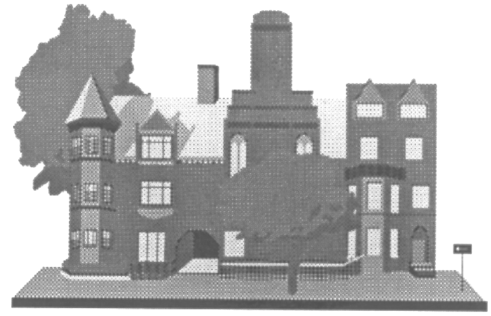
ROOTS IN SEWERS



Learning Objectives

After you complete your study of this unit you should be able to:

- Determine the two different types of root systems and which is associated with sewer problems.
- Be familiar with factors around sewer pipes that influence root growth.
- Identify the two types of root structures in sewer lines.
- Describe at least three non-chemical methods of root control.
- Name at least four different chemical control methods other than metam-sodium.
- Explain the differences between contact and systemic herbicides and between selective and non-selective herbicides.
- Describe three methods used to identify which lines have root problems.

Root-Related Sewer Problems

The intrusion of roots into sewers is probably the most destructive problem encountered in a wastewater collection system.

Root-related sewer problems include:

- sewer stoppages and overflows,
- structural damage caused by growing roots,
- formation of septic pools behind root masses which generate hydrogen sulfide, other gases and odors,
- reduction in hydraulic capacity, and loss of self-scouring velocities,
- infiltration where the pipe is seasonally under the water table.

Sewer stoppages and overflows are the way that most municipalities and homeowners find out about their root problems. Structural damage, on the other hand, usually goes unnoticed until the damage is determined through television probing. In the long run, structural damage is probably more costly than sewer stoppages.

Sewers are underground, so root problems are not noticed until backups or overflows occur. Effective use of early, preventive root control can avoid costly and permanent structural damage. However, municipalities are unlikely to fund a preventive root control program until a known problem alerts officials to the need for control.

Root Growth

Roots have three basic functions: 1) they anchor the plant and hold it upright, 2) they store food for the plant, 3) and they absorb and conduct water and nutrients.

Roots are tenacious and long-lived. The top of a plant is more dependent on the root system for survival than vice-versa. A plant can regenerate after it has been topped but cannot survive the loss of its root system. A willow tree root system can survive for many years after the top has been removed and will continually try sending up new shoots through the stump or exposed roots. The root systems of some grasses of the American Great Plains are thought to have remained alive for thousands of years. Just how far roots will grow in search of moisture and nutrients is uncertain. In the Rocky Mountains, in Colorado, live tree roots have been found penetrating a pipe in the Moffet tunnel, 2,500 feet from the nearest tree.

Root Systems. Plants may have either a fibrous root system or tap root system. Plants with **fibrous root systems**, such as garden plants and grasses, occupy the upper layers of soil and extend outward. They are not normally associated with sewer problems.

Plants with **tap root systems** are the trees and woody plants. The primary root of the plant grows directly downward into the soil. Tap root systems are well adapted to deep soils and soils where the water table is relatively low. Branches, or secondary roots, grow laterally from the primary root. Secondary root structures can grow several inches in diameter, and if they invade sewer pipes can exert enough pressure to spread pipe joints and break the pipe.

Feeder roots are fine, hairlike roots that may develop into secondary roots. The surface of feeder roots contain microscopic structures called root hairs. Root hairs greatly increase the total surface area available to absorb nutrients and water.

The leading tip of a root shoot, the **meristem,** "senses" minute differences in nutrient and moisture levels and grows toward them. The ability to detect these differences enables the root to locate a sewer pipe. Temperature variance between wastewater flow within a pipe and surrounding soil may cause condensation to form on the pipe. Also, loose pipe joints, cracks and pipe porosity allow water with a high nutrient content to seep from the pipe into the surrounding soil. This type of environment attracts and encourages root growth.

<u>Factors Affecting Root Growth</u>. A number of different soil conditions around sewer lines influence root growth. Back fill used during sewer construction may provide more favorable soil than undisturbed soils. Water table levels will fluctuate with seasonal changes. During drier seasons, the water table drops and tree roots will grow deeper in search of moisture. The tendency of roots to grow towards moisture is called hydrotropism. Sewer lines above the water table will draw roots in that direction. During colder seasons, especially where ground frost occurs, the warmer soil temperatures surrounding the sewer pipe may also cause the roots to grow in that direction. Moisture and warm temperatures surrounding a sewer pipe create an excellent environment for root growth. If the moisture level drops below a certain point, roots will begin to wilt.

