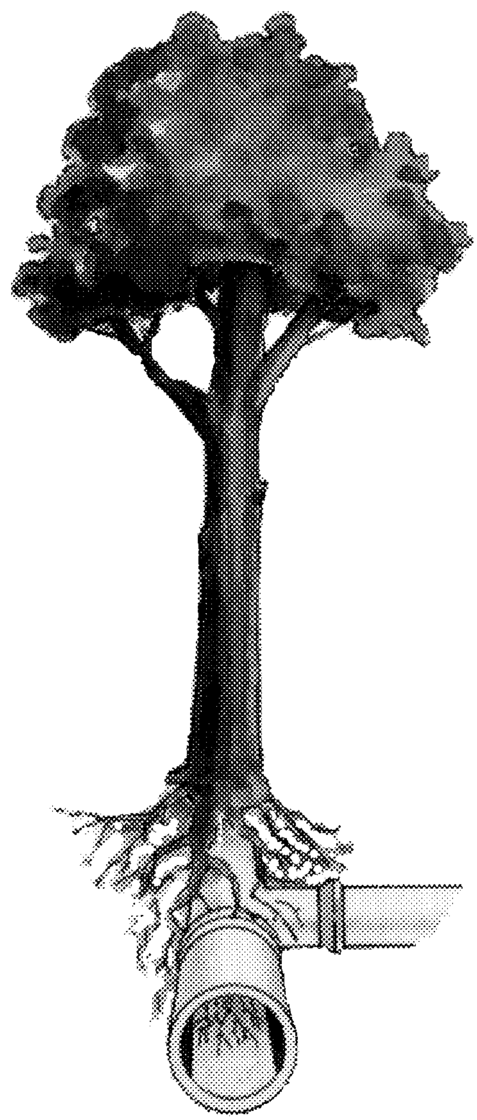
Sewer Line Root Control

University of California
Statewide Integrated Pest Management Project
Pesticide Education Program



Sewer Line Root Control

Patrick J. Marer
Pesticide Training Coordinator
University of California, Davis

Based on the EPA Publication
Sewer Line Chemical Root Control
Written by Kevin Duke and Eric Jessen
Robert V. Bielarski, Editor

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Principal Reviewers

The following people provided ideas, information, and suggestions and reviewed manuscript drafts for this California version.

T. Binder, Airrigation Engineering Company, Pleasanton, CA
M. Takeda, Department of Pesticide Regulation, Sacramento, CA
B. Tiernan, Airrigation Engineering Company, Pleasanton, CA

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L. Anderson, EPA Region VII, Lincoln, NE
J. Baker, Idaho Department of Agriculture, Boise, ID
P. Baker, University of Arizona, Tucson, AZ
D. Bishop, EPA Office of Research and Development, Cincinnati, OH
Boise City Public Works Department, Boise, ID
T. Creeger, Nebraska Department of Agriculture, Lincoln, NE
E. Crow, Maryland Department of Agriculture, Annapolis, MD
G. Davis, Michigan Department of Agriculture, Lansing, MI
T. Edwards, ESS, Inc., Oakland, CA
G. Florentine, EPA Region III, Philadelphia, PA
J. Fox, Kansas Department of Agriculture, Topeka, KS
M. Grodner, Louisiana State University, Baton Rouge, LA
P. Hannan, Washington Suburban Sanitary Commission, Laurel, MD
R. Hansen, Minnesota Department of Agriculture, St. Paul, MN
P. Houmere, Florida Department of Agriculture, Tallahassee, FL
T. Hughes-Lark, Clemson University, Clemson, SC
M. Lawson, Virginia Department of Agriculture, Richmond, VA
L. Lim, EPA Office of Water, Municipal Support Division, Washington, DC
N. Nesheim, University of Florida, Gainesville, FL
R. Prewitt, Lexington-Fayette Urban County Government, Lexington, KY
L. Quagliaroli, California Environmental Protection Agency, Sacramento, CA
C. Rew, Indiana State Chemist's Office, West Lafayette, IN

B. Scott, South Dakota Department of Agriculture, Pierre, SD
J. Spangler, Lansing Public Service Department of Wastewater, Lansing, MI
B. Swingle, Wisconsin Department of Agriculture, Madison, WI
B. Tiernan, Airrigation Engineering Company, Pleasanton, CA
F. Whitford, Purdue University, West Lafayette, IN
M. Zavala, University of California, Davis, CA

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Artists and Photographers

Airrigation Company, Inc., Pleasanton, CA *(Figures 2-1, 2-2, 2-4, 2-5, 5-1, 6-4, 7-1, 7-2, 7-3, 7-7, 7-9, 7-10, and 7-11)*
J. Clark, University of California, Davis, CA *(Figures 6-8, 6-9, 6-12, and 6-16)*
J. Juarez, Sacramento, CA *(Figures 1-1, 3-1, 3-2, 3-3, 4-1, 4-2, 4-3, 6-2, 6-3, 6-5, 6-6, 6-7, 6-10, 6-13, 6-14, 6-15, 6-17, 6-18, 6-19, 6-20, 6-21, 6-22)*
D. Kidd, Portland, OR *(Figures 6-1 and 6-11)*

