Tree Root Growth Control Series:

Methods For Root Control

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Introduction

There are a number of root growth control tools and techniques available today. There are eight primary forms of tree root growth control based upon limiting root growth processes, resource availability, and soil features. Below are listed primary growth control forms.

1) **Intelligent development** designs and applications utilizing tree-literate techniques and materials. If you build it correctly, they will not come!

2) **Kill Zones** (soil volumes) — use of cultivation, cutting, trenching, vibratory plows, and chemicals.

3) **Exclusion Zones** (soil volumes) — soil structural changes, soil compaction, water/aeration stress, anaerobic conditions, soil injection, soil additives, and chemicals.

4) **Air Gaps** (thick plane)— designed permanent and temporary air spaces for root pruning or lack of support, course stone cobbles, and drain systems.

5) **Barriers** (control plane)— commercial traps, deflectors or containment devices, metals, screens, plastics, paints, and inhibitors.

6) **Directed Growth** (ecological island and corridor resource space) — systems to concentrate roots elsewhere, guide growth along channels, allow survival in other areas, root culverts or layers, and engineered soils.

7) **Species Selection** — utilizing trees with lower soil oxygen requirements, improved root morphology and reactivity values, and more effective species / site choices for long term solutions.

8) **Avoidance** — separate zoning for infrastructure and trees, established biological-free zones, and avoiding problems.

Each of the primary forms attempt to change resource availability, control resource volume (space), or destroy / redirect biological colonization. Under each primary form exists a number of methods to accomplish root control. Single or compound root control strategies can be used, with combinations presenting the best long-term solutions. Other forms of root growth control exist and can be used.

Clearly tree-literate design and development processes that minimize material faults and tree accessible space (primary root growth control form #1) are the preferred means for maximizing a tree's, and tree owner's, quality of life over the long-run. Primary root growth control form #8 is simply avoiding problems by keeping

UNIVERSITY OF GEORGIA COOPERATIVE EXTENSION SERVICE FOREST RESOURCES PUBLICATION FOR98-11

large distances between trees and infrastructures. This is probably the most ecological distasteful and socially unacceptable of all forms.

The six remaining primary root growth control forms will be discussed. Remember that many root growth control techniques and tools exist, both outside and inside this particular information organizational system. The most important features of the various forms will be reviewed. Also, be aware that cost effectiveness is critical and that sometimes "cohabitation and correction" will be the lowest cost option even though occasional structural repairs are needed. Highly valued trees should not be damaged or removed because of the need to occasionally replace $50.00 of cement.

Kill Zones

Kill zones have been used for millennia in agricultural settings. Shelterbelt tree plantings along field edges in the Great Plains of the United States and elsewhere, have roots cultivated-off with crop care equipment at least once a year, and sub-soiled periodically. The key result remains that cutting tree roots, as a stand alone treatment, leads to similar root problems or worse in a short period of time (35,45). Cutting too close to the tree can also compromise structural stability (34,55). In some compacted soils, cutting and cultivating may bring some soil benefits, but roots not cleanly cut, exposed to the air in a damaged (bent, twisted, torn, broken, etc.) state, or opened to soil pathogens will initiate additional problems (36).

The most common arboricultural practices generating kill zones for root growth control are trenchers, root saws, rotary pipe knives, and chemicals. With all kill zone tools, it is critical to calculate how close to the tree, or how much resource and root volume can be removed from the tree before tree health concerns shift from root control to other systemic and structural problems. (Figure 1 (10)) Trenching has been cited, with increasing root damage severity, as decreasing vigor over longer time periods, constraining twig growth, and increasing twig die-back (36,56). The temporary nature of the treatment, the sometimes severe residual damage, and the loss of living mass usually suggest other means to accomplish root control.

The two primary chemicals used to generate a kill zone for root growth control are pipe clearance materials (traditional metal salts or herbicides) and in-ground fumigants (soil sterilants). Fumigants used to prevent root graphs can be used to control root growth (26). Both remain temporary solutions to a reoccurring problem. These materials are seeing declining use over time, as more efforts are being made to minimize broad-scale treatments and off-site damage from chemicals. Great care is required around infrastructures and other living things. For example, if a pipe clearance chemical is used with a rotary knife, the assumption is that there are significant pipe faults present or the roots would not be in the pipe. If the pipe is faulty and leaking, any biologically active herbicide or toxin will leak from the pipes affecting other plants in the area (52).

