuring that they are growing in the best possible conditions is necessary for trees, shrubs, and other plants to continue to thrive at the Morris Arboretum. Preventing problems from arising in the first place is the best management approach when it comes to root related issues. Not having to deal with damage will save money in the long and short term, as well as allow employees to focus their time and effort elsewhere. Using mulch around every tree in the landscape is the most effective possible measure to take when trying to prevent damage from occurring. Mulch reduces the number of soil related issues that arise. If damage cannot be prevented, it must be undone so that the affected plants are not damaged to a level that causes them to die. The use of an air tool to break up compacted soil is the best method to actively reverse damage that has already occurred, and in areas where there is severe soil damage the use of an air tool is very strongly recommended to attempt to undo the harm that has been done. There are many ways to prevent, and reverse soil related damage at the Morris Arboretum, all must be considered when trying to create a plan to improve the health of plant roots in the area so the specimen(s) can be enjoyed by visitors for years to come.

Mulch

Mulch mimics the natural conditions found on the forest floor where there is a layer of fallen twigs/branches and leaves. When this material breaks down over time it replenishes nutrients needed by plants and improves soil structure by increasing the amount of organic matter present. This layer spreads out the weight load from anything travelling through the forest, keeps the temperature of the soil cool helping retain moisture, and intercepts any water from a rainfall event preventing soil erosion.

Mulch rings are a great way to keep roots and soil healthy. It should always be used whenever a tree is planted and the mulch should be maintained yearly and reapplied at least every 2-3 years to ensure the ring is effective. It is important to avoid piling mulch against the trunk. This can be easily avoided by leaving a buffer between the trunk of the tree and the beginning of the mulch ring. The root flare of the tree should be easily visible when mulch is properly applied. Material that is against the trunk of the tree retains moisture that can lead to disease and pest issues and eventually cause the death of the plant. Mulching is crucial to help ensure that the soil stays moist and its temperature remains relatively consistent, giving the roots the best possible conditions to grow in. Mulch serves as an insulator for the soil and prevents root damage due to large temperature swings such as those seen in the last several years, keeps roots cool when the air temperature is high during the summer, and keeps the roots warmer when the air temperature cools during the winter months.

In addition to helping keep the temperature within an ideal range, mulch helps soil remain moist after irrigation events by keeping the soil cool long enough for the water to fully infiltrate the soil and be used by any plants in the area. While mulch helps tree roots by retaining moisture and keeping temperatures consistent, it also serves a critical function in keeping soil compaction from occurring. When there is mulch covering the soil surface, the weight of a pedestrian or vehicle is spread out due to the material dispersing the load. The total force that causes the compaction does not change, but the area that it affects is increased due to the mulch material spreading it out, which then reduces the overall amount of compaction that occurs.

Using mulch around trees, especially young trees, is essential to maintaining their health, and all old mulch rings must be refreshed when the material breaks down to the point where it is no longer serving its function. Mulch is necessary when trying to protect the roots of a plant from damage and should always be used and maintained. When mulch is not used many problems can arise that need to be fixed to keep all the plants in the area healthy. Using an air tool to undo soil damage is the best option to actively undo and problems that have occurred.

Air Tool Work

Properly managing soil-related root issues requires the use of an air tool that can be used to directly improve soil conditions so roots have the best possible growing environment. It can also allow people to inspect the roots for any issues. The best technique to manage soil compaction that has already occurred is by using an air tool to inject air into the soil at a very high pressure. This breaks up the large clumps of soil in the area, creating better soil structure allowing for water to be imbibed and drained more quickly, as well as increasing the amount of oxygen available to the roots in the area. Using an air tool to de-compact soil and integrate organic matter, or other soil amendments, into the root zone of a tree is an incredibly effective way to improve the long-term health of the specimen. This practice is a great way to improve the condition of mature trees that may not be able to tolerate more intrusive methods of incorporating soil additions. Increasing the amount of organic matter in the soil around a tree will

help the soil retain water while also improving drainage, and the soil will also hold on to nutrients for a longer period of time creating an environment that promotes root growth.

While using an air tool is a great way to improve soil conditions, it is also a great technique to make roots visible so necessary root pruning can be done. The ability to perform root collar excavations is crucial for the long-term health as it allows for the inspection of the roots near the trunk so anything growing incorrectly can be managed. Roots that grow around the trunk of a tree, called girdling roots, will over time grow so large that they choke the trunk and cause a large amount of dieback or even death. Finding girdling roots before they become a serious issue is relatively simple when an air tool is used, and after performing root collar excavation, organic matter integration and other soil improving actions can be easily done as well. Using an air tool to undo as much damage as possible is an excellent way to manage soil issues; however, changing practices that create problems is a great way to reduce the amount of corrective work needed.