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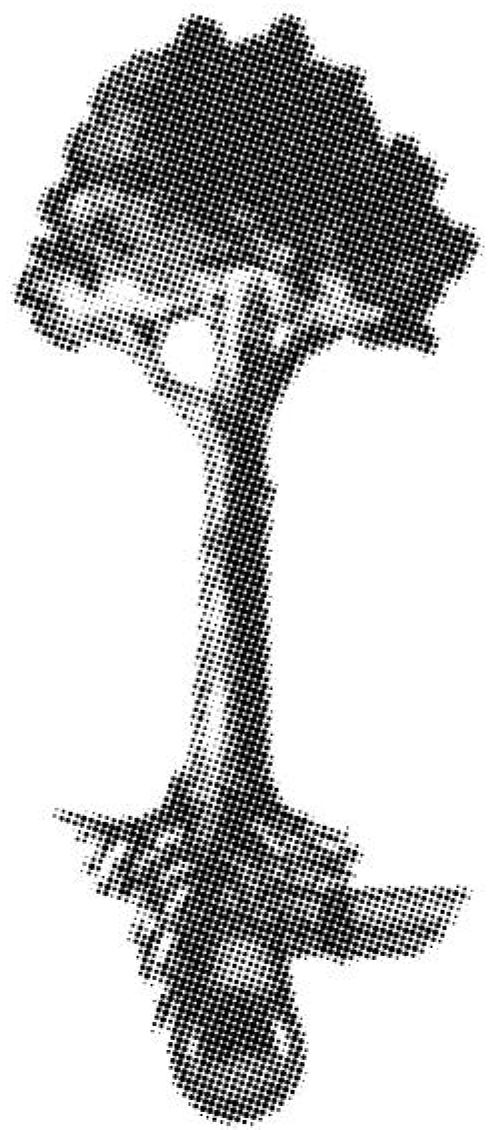


A pesticide may be defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. It may also be any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. The wise use of pesticides can contribute significantly to the health, welfare, and quality of human life. However, improper use of pesticides can be a threat to human health and environmental quality.

This chapter provides you with a general background in the safe handling of the pesticides used for sewer line root control. Although this manual focuses on products used for sewer line root control, it includes general information about pesticides, what they are, and how to handle them safely. For example, a product that is a *degreaser* may, in its marketing material, claim to kill or control roots. Products boasting this claim are considered *pesticides* and are subject to federal and state pesticide laws and regulations.

The following sections discuss the differences between *general-use* and *restricted-use* pesticides. Applicators using either general- or restricted-use pesticides must comply with specific federal, state, and local rules and regulations that control their safe use. These laws require that restricted-use products such as pesticides containing metam-sodium be handled by or under the direct supervision of a certified applicator. The laws are designed to protect pesticide handlers, customers, the environment, public health, and the systems being treated.

PESTS

A pest is anything that: (1) competes with humans, domestic animals, or desirable plants for food, feed, or water; (2) injures humans, animals, desirable plants, structures, or possessions; (3) spreads diseases to humans, domestic animals, wildlife, or desirable plants; or (4) annoys humans or domestic animals. Types of pests include:

- insects such as roaches, termites, beetles, mosquitoes, and fleas
- insect-like organisms, such as ticks, spiders, and scorpions
- mollusks, such as snails, slugs, and shipworms
- weeds, which may include mosses, algae, dandelions, and plant parts such as root intrusions into wastewater collection systems
- plant disease pathogens such as fungi, bacteria, and viruses that cause plants to become different from normal plants in appearance or function

- vertebrates such as rats and mice and certain birds, reptiles, and fish

PESTICIDE LAWS AND REGULATIONS

Figure 1-1. Pesticide handlers include people who mix, load, or apply pesticides and those who clean or repair pesticide-contaminated equipment, handle empty containers, or work as flaggers.

Anyone who mixes, loads, or applies any pesticide, cleans or repairs pesticide-contaminated equipment, handles empty containers, or works as a flagger is considered a *pesticide handler* (Figure 1-1). Several laws and regulations affect the sale, distribution, and use of pesticides by pesticide handlers. Handlers must be aware of these laws and the penalties that may be imposed for violating them.

Federal Insecticide, Fungicide, And Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed in 1972 and has been amended several times since. The highlights of FIFRA that affect pesticide handlers include:

- all pesticide products must be classified as either general- or restricted-use
- handlers must be certified as competent to use or supervise the use of any restricted-use pesticide
- two general categories of certification— *private applicator* and *commercial applicator*—are established
- all pesticide must be applied according to label directions. Penalties including fines and jail terms are established for violations
- states are given the authority to regulate further the sale or use of any federally-registered pesticide

The US Environmental Protection Agency was authorized to create regulations that allowed enforcement agencies to carry out the provisions of FIFRA. As a result, the EPA set minimum standards of competency for certification of pesticide applicators. This regulation, 40 CFR 171 *Certification of Pesticide Applicators*, allows States and Indian Tribes with EPA-approved plans to administer certification programs within their states.

Certification of Pesticide Applicators. Certification is proof that an applicator knows the correct and safe way to handle restricted-use pesticides. Both private and commercial applicators have to be certified to handle or supervise the handling of restricted-use pesticides. A *private applicator* is anyone who uses or supervises the use of any restricted-use pesticide for the purpose of producing any agricultural commodity on property owned or rented by the applicator or the applicator's employer. A *commercial applicator* uses or supervises the use of any restricted-use pesticide for any purpose or on any property other than as provided under the private applicator definition. A state may have several different categories of commercial applicator.

State Pesticide Applicator Certification Programs. Each state designate pesticide lead agencies to administer its applicator certification program. The California Department of Pesticide Regulation is one of the state agencies responsible for certification of pesticide applicators in California and has jurisdiction over applicators involved in sewer line root control. Commercial pest control firms must also be licensed by the Department of Pesticide Regulation or other state agencies, depending on the type of pest control they perform. These firms must have certified applicators on staff and all pesticides, regardless of classification, must be applied by or under the supervision of a certified applicator.

Classification of Pesticides. Manufacturers must register every pesticide with the USEPA and the California Department of Pesticide Regulation. By statute, all uses must be classified by EPA either as *general*- or *restricted-use*. Pesticides that are not likely to harm humans or the environment when used according to label directions are classified for general use. Those that have more potential for harming humans or the environment than general use pesticides and require special knowledge or training to assure correct application are classified for restricted use. Restricted-use pesticides may only be applied by or under the direct supervision of certified applicators (Figure 1-2).