Microscopic openings only a few cells wide permit hair-like structures to penetrate pipe joints, cracks, connections or any other opening. Heavy secondary root structures may follow a sewer pipe for many feet, exploiting each opportunity to penetrate pipe joints.

Roots thrive in sewer pipes, a perfect hydroponic environment. Roots are suspended in a well-ventilated, oxygen-rich environment with a plentiful supply of water and nutrients.

Generally, root growth is greatest in fall, winter and spring before leafing. At these times, roots are either storing or distributing nutrients. Root growth is less active in the late spring and summer when the aboveground portion of the tree is growing. Little is known about the growth rate of tree roots.

Roots of most trees cannot grow or survive if constantly submerged. Therefore, roots generally do not cause problems in sewers that are located below a <u>permanent</u> water table. With adequate water available, roots need not expend energy trying to penetrate the water table and sewer pipes. However, if the water table fluctuates, or if porous soil profiles permit rapid downward movement of rain water, roots can be found in saturated soil and can be a major cause of sewer infiltration. In this case, tree roots suspended in the atmosphere of the sewer can carry on metabolic activity, while the woody, submerged portion of the root system serves as a pipeline for plant nutrients.

Roots must always grow, because parts of the root system are constantly dying. If a root system stopped growing, the plant would die. When the nutrients or moisture in an area of soil is depleted, feeder roots die. Secondary roots elongate or stop growing, depending on the availability of additional nutrients. In time, bacteria in the soil break down the dead root tissue, helping to replenish the depleted nutrients.

Roots in the Sewer Environment

In urban environments, finding good sources of nutrients for tree roots may be difficult. Expanses of concrete and asphalt, removal of leaves and other organic debris from lawns and storm sewers draining away surface water cause roots to seek nutrition at greater depths. Some roots may follow building sewers well beyond the tree's drip line to the main-line sewer.

Two types of root structures found in sewer lines are known as veil and tail. The **veil root structure** occurs in lines with steady flows, such as interceptor pipes and other lines with constant flow. The roots will penetrate the pipe at the top or sides and hang from the upper surface, like a curtain, touching the flow. Live roots are seldom found below the water line. The roots will rake the flow, accumulating solids and debris. Grease and other organic materials will also accumulate. Eventually the root mass and accumulated material will cause a stoppage of flow, and gasses may develop.

The **tail root structure** occurs in sewers that have very low or intermittent flow, as in small-diameter collector sewers, building sewers and storm drains. The tail root structure looks like a horse's tail. The roots will grow into the pipe from the top, bottom or sides, and continue to grow downstream, filling the pipe. Tail root structures more than 20 feet long have been removed from sewers. Such root structures may appear as solid tubes of tree root, possibly with a slightly flattened area along the bottom where submergence in sewer flows would prevent root growth.

Roots that enter the sewers or are visible during a television inspection represent only a small percentage of total root structures in the vicinity of the sewer. Roots girdling the pipe on the outside are responsible for pipe damage as they swell inside joints and cracks.

Non-Chemical Methods of Root Control

Chemical, as well as several non-chemical, methods of sewer line root control are available to the root control expert and public works officials. Although non-chemical methods generally do not provide the same level of results as chemical methods, they have an important place in sewer maintenance. For example, mechanical methods are best for opening plugged sewers and for removing roots from sewers that are at imminent risk of plugging. In some cases, chemical control methods should not be used, especially when near treatment plants or when other environmental or safety considerations are in question. Pipe re-lining, grouting and sealing may also deter intrusion by roots. Municipal planners may discourage future root problems by discriminate selection and planting of trees in the proximity of proposed sewer lines. A successful line root control program will integrate a variety of root control methods, including cultural, physical, mechanical and chemical.

Cultural Control. Cultural control of roots in sewers is a routine management practice that can prevent tree roots from invading sewer lines. Cultural control must be implemented before roots have a chance to become a problem. Two major cultural methods are: 1) careful installation and inspection of sewer lines during construction, and 2) control of the selection of tree species and planting sites. Sewer connections with air-tight joints, or seams, will make it difficult for roots to penetrate. Municipalities should carefully inspect connections where plumbers join building laterals to the main-line sewer. Also, homeowners should be advised of the potential for future root problems and should be discouraged from planting deep-rooted or fast-growing trees near sewer lines. Willow trees, in particular, have adventurous and thirsty roots. Unfortunately, when a sewer root problem is detected, it is too late for cultural control.

Physical Control. Physical pest control relies on devices or procedures which physically separate the pest from the target area. A mosquito net is a physical pest control method. Physical control of sewer line roots involves isolating the environment of the sewer pipe from the roots around or near the sewer pipe. Three examples of physical control are: 1) tree removal, 2) pipe replacement, and 3) pipe re-lining.