Exclusion Zones

Exclusion zones prevent roots from colonizing soil resource areas due to physical or chemical changes in the three-dimensional soil matrix. From one point of view, urban soils are already root growth exclusion zones. Changing soil structure, pore space volume, or drainage / aeration patterns can generate a soil environment that roots cannot effectively colonize. Additions of physical- or chemical-based soil altering materials (soil injected clay slurry or cement solutions) can be effective, at least over the short run if adequate soil volume is treated.

Compacting soils remain the best way to prevent root colonization. With high levels of soil strength and penetration resistance, low oxygen, significant amounts of unavailable water, no air-filled pores, and small diameter water-filled pores, compaction of soil will minimize any root growth. Expansive clay soils, freeze cycles, and biological activities over time can reduce compaction and generate root-accessible pore space.

Addition of nitrogen gas, sulphur (29), sodium, zinc, borate, salts, or herbicides (28) to soil areas, or to infrastructure building materials, all can carry severe environmental costs, short term results, and non-target damage potential. Other potential treatment such as electric plasma soil fusion and resin infiltration of soils are cost prohibitive.

Air Gaps

One of the more effective means of controlling tree root growth is creating supporting stone matrices that dry quickly, have extremely large pores filled with air, have poor water holding capacity, and are impermeable to root penetration. These large air gaps are produced by layers or areas where large gravel (>2cm or >3/4in) and coble-sized stones are deposited and then paved over. This stone structure reduces rooting significantly (43). Clean, graded, medium-sized rubble (crushed brick remnants) provides an excellent gap material if it is not covered or filled in with sand (28,29,41). The requirements of this type of construction practice could help recycle old paving and wall materials.

Some communities are experimenting with an air gap left between the soil surface and the pavement (34,35). A variety of existing soil drain systems (plastic spreaders between geotextile) that yield air-filled gaps can provide root control options along with water drainage control. A reinforced narrow open trench, provided with full and rapid drainage can also be effective. Engineered soils can also provide a variety of root promoting and root inhibiting areas with the same basic load bearing framework. Gaps have been shown to be effective, but are rarely used because of builder resistance and lack of demand.

Barriers

One of the easiest and most available materials used to control root growth are various types of two-dimensional barriers. There are a number of commercial products on the market, some using a herbicide. In a survey of community management programs, 50% of surveyed programs said barriers are considered at least partially effective (24). Listed by survey in order, after species selection and mechanical cutting, barriers represent a more tree-literate approach to root growth control. But as with most things biological and installed by humans, no barrier is completely effective as applied (43).

Many types of barriers have been shown to be effective, a sampling is given in Table 1. Table 1 does not represent an exhaustive list, but is provided to show the diversity of root growth control barriers. There are many "weeding" and mulch fabrics that are not effective for root growth control because they lack fiber-to-fiber strength to resist root elongation or radial expansion (28).

Table 1: Selected list of tree root growth control barriers found to be effective for various lengths of time.

Copper sulfate-soaked, synthetic, non-woven fabric (51)
Copper screen (55)
Cupric carbonate ($CuCO_3$) in latex paint (2)
Fiberglass and plastic panels
Fiber-welded synthetic fabric / mesh (28)
Galvanized metal screen
Ground-contact preserved plywood
*Heavy rigid plastics (4,5,34,35)
Infrastructure aprons and footings (34,35)
Metal roofing sheets
Multiple layers of thin plastic sheets
Nylon fabric / screen (55)
Permeable woven fabric sheets (28)
Rock impregnated tar paper / felt (28)
*Slow-release chemical barriers (34,35,55)
Thin layer asphalt / herbicide mix (43)
Woven and non-woven plastic sheets (28)

* = common commercial tree growth control products

From the sample of effective root barriers listed in Table 1, three barrier types are most common: traps (root engaging and constricting), deflectors (walls), and inhibitors (chemical constraints). Note that no barrier stops all roots under all conditions. Combined features of the barrier, the site, and barrier installation and maintenance are critical to effectiveness (55).

Directed Growth

Roots grow where there are adequate resources, and proliferate where good supplies of resources exist and can be ecologically recycled. Understanding root elongation, colonization, and survival processes allows growth favoring soil layers, corridors, and areas to be designed for directing roots away from infrastructures. Two principle methods are baiting and channeling.

Baiting is providing ideal essential resources with a healthy soil in some other area, rather than next to infrastructures. Sometimes this process is not possible, but under-soil hydroponics and special in-ground containerization are workable. For practical purposes, an area of open soil surface is identified away from roots impacting infrastructure. (Figure 2) These roots are provided with near optimum resources and additional organic matter. The net result is a much higher survival and growth rate in that part of the root system as opposed to roots near infrastructures. Near infrastructures, water, growth materials, essential elements, and oxygen should be limited. It is intellectually ridiculous to provide high levels of resources across an entire site and still complain about tree root growth problems.