Figure 1-2. Pesticide handlers require special knowledge and training to use hazardous pesticides.

Label Directions. You may not use any pesticide in a manner not permitted by the product's label. A pesticide may be applied only to the plants, animals, or sites specified in the directions for use. You may not use higher dosages, higher concentrations, or more frequent application. You must follow directions for use, safety, mixing, diluting, storage, and disposal, as well as any restrictions.

Penalties. Any commercial applicator who violates provisions of FIFRA may be assessed a penalty of not more than $5,000 for each offense ($1,000 for private applicators). Before enforcement agencies impose fines, applicators have the right to ask for hearings in their own cities or counties. Any applicator who *knowingly* violates any provision of FIFRA shall be fined not more than $50,000 and/or given up to one year in prison ($1,000 and/or 30 days in prison for private applicators). Additional penalties may be levied under California laws.

Other Regulations

In addition to FIFRA and California pesticide laws, you should be familiar with a number of other regulations such as those listed below:

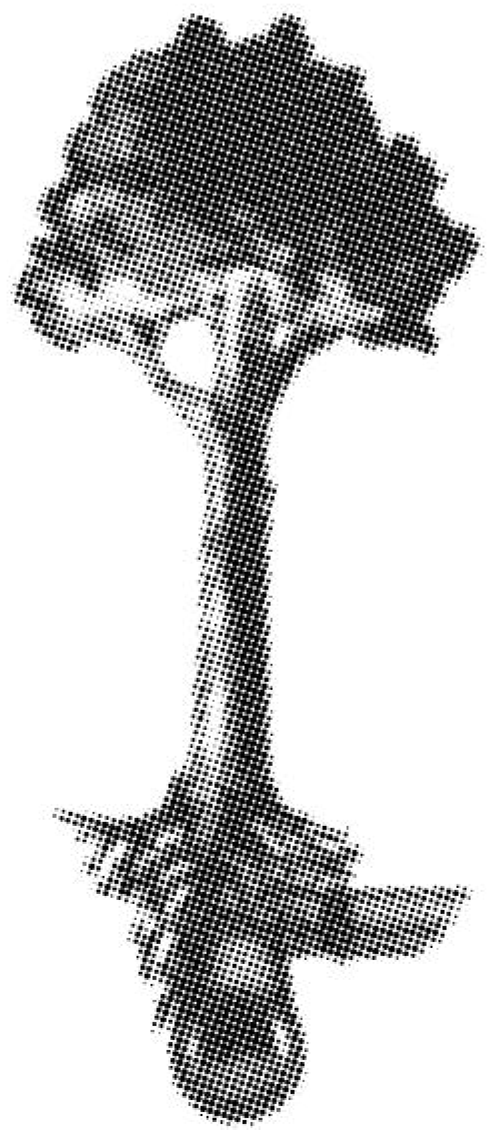
Figure 1-3. Before making any pesticide application, you must be sure no endangered species are located on or immediately adjacent to the site to be treated.

Endangered Species Act. The Endangered Species Act is a federal law designed to protect plant and animal species that are in danger of extinction. The EPA in cooperation with other federal, state, and county agencies have established limitations on the use of certain pesticides in specific areas known to harbor endangered species. Prior to making any pesticide application, you must determine that endangered species are not located on or immediately adjacent to the site to be treated (Figure 1-3). If in doubt contact the regional US Fish and Wildlife Service Office or the nearest California Department of Fish and Game office. **Note**: sewers may not be devoid of endangered species. It is reported that the endangered Gray Myotis bat is present in the city sewers of Pittsburg, Kansas.

Hazard Communication Standards. Regulations administered by state and federal Occupational Safety and Health Administrations (Federal OSHA and Cal-OSHA) require employers to provide protection to workers who may be exposed to hazardous chemicals under normal operating conditions or in emergencies. The regulation requires employers to:

- make list of hazardous chemicals in the workplace
- obtain material safety data sheets (MSDS) for all hazardous substances on their lists
- ensure that all containers of hazardous materials are labeled at all times
- train all workers about hazards in their workplaces and document training
- keep files (including the MSDSs) on the hazardous chemicals and make them available to workers

2 Roots in Sewers



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 in areas where pipes are seasonally under a water table; and exfiltration of sewage into soils around cracked or separated joints.

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 verified through video probing. In the long run, structural damage is probably more costly than sewer stoppages. Effective use of early, preventive root control can avoid costly and permanent structural damage. However, municipalities are unlikely to fund preventive root control programs but usually wait until identified problems alert 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; and (3) they absorb and conduct water and nutrients.

Roots are tenacious and long-lived. Aboveground plant parts depend on root systems for survival (Figure 2-1). Most plants can regenerate after having been topped but none can survive the loss of their root systems. For example, a willow tree root system can survive for many

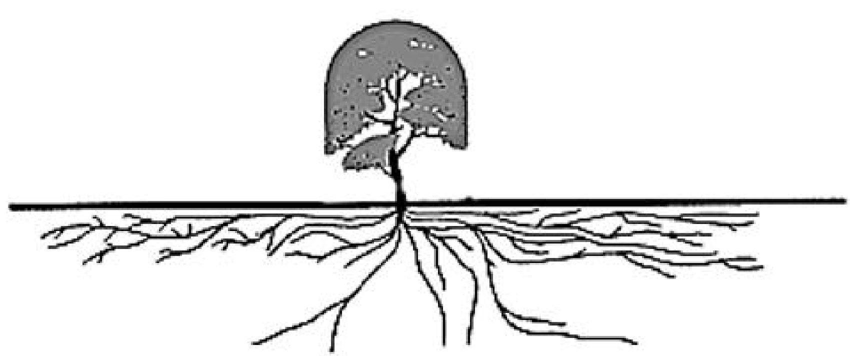


Figure 2-1. The aboveground parts of trees depend on elaborate root systems for survival. Roots can travel hundreds of feet to moisture and nutrients.