Tree removal. This method works best when removing a single troublesome tree such as a willow whose roots have invaded pipes. Unfortunately, it would be difficult to convince homeowners along "Shady Lane" that the municipality's public works department should remove their trees in the vicinity of sewer lines. This would not only be expensive, but would not guarantee removal of the root problems. Roots may survive long after the death of the aboveground part of the tree, necessitating the use of mechanical or chemical controls for some time afterward. For tree removal to be most effective, the stump should be pulled or chemically treated with a basal application herbicide.

Pipe replacement involves removing old, defective sewers and replacing them with new sewers. As discussed above, the new sewers must have air-tight joints and properly installed connections to prevent the roots from becoming a problem. Pipe replacement corrects structural defects as well as root problems. There are four major disadvantages to pipe replacement: 1) cost, 2) disruption of traffic and property, 3) roots can still enter through building sewers, and 4) the destruction of trees planted in the vicinity of the trench line. If the pipe is in danger of collapsing, or is in a state of structural failure, pipe replacement may be the best method of control. Pipe replacement is not warranted when the pipe is in sound structural condition.

Pipe lining includes various technologies for rehabilitating sewer pipes. Roots must be chemically or mechanically removed prior to installation. One method, "slip-lining," involves pulling a seamless pipe through the existing sewer and digging only where building laterals require connecting. Another method, "cured-in-place" lining, involves inflating and curing a sock or plastic tube that conforms to the shape of the pipe. Robotic devices are then used to cut building connections into the liner.

Advantages of pipe lining are that it: 1) addresses infiltration problems and some structural defects, 2) is less disruptive than pipe replacement, and 3) promises long-term control against root regrowth through joints. Disadvantages of pipe lining are: 1) it is often more costly than replacement, and 2) roots can still re-enter the main-line sewer through building laterals. Even after relining the main-line sewer, chemical control may be required to prevent roots from penetrating the main-line sewer through service connections.

Mechanical Control. Mechanical control is the most common method of root control, and the most important non-chemical method for applicators to understand. Mechanical control involves the use of tools or other devices which cut and remove roots from sewers.

Drill machines, also called coil rodders, are either hand or power-driven, spring-like, flexible steel cables which turn augers or blades within the sewer. They are most often used by plumbers to relieve blockages in house-lines or other small diameter sewers. They are seldom used in main-line sewers.

Rodding machines are flexible steel rods with attached rotating blade cutters, augers or corkscrews. Rodding machines are most effective in small diameter sewers, up to 12 inches.

Jetters are also known as flushers, flush trucks, jet rodders, jet trucks and hydraulic sewer cleaners. Jetters consist of a high-pressure water pump, water tank, hose reel and 1/2 to 1-inch sewer cleaning hose. Orifices in the rear of the nozzle propel the hose through the sewer. The nozzle blasts through obstructions. As the hose and nozzle is retrieved, debris is hydraulically flushed back to the insertion manhole for removal. Jetters can also be equipped with root cutters which use the force of water to spin blades. Unfortunately, root cutters can easily get stuck in the sewer, especially where there are protruding taps or other structural defects. Bound cutters can only be removed by digging them out.

Winches, also called drag machines or bucket machines, are large, engine-driven winches which pull buckets, brushes or porcupine-like scrapers through the sewer. Special tools are designed to cut roots. Winches are most often used on large-diameter sewers which cannot be cleaned efficiently with jetters. Winches are used in heavy cleaning to remove large volumes of solids.

The main advantage of mechanical control is that it is the only method of relieving a root blockage. Chemicals are ineffective and dangerous when used in plugged or surcharging sewers. Sewer stoppage is an emergency situation and the municipality should have some type of mechanical control device for correcting such problems.

The main disadvantage of mechanical control is that it provides no residual control or long-term effectiveness. Roots respond to injury by producing a hormone, abscisic acid, which hastens and thickens regrowth. Root masses grow back heavier each time they are cut. Tap roots continue to grow in diameter, and, in time, they place additional stress on sewer pipes. Good results are obtained if the roots are cut flush with the joints; however, offset joints and cut-in laterals can prevent the use of full-gauge cleaning tools.

Mechanical control is often used in conjunction with chemical control, for example, to prepare sewer lines for rehabilitation with pipe-lining and grouting.

Chemical Root Controls

Chemicals can kill roots for a distance beyond the point of contact, providing control of root growths outside the sewer pipe.