Where open surface area is limited or soil resource volumes are small, “sheparding” roots to desirable locations can provide valuable resource volumes. The use of surface or near surface trenches, channels, layers, and tunnels that are surrounded by root control obstacles, barriers, or resource constraints, can provide needed resource volumes. Growth channels filled with rich, well-aerated, ecologically healthy growth medium will encourage root colonization and survival (35). Using culverts, bridges, raceways, tunnels, and other infrastructure devices can lead roots away from more sensitive infrastructure targets. Under pavements, the use of compacted layers above and below a moist, oxygenated coarse layer (sand) can lead roots under infrastructures and out into open soil surface areas.

Species Selection

Species selection is fraught with problems because of the genetic plasticity of trees under different site conditions lead to phenotypic selections without controlled testing, demonstration, and consistent reproduction. The literature seems obsessed with good tree / bad tree lists. You are free to find or prepare your own lists from local and regional sources and your own experience.

A large majority of managers (90% in one survey) believe that by planting particular species and by avoiding others for a given site, infrastructure damage can be minimized (24,34,35). Managers develop species preferences over time based upon chance, experience, and integrated perceptions of problems. One reporting system tried to objectively highlight species generating the most infrastructure damage. On a genus basis, *Fraxinus*, *Populus*, *Quercus*, *Robinia*, *Salix*, and *Tilia* were cited for greater than expected incidences of infrastructure damage (20). Planting smaller, less aggressive rooting, and slower growing species have been recommended, in addition to avoiding specific species / site combinations (54).

Confounding tree species selection is tree size. Different individuals, populations, and species attain varying sizes and rooting characters depending upon soil, site, and environment. Some species grow fast and become large, thereby mechanically and biologically initiating changes in the site and associated infrastructures. Shear size, rate of growth (size change rate), and mechanical adjustments generated to remain structurally stable, all interact closely with available rooting volume, soil strength, and distance to infrastructures. Potentially large trees planted in small soil volumes will be quick to exert mechanical forces on surrounding infrastructures.

The size of the root plate, or the zone of rapid taper, does vary by genus and species (19). Using root plate or structural rooting distances as a minimum distance to infrastructure is possible. Table 2 shows a means of representing the minimum distance away from a tree stem to use in minimizing root plate interactions. Note that Table 2 represents mechanical functions regardless of species.

Table 2. Estimated area of root plate, or zone of rapid taper, by tree diameter. The structural roots (roots maintaining stability under compression) should not be damaged or disrupted without significant risk of structural failure. (10, after 32)

tree diameter (inches)	structural root distance (feet of radius)	tree diameter (inches)	structural root distance (feet of radius)
1	1	26	10
2	2	27	10
3	2	28	10
4	3	29	10
5	3	30	10
6	4	31	10
7	4	32	10
8	5	33	10
9	5	34	10
10	6	35	10
11	6	36	10
12	7	37	11
13	7	38	11
14	7	39	11
15	8	40	11
16	8	45	11
17	8	50	12
18	8	55	12
19	9	60	13
20	9	65	13
21	9	70	14
22	9	75	14
23	9	80	15
24	10	85	15
25	10	90	16
		95	16
		100	16

The second rooting concern in infrastructure damage is the woody, radially growing, transport roots growing away from the root plate area. Minimum distances that provide adequate resource space, structural support, and minimize (not eliminate) infrastructure damage can be determined. Table 3 estimates the minimum radius measured from the stem which encompasses the critical rooting area needed for healthy tree survival, which minimizes infrastructure damage, and which should not be encroached upon (10). It should be clear that the general values of Table 2 and Table 3 offer only rough estimates for planning and designing local, regional, and species specific guidelines.

Table 3. Estimated minimum radius measured outward from tree stem center which encompasses the critical rooting area needed for healthy tree survival and which minimizes infrastructure damage. (10)

tree diameter (inches)	critical rooting distance (feet of radius)	tree diameter (inches)	critical rooting distance (feet of radius)
1	1	26	33
2	3	27	34
3	4	28	35
4	5	29	36
5	6	30	38
6	8	31	39
7	9	32	40
8	10	33	41
9	11	34	43
10	13	35	44
11	14	36	45
12	15	37	46
13	16	38	48
14	18	39	49
15	19	40	50
16	20	45	56
17	21	50	63
18	23	55	69
19	24	60	75
20	25	65	81
21	26	70	88
22	28	75	94
23	29	80	100
24	30	85	107
25	31	90	115
		95	120
		100	125

It is haunting that for all the preconceived concepts about species inherent in management, and blame in infrastructure damage, that distance to infrastructure and its damage can be found to be structural related and independent of species (21). It is the physical forces of tree biological colonization and survival, coupled with systemic design and material flaws in infrastructures (without regard to species), that confound tree root growth control.