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 are thought to have remained alive for thousands of years. Just how far roots will grow in search of moisture and nutrients is uncertain. However, in the Rocky Mountains of Colorado, live tree roots have been found penetrating a pipe in the Moffet tunnel, 2500 feet from the nearest tree.

Root Systems

Plants may have either fibrous or tap root systems. Plants with fibrous root systems, such as garden plants and grasses, occupy the upper layers of soil and extend outward. These types of root systems not normally associated with sewer problems.

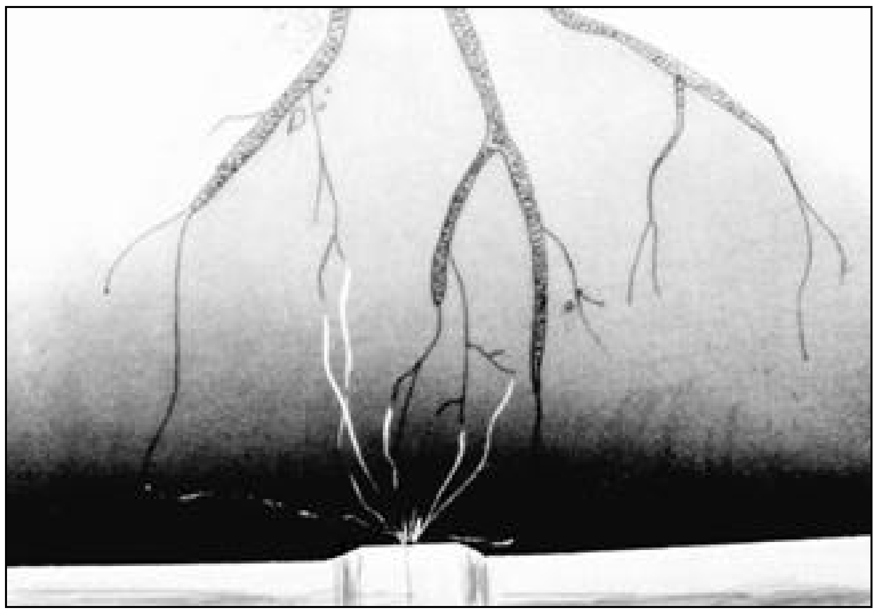


Figure 2-2. Plants with tap roots, such as trees and woody shrubs, can invade sewer pipes. These roots can exert enough pressure to spread pipe joints and break pipes.

Plants with tap root systems include trees and woody shrubs. The primary roots of these plants grow downward into the soil. Tap root systems are well adapted to deep soils and soils where the water table is relatively deep. Branches, or secondary roots, grow laterally from the primary root. Secondary root structures can grow to several inches in diameter. If these invade sewer pipes, they can exert enough pressure to spread pipe joints or break pipes (Figure 2-2).

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

Factors Influencing Root Growth. Little is known about the growth rate of tree roots. However, root growth in deciduous trees is generally greatest in fall, winter, and spring before leafing. During these times roots are either storing or distributing nutrients. Root growth becomes less active in the late spring and summer seasons when aboveground portions of trees are growing. Roots respond to moisture, nutrients, and soil temperatures. The leading tip of root shoots, the meristem, can detect and grow toward nutrients and moisture. This tendency for roots to grow toward moisture is called hydrotropism. As water tables drop, tree roots grow deeper in search of moisture. When soil moisture is depleted roots begin to wilt and will eventually die. Roots are always growing because parts of the root system are constantly dying as they deplete nutrients or moisture in an area of soil.

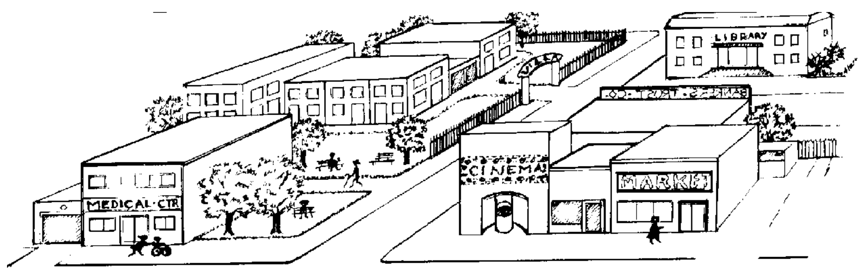


Figure 2-3. Urban environments often do not provide adequate water or nutrients for tree growth. Tree roots seek out other sources, including sewer lines.

In urban environments, good sources of nutrients and moisture for tree roots may be scarce. Much of the soil surface is covered with concrete and asphalt (Figure 2-3). Leaves and other organic debris from lawns and landscaped areas are hauled away, preventing these materials from increasing soil nutrient levels. Storm sewers drain surface water away from planted areas, reducing available sources of water for plant roots. These factors cause tree roots to seek water and nutrition at greater depths or from other sources.

Moisture and warm temperatures surrounding sewer pipes create excellent environments for root growth. Temperature variance between wastewater flow within the pipes and surrounding soil may cause condensation to form on outer pipe surfaces, providing a source of moisture. Backfill used during sewer construction may provide more favorable soil for root growth than surrounding undisturbed soils. Also, loose pipe joints, cracks, and pipe porosity allow water with high nutrient content to seep from the pipes into surrounding soils. Sewer lines above the water table will draw roots in that direction. During colder seasons, especially where ground frost occurs, warmer soil temperatures surrounding sewer pipes may attract tree roots.

Heavy secondary root structures may follow sewer pipes for many feet, exploiting each opportunity to penetrate them. Even microscopic openings only a few cells wide permit hairlike root structures from these roots to penetrate pipe joints, cracks, connections, or any other openings (Figure 2-4). Once they gain entry, roots thrive in sewer pipes because sewer pipes usually provide a perfect hydroponic environment—roots are suspended in a well-ventilated, oxygen rich atmosphere with a plentiful supply of water and nutrients.