Pesticides are the fastest way to control pests. For root control, they are practically the only tool available. Choosing the best chemical for the job is important. Chemicals used to control weeds are called herbicides. They kill plants by contact or systemic action. A **contact herbicide** has a localized effect and kills only the plant parts which the chemical comes in contact with. **Systemic herbicides** are absorbed by roots or foliage and carried throughout the plant. Contact herbicides result in quick die-back. Systemics take longer, two weeks or more, to provide the desired results. Metam-sodium is a contact herbicide.

Herbicide activity is either selective or non-selective. **Selective herbicides** kill certain types of weeds such as broadleaf or grassy plants. They are used to reduce unwanted weeds without harming desirable plants. **Non-selective herbicides** kill all plants present if applied at an adequate rate. They are used where no plant growth is wanted. Metam-sodium is a non-selective herbicide.

Many chemicals such as bensulide, dichlobenil, dinoseb, endothall, metham, paraquat, trifluralin, 2,4-D, 2,4,5-T, copper sulfate and chlorthiamid have been tried for root control. Note: not all of these products may be registered in all states, or there may be special handling requirements not specified on the label. Applicators should check with local authorities before using these pesticides. Also, acid and basic compounds such as sulfamic or sulfuric acid and sodium or potassium hydroxide are commonly used as "pour down" products in residential settings.

Trifluralin. Brand Names: Treflan®, Bio-Barrier®.

Fabric or rubber impregnated with trifluralin pellets is a relatively new concept in sewer line root control. The impregnated fabric is placed between the sewer pipe and trees at the time of sewer installation. The fabric is porous, allowing water to pass through. The trifluralin pellets are time-released, with manufacturer's claims that the active ingredient leaches only a few inches before being trapped by soil particles. Impregnated rubber is used for joint gaskets. Trifluralin is not water soluble, and unsubstantiated claims state that root control lasts for "decades."

Three advantages of this method are: 1) root control is long-lasting without need for re-treatments, 2) pesticides are not directly introduced into the sewer collection system, and 3) environmental risk is minimized.

The main disadvantage of this method is that installation must be well in advance of roots actually becoming a problem. This method cannot be employed economically after a problem occurs.

Actually, modern pipeline installation, if done correctly, can adequately deter root penetration, making preventive chemical control unnecessary.

Copper Products. Synonyms: Copper sulfate, Bluestone. Numerous brand names.

Although small amounts of copper are required by plants for normal growth, excessive amounts of copper will cause leaf damage and could result in the death of the tree. Copper is a heavy metal which may not be removed by the normal treatment process. Not only can it be toxic to the treatment plant's microbes, but it leaves the treatment plant as a pollutant in both the effluent and the biomass (sludge), thus becoming a potential environmental contamination.

Copper sulfate has been used for many years for root control in sewers and as an algicide. Some studies have shown that high concentrations of copper sulfate cause systemic injury without completely killing the roots. Nevertheless, copper sulfate products are still in widespread use by many plumbers and homeowners as a "pour down" application for controlling roots in building sewers. Copper sulfate is believed to be a relatively safe material to handle, and poses little health risk to the applicator.

The use of copper products may not be permitted in some states. Check with local authorities before use.
Some are registered in Tennessee.

Metam-Sodium and Dichlobenil. Synonyms: Metam, Metam-Sodium, Metham-Sodium, Vapam®; Synonyms - Dichlobenil: Casaron®

Metam-sodium and dichlobenil have been used together as a root control product in sewers for approximately 25 years. Metam-sodium is a fumigant, meaning it breaks down into a gas, methylisothiocyanate (MITC), which kills the plant roots. It is non-systemic and does not move throughout the root system and kill the whole plant. Metam is used with dichlobenil because dichlobenil is an effective growth inhibitor.

These two pesticides were originally applied together by spray or soak methods. Soaking entailed plugging the pipe, filling it with the chemical for a period of time, allowing the chemicals to penetrate any blockages, as well as soaking out cracks and joints and killing further up the root system. Spraying involved coating the interior of the pipe with the chemical solution. Because of the large doses of chemical used and the apparent threat to treatment facilities, the soak or spray method is no longer recommended.

Current methodology uses metam-sodium products as a dry foam (similar to shaving cream). Specialized foam-generating equipment is used to produce the foam, which is then applied to the interior of the pipe. Application is made through a hose which is inserted in the pipe to be treated. While the hose is being retracted, foam is pumped through the end, filling the pipe with foam. As the foam collapses (over a period of one hour or more), it has a tendency to adhere to the pipe and root surfaces.

Any product that does not adhere to the roots and pipe walls enters the wastewater in the pipe and is carried to the treatment facility. The dilution of the product in the wastewater, and the instability or rapid breakdown (fuming off) of the metam-sodium, allows a safety margin for the treatment plant.