Conclusions

We have never had more tools available for minimizing infrastructure damage exacerbated by tree root growth. The most important management concept to understand is how we invite tree roots to be associated with infrastructures and colonize faults, cracks, and resource availability areas. Design and engineering mistakes, for which trees are easy scapegoats, tend to be accepted by tree professionals as our failings. It is time to intelligently fight back against the real, demonstrable causes of infrastructure damage, not ignore what we know about tree growth and development. We must not abdicate our professional role in solving tree root growth and infrastructure damage problems. Our responsibilities must lie with creating and using root growth control tools and techniques that are tree-literate and do not destroy the many goods and services which trees bring to people's lives.

Literature Cited

Full citations in: Coder, K.D. 1998. Selected Literature: Root Control Methods. University of Georgia Cooperative Extension Service publication FOR98-13. Pp.4

code number	author / date citation
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21	Francis et.al. 1996
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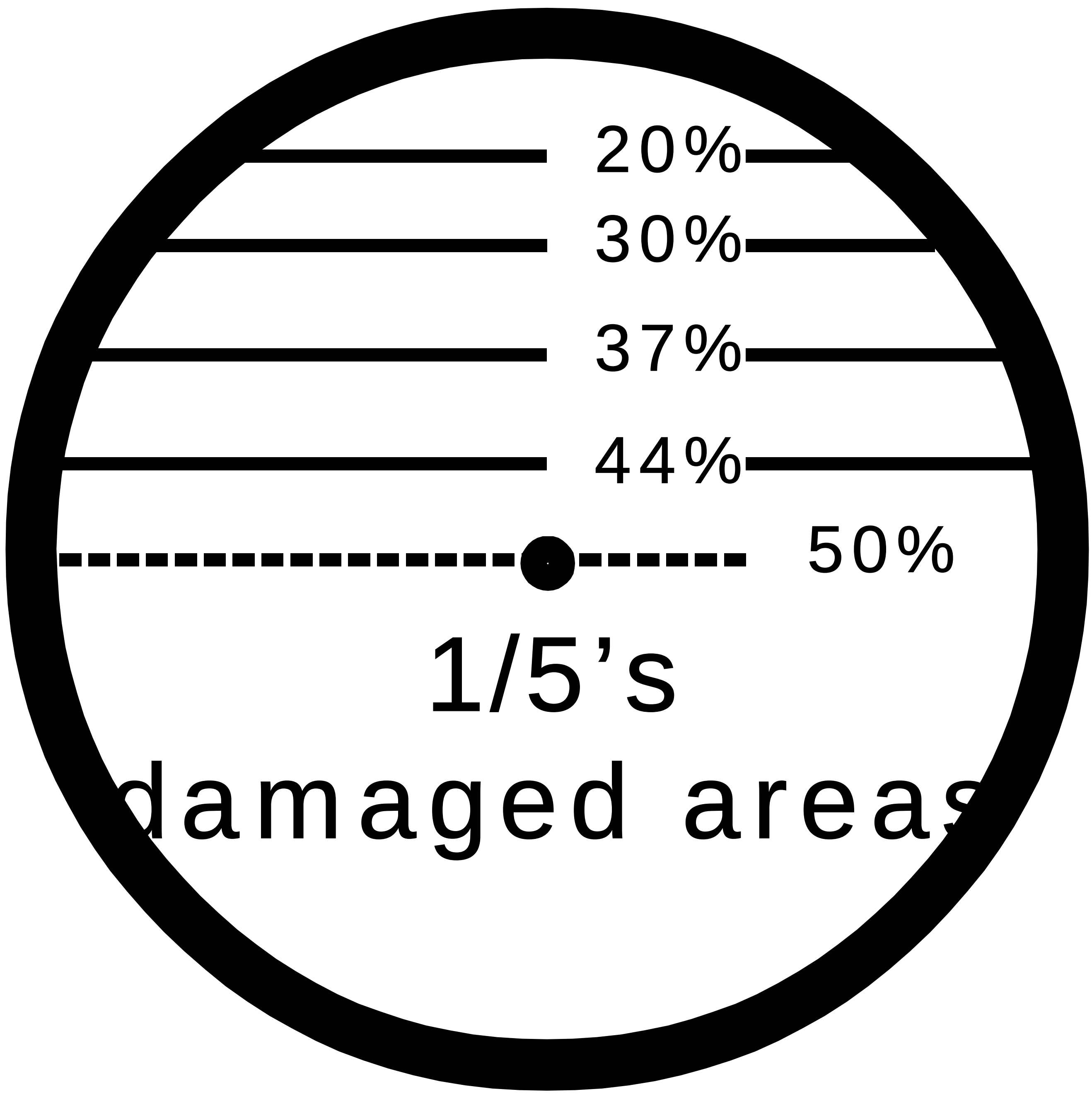