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 permanent water table. With adequate water available, roots need not expend energy trying to penetrate the water tables and sewer pipes. However, if a water table fluctuates, or if porous soil profiles permit rapid downward drainage of rain water, roots can be found in saturated soils and can be a major cause of sewer infiltration. In these cases, tree roots suspended in the atmosphere of sewer lines can carry on metabolic activity while the woody, submerged portions of root systems serve as pipelines for plant nutrients.

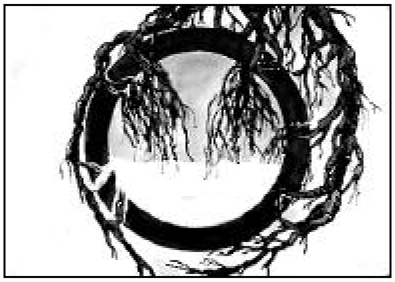


Figure 2-4. Hairlike roots can enter microscopic openings in sewer pipes. Once inside, they rapidly grow to exploit the water and nutrients.

Roots in the Sewer Environment. Several types of root structures are found in sewer lines. Veil type root structures occur in lines with steady flows, such as interceptor pipes and other constantly flowing lines. Roots penetrate these pipes at the top or sides and hang from upper surfaces like curtains, touching the flow. Live roots are seldom found below the water level within pipes with steady flows. These hanging roots rake the flow and accumulate solids and debris. Grease and other organic materials also accumulate. Eventually root masses and accumulated materials cause flows to stop. In these situations, gasses may develop in the sewer lines.

Tail type root structures occur in sewers that have very low or intermittent flows, such as in small diameter collector sewers, building sewers, and storm drains. Tail root structures look like horse tails. The roots grow into the pipes from the top, bottom, or sides, and continue to grow downstream filling the pipe. Tail root structures over 20 feet long have been removed from sewer lines. 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 prevent root growth.

Roots that enter sewers and those visible during a video inspection of sewer lines represent only a small percentage of the total root structures in the vicinity. Roots girdling the pipe on the outside are also responsible for pipe damage because they can enter joints and cracks and cause breakage as they swell.

IDENTIFYING SEWER LINE ROOT PROBLEMS

In sewer line root control, you are confronted with the problem of determining which sewer lines have been infiltrated by roots. Several indicators are available for determining which collection lines have root penetration. Use the following information to help you identify root infiltration problems:

Maintenance Histories. Maintenance records will show which sewer lines have experienced stoppages and the causes of these .

Sewer Line Video Reports. If sewer lines have been examined with video cameras, the video tapes will provide documentation of root problems and help you make assessments of the extent of infiltration.

Commonalties In Root-prone Areas. Generally, sewer lines in the same area that were installed at the same time and have similar tree-planting patterns will experience similar root problems.

PREDICTING SEWER LINE PROBLEMS

Conditions which increase the likelihood of root problems in a particular sewer section include:

- 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 curb lines near trees and roots
- sewer lines located along tree-lined streets and easements
- sewer lines with many lateral connections per lineal foot (these afford greater opportunities for root intrusion)
- sewer lines located in residential areas (residential sewer lines are more susceptible to root problems than those in industrial areas)
- sewer lines constructed with loose-fitting joints or out-dated joint packing materials (asbestos-cement pipes, orangeburg pipes, and clay tile sewers with oakum joints are very susceptible to root penetration while systems with air-tight rubber gaskets and seamless pipes are less susceptible)

A useful tool for planning root control programs is the scattergram. This is a map of a sewer collection system with known root problem lines highlighted. As root-related stoppages occur, or if other evidence of root problems is detected, the line is highlighted on the map. Over time, patterns begin emerging that will indicate areas which are root-prone (Figure 2-5).

Figure 2-5. Marking problem areas on a sewer system map can assist in planning root control programs. This map is known as a scattergram.

ROOT CONTROL METHODS

A successful sewer line root control program will integrate a variety of root control methods. This includes *non-chemical* control methods such as planning and management during sewer line construction, physical control procedures, and mechanical root removal. Non-chemical methods are usually augmented with *chemical* control methods when necessary. Chemical control involves the use of certain herbicides.

Non-Chemical Control

Several non-chemical methods of sewer line root control are available to root control experts 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 line maintenance. For example, mechanical methods are best for opening plugged sewers and for removing roots from sewers that are at imminent risk of plugging. Pipe re-lining, grouting, and sealing may deter intrusion by roots. Proper planning during design and installation of sewer lines may discourage root problems.

In some cases chemical control methods should not or cannot be used. For instance, chemicals are not normally applied to sewer lines that are near treatment plants. Also, herbicide use may be restricted due to environmental or safety considerations.

Planning. Proper planning during sewer line design and construction is a practice that can prevent or minimize tree root invasion problems. Root problems are reduced by: (1) carefully installing and inspecting sewer lines during construction to assure all joints are properly sealed; and (2) controlling the selection of tree species and planting sites near sewer lines. Sewer connections with air-tight joints and seams make it difficult for roots to penetrate. Municipalities should pay special attention to and carefully inspect connections where plumbers join building laterals to the mainline sewer to be sure these are tight. 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 and can cause serious sewer line problems.

Physical Control. Physical control of sewer line roots involves isolating the environment of the sewer pipe from roots that could cause problems. Examples of physical control include tree removal, sewer pipe replacement, and pipe relining.

Tree removal works best when removing a single troublesome tree such as a willow whose roots have invaded sewer pipes. Unfortunately it is often difficult to convince homeowners to remove trees in the vicinity of sewer lines. This is not only expensive but does not guarantee an end to root problems. Roots may survive long after removal of aboveground tree parts, necessitating the use of mechanical or chemical controls for some time afterward. For tree removal to be most effective, stumps should be removed or chemically treated with a basal application herbicide.