Mowing Requirements

Changes in the turf management practices at the Arboretum must be implemented with the protection of trees root systems in mind. The management practice that needs review most urgently is the way that turf areas are mowed. The way it is currently done causes harm to plants in the landscape. The mowers that are in use now are large machines that are heavy and cause substantial compaction wherever they travel, which is commonly very close to trees in order to cut the turf that grows almost up to the trunk of the trees in many cases. A good alternative to this practice is to buy a much smaller, lighter mower that is used solely to manage the space immediately around the tree or shrub in order to prevent compaction. Although the cost of a new mower is relatively high, over time it would save money as the time and money needed to do air tool work adds up very quickly and would shortly be more costly than a new mower. Allowing the turf to grow to a higher height than it currently is would decrease the amount of mowing needed and would improve the root growing conditions of all specimens surrounded by turf. A reduction in the number of times mowing is needed will help lower the amount of compaction and prevent the initiation of erosion while also lessening the Arboretum's financial costs and environmental impact. Managing turf can cause many soil problems, but plants can be used to prevent damage and to restore soil conditions so that all trees in the area can thrive.

Plantings

Plantings can be implemented for many purposes, such as acting as an obstacle to pedestrian/vehicle traffic or to prevent and mitigate erosion in problem areas. Using plants as a deterrent for pedestrian traffic would be an incredibly effective method for reducing the amount of travel by people over an area that has a problem or has been recently had work done to reduce compaction. Guests that come to the Arboretum tend to avoid walking in garden beds or in areas where there are trees, shrubs, or other herbaceous plants. Section leaders and other staff members

can utilize this behavior advantageously by using plants to control the flow and movement of traffic in certain areas of the Arboretum. New garden beds and shrub plantings can be used specifically to steer people and vehicles away from sensitive areas such as within the CRZ of already damaged trees or areas where water does not drain well that makes the area susceptible to soil damage.

Employees do not drive vehicles in areas where there are plants in garden beds but commonly drive over areas containing only turf, meaning that plantings can be used specifically as a deterrent to vehicular traffic. Given that vehicular traffic causes substantial compaction at the Arboretum and initiates soil erosion in many sites, reducing the area that vehicles and mowers can drive over will only help improve the health of the trees and shrubs in the area. Plants can be easily incorporated into areas that have recently had air tool work done in the area as the soil will be easily workable and will contain a large amount of organic matter. Plants can be used to prevent damage from occurring, keeping trees healthy for many years to come.

Using plants around trees to reduce the amount of mowing needed close to the root zone of the specimens located throughout the Arboretum will improve growing conditions. Alternatives to traditional turf near trees are strongly recommended, and there are several options for section leaders. Using 'No-mow' grass seed mix is the best possible option for areas where turf may be required but using mowers is discouraged, particularly on slopes or within the CRZ of trees. Many different turf seed mixes are available that can be used to reduce the need for mowing, 'no-mow' mixes as well as 'low-mow' mixes are available from many different vendors. Increasing the area growing lower maintenance grass mixes will help reduce environmental and financial costs and will simultaneously reduce the amount of damage done to the soil in the area in the future.

Groundcovers and other low-growing plants that grow well at the desired site are recommended as an alternative to turf specifically to reduce the amount of mowing needed in an area. Plants such as *Vinca minor*, *Pachysandra procumbens* (PA native), or *Pachysandra terminalis* can be used in a wide range of sites as an alternative requiring less maintenance and still working as a great ground cover. The use of ground covers is strongly encouraged as they require less time and effort to maintain, reduce financial costs, and allow employees to focus their attention elsewhere. While also being a great way to prevent people from walking in certain areas, plantings are a fantastic way to stop soil erosion from becoming more severe or even occurring at all.

Plantings can also be used to manage erosion across the Arboretum. In several places in the landscape, primarily on slopes, there is serious erosion damage that is impacting large trees. Sparse turf in shady areas that has not grown in well is not an effective method to prevent erosion so a new strategy must be implemented. Increasing the amount of perennial plants around trees will help keep the specimens healthy and decrease the amount of damage that occurs. Flowers and grasses are found around trees and shrubs in their native environments. Using plants around the trees will mimic the conditions found where the specimen plants grow naturally. This will improve the soil conditions as the perennials will take in different soil nutrients and every winter will die back and allow for natural nutrient cycling to occur and will

increase the amount of organic matter in the soil. Sedges, plants in the genus *Carex*, are one of the best possible plants to use around trees and can be used as a turf alternative. They are commonly available from many different sources. There are many different *Carex* species that grow anywhere from 6 inches tall to over 3 feet tall and can tolerate almost any sunlight and soil moisture/nutrient conditions. Many sedges grow well in shady, dry areas and spread easily via rhizome or seed, making these plants an excellent choice for a replacement for turf in many difficult areas. Specialized roots that sedges create called dauciform roots help all plants in the area by secreting compounds that increase the availability of soil nutrients that are typically chemically unavailable. With such a diverse selection of sedges, there are many possible areas in which plants can be used to make mowing unnecessary, or implemented to reduce erosion, and can be used to increase soil nutrient levels. Planting sedges around trees and shrubs will not only allow the tree to acquire more hard-to-find nutrients such as phosphorus, but they will also stop heavy mowers from coming close to the tree and compacting the soil potentially causing severe problems that may not be apparent for many years. Another strategy that can be easily implemented is educating all staff members on root health and how to avoid causing problems. By ensuring that all Arboretum employees are aware of how roots function and how to keep them healthy, a large amount of easily avoidable damage can be prevented.