Figure 1: Geometric estimate of rooting area disrupted by trenching or new infrastructure. (10)

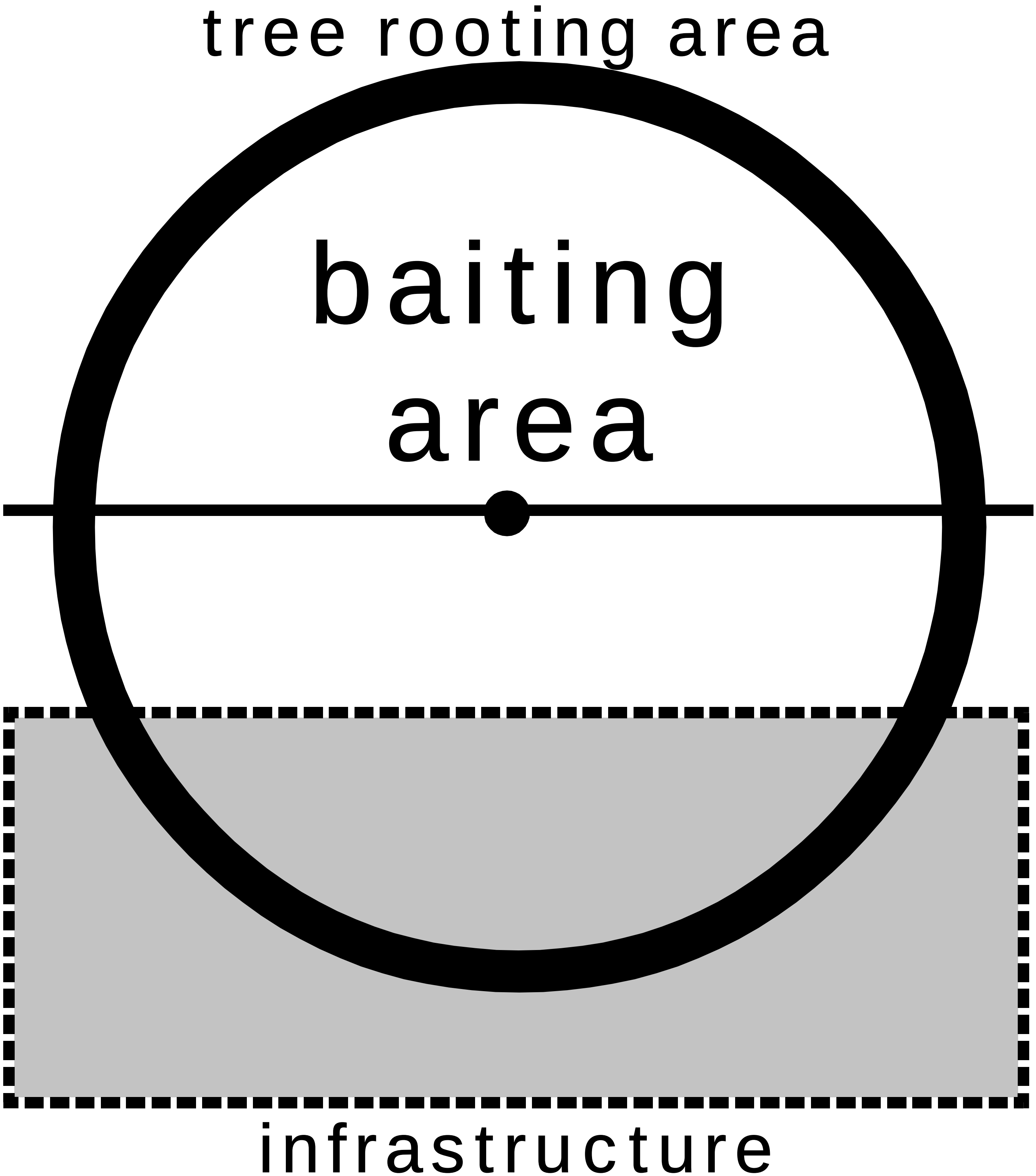

Figure 2: Root baiting area, part of a directed growth root control technique.