Pipe replacement involves removing old, defective sewer lines and replacing them with new pipes. As discussed above, the new lines must have air-tight joints and properly installed connections in order to prevent tree roots from becoming problems. Pipe replacement corrects structural defects as well as existing root problems. Major disadvantages to pipe replacement include cost, disruption of traffic and property, and the destruction of trees and shrubs planted in the vicinity of the trench line. Also, roots can still enter the newly installed line through older lateral lines coming from buildings. If existing sewer pipers are in danger of collapsing or are in a state of structural failure, pipe replacement may be the best method of control. Pipe replacement is not warranted, however, when sewer lines are in sound structural condition.

Pipe lining includes various techniques that are used for rehabilitating sewer pipes. Roots must be chemically or mechanically removed before installing pipe linings. A method known as *slip-lining* involves pulling a seamless pipe through the existing sewer and digging only where building laterals require connecting. Installing a *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 lateral building connections into the liner.

Installing linings in existing sewer lines addresses infiltration problems and some structural defects and is less disruptive than pipe replacement. This technique promises long-term control against root regrowth through joints and cracks. A disadvantages to this technique is that it is often more costly than sewer line pipe replacement. Also, roots can still re-enter the mainline sewer through unlined building laterals. Even after relining the mainline, chemical control may be required to prevent roots from penetrating through these service connections.

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

Drill machines, also called coil rodders, are spring-like, flexible steel cables which turn augers or blades inside the sewer line. These devices are either hand or power driven. Drill machines are most often used by plumbers to relieve blockages in house-lines or other small diameter sewers. They are seldom used in mainline 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. A jetter consists 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 as 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 sewer lines, especially where there are protruding taps or other structural defects. Once root cutters become stuck they often can only be removed by digging them out.

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

The main advantage of mechanical controls is that they are the only methods of immediately relieving root blockages. Chemicals are ineffective and dangerous when used in plugged or surcharging sewers. Sewer stoppages are emergency situations that require municipalities to have some type of mechanical control devices to correct such problems. However, mechanical control methods do not provide residual or long-term control. Roots respond to injury by producing the plant hormone *abscisic acid* which hastens and thickens regrowth. As a result, root masses grow back heavier each time they are cut. Tap roots continue to grow in diameter and in time place additional stress on sewer pipes.

Mechanical control is often used in conjunction with chemical or other controls. For example, mechanical cleaning is used to prepare sewer lines for rehabilitation with pipe lining or regrouting.

Chemical Root Control

Herbicides registered by the US EPA and the State of California for use as root control agents can kill roots for distances beyond the point of contact, providing control of root growth even outside sewer pipes. Choosing the best herbicide for the job is important. Herbicides kill plants or plant parts by contact or through systemic action. A *contact herbicide* has a localized effect and kills only the plant parts contacted by the chemical. *Systemic herbicides* are absorbed by roots or foliage and carried throughout the plant. Contact herbicides result in quick die-back of the affected parts while systemics take longer, up to two weeks or more, to provide the desired results. Metam-sodium is a contact herbicide.

Herbicide activity is either selective or non selective, depending on the chemical used. 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, for example, is a non selective herbicide.

Many chemicals such as bensulide, dichlobenil, dinoseb, endothall, metam-sodium, paraquat, trifluralin, 2, 4-D, 2, 4, 5-T, copper sulfate, and chlorthiamid have been used for root control. 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. Not all of these herbicides are registered for use in California for sewer root control. Before using any chemical for root control, check to see that it is labeled for use in California for this purpose.

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

Fabric or rubber impregnated with trifluralin pellets is a method of sewer line root control used at the time of pipe installation. The impregnated fabric is placed between sewer pipes and trees in the area at the time of sewer line installation. The fabric is porous to allow water to pass through. The trifluralin pellets are time-released and manufacturers claim that the active ingredient leaches only a few inches before being tied up in the soil. Trifluralin-impregnated rubber is used for joint gaskets. Trifluralin is not water soluble.

Advantages of this method are long lasting root control without need for retreatments. Also, pesticides are not directly introduced into the sewer collection system, thus reducing environmental risk. The major disadvantage of this method is that installation must be done well in advance of roots actually becoming a problem. This method cannot be employed economically after root intrusion problems occur.

In many cases 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 cause leaf damage and could result in the death of trees and other plants. 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 have had widespread use by plumbers and homeowners as a *pour down* application for controlling roots in building sewers.

Copper is a heavy metal which may not be removed by the normal sewage treatment process. It is also toxic to beneficial microbes used in the sewage treatment process. Copper compounds are pollutants in sewage plant effluents and the biomasses (sludges) and are therefore potential environmental contaminants. *Copper compounds are not registered for use in California for sewer line root control.*

Metam-Sodium and Dichlobenil. Synonyms for metam-sodium: metam, metham-sodium; trade names for metam-sodium: Vapam®, Trimaton®, Metam 426®, Metam 42®; trade names for dichlobenil: Casaron®, Barrier®.

Metam-sodium and dichlobenil have been used together as root control products in sewers for over 30 years. After application, metam-sodium breaks down into methylisothiocyanate (MITC) gas which also has herbicidal activity on plant roots. It is non-systemic and is not taken up into the plant, but kills roots on contact. Metam-sodium is used with dichlobenil because dichlobenil is an effective root growth inhibitor.

These two pesticides were originally applied together by using spray or soak methods. Soaking entailed plugging a pipe and filling it with a mixture of the chemicals for a period of time. This allowed the herbicides to penetrate blockages and to also soak out through cracks and joints, providing some root control around the outside of sewer pipes. The spray method involved spraying interiors of sewer pipes with a solution of these two herbicides. Dosages were difficult to control with these methods and as a result soaking or spraying methods are no longer used.