Educational Material

Educating employees and guests on how they can avoid damaging trees roots when visiting the Arboretum will help preserve or even improve the health of specimens throughout the landscape. Many people do not have a good understanding of what roots do or why they are important, and they are unaware of what activities can damage these very important roots. Providing easy-to-understand information with the purpose of educating the public about the importance of tree roots to a tree's overall health and beauty will help avoid problems in the future. By not causing problems in the first place, substantial money, time, and effort would be saved because corrective work would not be needed. Having easy-to-grasp material available online is a great way to reach many people and educate them about how they can avoid harming any trees. Creating a presentation with the intention of having it shown to all new staff and once a year to all Arboretum employees as a refresher course will prevent more root-related issues from arising. Given that prevention is the best management strategy when referring to root and soil problems, educating people on how they can help avoid or manage them will not only save specimens from damage but will also save money by making remedial work unnecessary. By educating employees on how to avoid causing soil damage many practices that cause soil problems can be avoided entirely.

Keeping Vehicles Off Grass

Keeping all vehicles away from areas around trees is a very easy way for soil compaction to be significantly reduced across all of the Morris Arboretum. Trucks, lawn mowers, and golf carts are commonly driven on the turf creating areas of soil that are repeatedly compacted,

sometimes within the CRZ of one or several trees. Educating staff members on soil compaction and how to avoid causing it is the best method to prevent the problem from occurring in the first place. Encouraging staff to avoid driving or parking on non-paved surfaces whenever possible are highly recommended strategies to help avoid compaction. Something that absolutely must be avoided by everyone is parking personal vehicles on turf near trees, which has been observed when the Arboretum was hosting a class at the horticulture center and there was not enough available parking. Increasing the amount of available parking at the public and private parts of the Arboretum are ways of potentially decreasing the instances of vehicles being parked on non-paved surfaces. Dropping off all necessary tools and materials at the work site, then parking the vehicle on a paved surface and using a tarp to haul any debris away is a highly recommended method for all employees to prevent compacting soil. With all staff members being more aware of ways that compaction is caused and how to avoid it there should be fewer issues in the future. Keeping vehicles off grass whenever possible will prevent the initiation of many issues; however, visitors to the Arboretum can cause many problems as well.

Creating Pedestrian Pathways

Pedestrian traffic across the Arboretum has caused substantial soil compaction near trees both young and old. Pedestrians walk in the same areas repeatedly, causing soil compaction in places where there are the most interesting or enticing sites, such as around the swan pond or the pathways leading to the log cabin. Creating well defined pathways in all areas that are currently suffering from compaction issues will help alleviate problems that currently exist and will help prevent more soil compaction from occurring in that space. Identifying pathways in the all sections of the garden that are not paved where people clearly walk across soil that contains tree roots will help section leaders better understand the way that movement flows through the area. When this flow is better understood it will be easier for section leaders to determine where a new pathway could be placed in order to mitigate damage done to tree roots in the area. Using materials like stone, gravel, wood, or woodchips to create pathways that define areas where pedestrians should walk spreads out the load created by repeated traffic. After air tool work has been done is a critical time when pathways or pedestrian deterrents must be utilized by section leaders. To ensure that root health and growing conditions return to an optimal level there would ideally be several months when there is no pedestrian traffic in the restored area. Section leaders can use pathways or fencing to keep visitors out of the area to allow for the replenishment of soil health creation an environment where roots will grow well. Containing visitor traffic to specific areas and pathways will make it easier for compaction and other soil issues to be avoided in the future as guests can be directed onto paths with fences and signs.

CONCLUSION

The Morris Arboretum has a wide range of beautiful plants, especially trees and shrubs, that must be kept healthy and in good condition so they can be enjoyed for many more years to come. Roots are the connection between the plant and the space around it. Creating the ideal growing conditions for roots must be on the forefront of every employee's mind. By ensuring that all employees are aware of what damages soil conditions and how to avoid causing soil related issues in the first place, almost every root zone problem can be easily avoided. Keeping the soil healthy and a place where optimal root growth can easily occur will save a large amount of time and money and allow section leaders and other employees to focus their time and effort elsewhere. Preventing damage from occurring is the best possible management method, but if prevention is not possible, it is good to make sure that staff members are aware that there are ways they can improve and correct poor growing conditions.

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