Once the roots have been killed (within hours of application), bacteria and other microbes in the sewer begin to breakdown the dead tissue. Total decomposition of the roots may take several months to a year or more. The decomposed organic matter enters the wastewater stream and is carried to the treatment plant for disposal. Root regrowth will start in a couple of years, which may necessitate retreatment at three- to five-year intervals.

Identifying Which Lines Have Root Problems

Pest identification is usually the first and most important step in a pesticide control program. In sewer line chemical root control, pest identification is not a issue because it does not matter which species of tree is producing the nuisance roots. All roots in sewers are pests; there are no beneficial species.

In sewer line chemical root control, the sewer applicator must discover which sewer lines have been infiltrated by roots. Several indicators are available for determining which collection lines have root penetration:

Maintenance histories. Maintenance records will indicate sewer lines which have experienced a stoppage and the cause of stoppage.

Sewer line television reports. These provide accurate evidence of a root problem.

Commonalities in root-prone areas. Generally, sewer lines in the same area that were installed at the same time with similar tree-planting patterns near sewers will experience similar root problems. Conditions which increase the likelihood of root problems in a particular sewer section are:

- Sewers located near other sewers with known root problems.
- Sewer pipes located near the surface and closer to tree roots.

- Sewer lines located off-road in wooded easements, or at a curb line, near trees and roots.
- Sewer lines with many lateral connections per lineal foot, affording greater opportunity for root intrusion.
- Sewer lines located in tree-lined streets and easements.
- Residential areas are more susceptible than industrial areas.
- Sewer pipe constructed with loose fitting joints or out-dated joint-packing material. (Asbestos-cement pipe, orangeburg pipe and clay tile sewers with oakum joints are very susceptible to root penetration; whereas, pipe with air-tight rubber gaskets and seamless pipe are less susceptible).

A useful tool for planning root control programs is the scattergram. This is a map of the sewer collection system with known root problem lines highlighted. As a root-related stoppage occurs, or if other evidence of a root problem is detected, the line is highlighted on the map. Over time, patterns begin emerging indicating an area is root-prone.

Test Your Knowledge

1) The most costly, long-term problem roots cause to sewer systems is probably:
   a) stoppage and overflow.
   b) structural damage.
   c) reduction in hydraulic capacity.
   d) formation of septic pools.

2) Sewer lines are most likely to be damaged by:
   a) fibrous root systems.
   b) veil root systems.
   c) all types of roots.
   d) tap root systems.

3) Which of the following factors does not encourage root growth toward and around sewer lines?
   a) constantly water-saturated soil above the sewer line.
   b) loose, back-filled soil.
   c) moisture associated with the sewer line.
   d) warmer soil temperatures around the line.

4) Tail root structures are found:
   a) in sewer lines with a steady flow.
   b) only in sewer lines consisting of asbestos-cement pipe.
   c) in sewers with very low or intermittent flow.
   d) sewer lines located below the water table.

5) One cultural method for sewer line root control is:
   a) tree removal.
   b) selection of proper species and site when planting trees.
   c) pipe replacement.
   d) television inspection.

6) When is tree removal more appropriate for root control?
   a) when only one tree must be removed.
   b) when a sewer line is blocked by a tail root structure.
   c) during the fall and winter.
   d) when several trees must be removed.

7) Sewer lines can be improved by pipe lining, but only after:
   a) overhead trees have been removed.
   b) the affected pipes have been replaced.
   c) roots have been chemically removed from the pipes to be lined.
   d) roots have been chemically or mechanically removed from the pipes to be lined.

8) The most common method of root control is:
   a) cultural control.
   b) mechanical control.
   c) quality control.
   d) physical control.

9) The only method to rapidly remove a root blockage is:
   a) with chemicals.
   b) to remove and replace the pipe.
   c) mechanical control.
   d) with abscisic acid.

10) Two characteristics of metam-sodium are that it is:
   a) systemic and non-selective.
   b) a contact herbicide and selective.
   c) a copper product and non-selective.
   d) a contact herbicide and non-selective.

11) Current metam-sodium products are applied:
   a) as a dry foam.
   b) as a soak.
   c) as a spray.
   d) after roots are mechanically removed.

12) Which of the following is not a condition which increases the likelihood of root problems in a particular sewer line:
   a) being located in a residential area.
   b) having many lateral connections per linear foot.
   c) being located near the soil surface and close to tree roots.
   d) the line is constructed of seamless pipe and located near a street.

Answers:
1) b, 2) d, 3) a, 4) c, 5) b, 6) a, 7) d, 8) b, 9) c, 10) d, 11) a, 12) d