The current application method involves applying metam-sodium products in foam carriers (similar to shaving cream). Specialized foam-generating equipment is used to produce the foam which is then applied to the interiors of sewer pipes. Applications are made through hoses which are inserted into pipes being treated. While the hoses are being retracted, foam is pumped in, filling sewer pipes with foam. As the foam collapses (over a period of approximately 1 hour) it has a tendency to adhere to pipe and root surfaces.

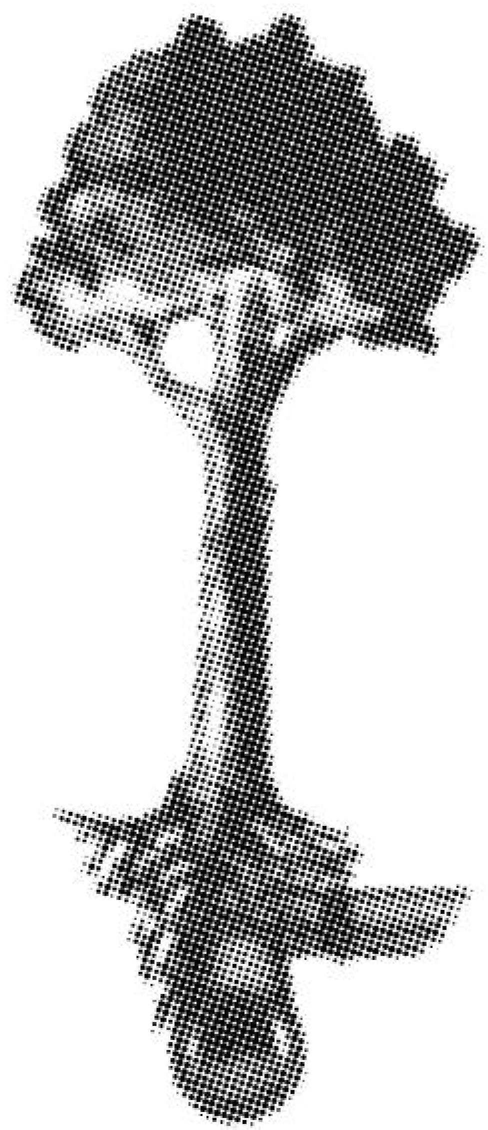
Foam that does not adhere to the roots and pipe walls enters the wastewater that is running through the sewers and is carried to treatment facilities. The dilution of the product in the wastewater and the rapid breakdown characteristics of metam-sodium allows a safety margin for treatment plants.

Treated roots are killed within hours of foam application. After the roots die, bacteria and other microorganisms in the sewers begin to break down the dead root tissues. 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 treatment plants for disposal. Root retreatment will probably be needed in approximately three years.

Sodium Hydroxide and 2,6 Dichlorobenzonitrile.

Sodium hydroxide acts to liquify soluble materials such as grease and soap that contributes to sewer line blockage. 2,6, dichlorobenzo-nitrile is a growth control agent that assists in destroying tree roots and supresses regrowth. This material has contact activity and is adsorbed on organic material and clay, creating a barrier to root regrowth.

3 Root-Control Pesticides



Several sewer line root control pesticides are classified as *restricted-use* and as such must be handled and applied only by certified pesticide applicators or under the direct supervision of certified applicators. This chapter and the remaining chapters of this book will provide information to help you safely and legally handle and apply these root control herbicides.

PESTICIDE FORMULATIONS

Figure 3-1. Pesticides used for sewer line root control are made up of active and inert ingredients. These must be diluted with the proper amount of water before use.

A pesticide that you purchase for sewer line root control is made up of active and inert ingredients (Figure 3-1). *Active ingredients* are the chemicals that control target pests. The herbicidal chemicals used for sewer line root control (active ingredients) are dissolved in carriers such as oil, water, or in the case of wettable powders, finely ground clay. Other chemicals such as surfactants may also be part of the pesticide you purchase. These carriers, surfactants, and other materials that do not have pesticidal activity are known as *inerts*. Inerts usually make the product easier to apply, more convenient to handle, and more accurate to measure. They sometimes make pesticide products safer to handle. A mixture of active and inert ingredients is called a *pesticide formulation*. Some types of formulations are ready for use and can be applied directly from their containers. You must dilute other formulations with water, petroleum solvents, or air, before they are applied.

Types of Formulations

The same active ingredient may be available in two or more different kinds of formulations. Certain formulations are more suitable when you must consider factors such as type of pests being controlled, available application equipment, application site hazards, and safety to applicators, the public, and the environment where the application is being made. Table 3-1 lists some of the types of pesticide formulations. When controlling tree roots in sewer lines, the choice of formulation type has been much simplified since there is a single type of target pest confined to the interiors of pipes. Two formulations you will encounter are foams and wettable powders.

Foams. In sewer-line root control, foams are the only method approved for applying metam-sodium herbicides.

Table 3-1. Suffixes of Chemical Brand Names and Their Meanings.

SUFFIX	MEANING
Describe the Formulation:	
AF	Aqueous Flowable
AS	Aqueous Suspension
D	Dust
DF	Dry Flowable
E	Emulsifiable Concentrate
EC	Emulsifiable Concentrate
ES	Emulsifiable Solution
F	Flowable
FL	Flowable
G	Granular
OL	Oil-Soluble Liquid
P	Pelleted
PS	Pelleted
S	Soluble Powder
SG	Sand Granules
SL	Slurry
SP	Soluble Powder
ULV	Ultra-Low-Volume Concentrate
W	Wettable Powder
WDG	Water-Dispersible Granules
WP	Wettable Powder
Describe How a Pesticide is Used:	
GS	For Treatment of Grass Seed
LSR	For Leaf Spot and Rust
PM	For Powdery Mildew
RP	For Range and Pasture
RTU	Ready To Use
SD	For Use as a Side Dressing
TC	Termiticide Concentrate
TGF	Turf Grass Fungicide
WK	To Be Used with Weed Killers
Describe Characteristics of the Formulation:	
BE	The Butyl Ester of 2,4-D
D	An Ester of 2,4-D
K	A Potassium Salt of the Active Ingredient
LO	Low Odor
LV	Low Volatility
MF	Modified Formulation
T	A Triazole
2X	Double Strength
Label For Use in Special Locations:	
PNW	For Use in the Pacific Northwest
TVA	For Use in the Waterways of the Tennessee Valley Authority

Advantages of Metam-Sodium Foam

Foam applications of metam-sodium are used because:

- they effectively fill pipe voids above the flow lines, contacting pipe walls and root masses
- foams do not break down for a period of time after application and therefore provide the required contact time for metam-sodium
- foams prevent metam-sodium vapor from drifting through pipes into manholes and house vents
- foam formulations contain surfactants and emulsifiers which increase metam-sodium herbicide penetration through the grease and organic deposits on root masses
- foam applications allow treatments to take place while pipes remain in service

Foam quality may vary and is difficult to define. For instance, foam may have the consistency of an aerosol shaving cream (dense, small dry bubbles) or that of dish washing soap suds (fluffy, large watery bubbles). For sewer use, the desired bubble type has an appearance similar to shaving cream. Drier foams are used to treat smaller pipes—less than 12 to 14 inches in diameter—and wetter foams are used to treat pipes greater than 14 inches in diameter. Drier foams are used to fill pipes while wetter foams are used for coating pipe interiors. Each of these types of foams are registered for use under separate usage instructions and separate EPA Registration Numbers.

Specially designed foam generating equipment is required to produce and deliver foam formulations of metam-sodium to the interiors of sewer pipes. For sewer line root control training purposes *dry foam* is 20 gallons of foam produced from 1 gallon of chemical-water solution. *Wet foam* is 14 gallons of foam produced from 1 gallon of chemical-water solution.

Wettable Powders (WP).Wettable powders are dry, finely ground formulations which look like dusts. They must be mixed with water for application. Dichlobenil as used in sewer line root control falls into this classification. Two formulations of wettable powder are available for sewer line root control—50W and 85W. The 50W is lighter weight so stays in suspension longer.

METAM-SODIUM

Metam-sodium (sodium-N-methyldithiocarbamate), is also known as metham sodium, SMDC, Vapam®, Busan®, and other trade names. Metam-sodium is a fumigant pesticide with end use products formulated as 18% to 42% aqueous solutions. This chemical has been registered since 1954 for use in agriculture as a preplant fumigant to control weeds, nematodes, fungi, bacteria, insects, and other pests. There are approximately 35 registered metam-sodium products. Some minor applications include its use as a wood preservative, slimicide, tree root control agent, and aquatic weed herbicide. Metam-sodium has been used commercially in combination with dichlobenil for sewer root control since the early 1970s.

Reactivity

Figure 3-2. To protect your lungs from the breakdown products of metam-sodium, always wear appropriate respiratory equipment.

Metam-sodium is stable under normal conditions and very stable at a pH higher than 8.8 The commercial metam-sodium formulation is stable at a buffered pH of about 10. Metam-sodium is unstable below pH 7 at which point it breaks down into other chemical compounds. Prolonged exposure to air results in gradual decomposition to form MITC, a poisonous gas. When metam-sodium is mixed with water it rapidly converts to MITC. MITC gas penetrates root masses to kill roots and is much more toxic than metam-sodium. MITC may reach unsafe levels in poorly ventilated or confined spaces, so use of air-supplied respirators are required under such conditions.

During normal conditions of use metam-sodium is diluted with water and air to create a foam. Dilution with water lowers the solution's pH, causing rapid breakdown of the metam-sodium. In addition to MITC, hydrolysis also yields a very small amount of carbon disulfide (CS_2), hydrogen sulfide (H_2S), elemental sulfur, and 1,3-dimethyl-thiourea.

Inhalation Exposure

The exposure hazard of metam-sodium by inhalation is assumed to be slight. However, since metam-sodium decomposes to MITC, CS_2, H_2S, and other products, a significant hazard potential exists (Figure 3-2). MITC is a gas that is extremely irritating to respiratory mucous membranes and the lungs. Inhalation of MITC may cause pulmonary edema (severe respiratory distress, coughing of bloody, frothy sputum). For this reason metam-sodium must be used outdoors only and precautions must be taken to avoid inhalation of evolved gas by wearing an approved canister respirator or air supplied respirator. If pulmonary irritation or edema occur as a result of inhaling MITC, transport the victim promptly to a medical facility.

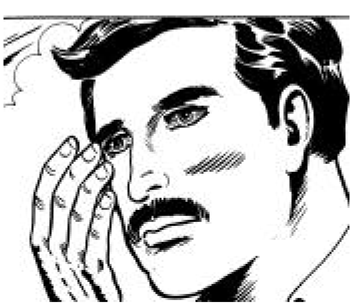


Figure 3-3. MITC, the breakdown product of metam-sodium, is extremely irritating to the eyes. Always wear protective eyewear when working with metam-sodium.

Dermal and Eye Exposure

Exposure to metam-sodium through the skin or eyes is expected to be minimal if adequate personal protective equipment (PPE) is worn. In addition to an approved respirator, the personal protective equipment must include chemical resistant gloves, long sleeved shirt, long pants, shoes and socks, and goggles. Since the surface of the skin is acidic, pH MITC is extremely irritating to the skin and eyes (Figure 3-3). Contamination of the skin or eyes should be treated immediately with copious amounts of water to avoid burns or corneal injury. If skin or eye irritation persists, seek medical attention.

Developmental Effects

Studies with laboratory animals indicate that metam-sodium ingested over a period of several days can cause pregnant female test animals to lose weight and their fetuses and offspring to exhibit skeletal irregularities.

DICHLOBENIL

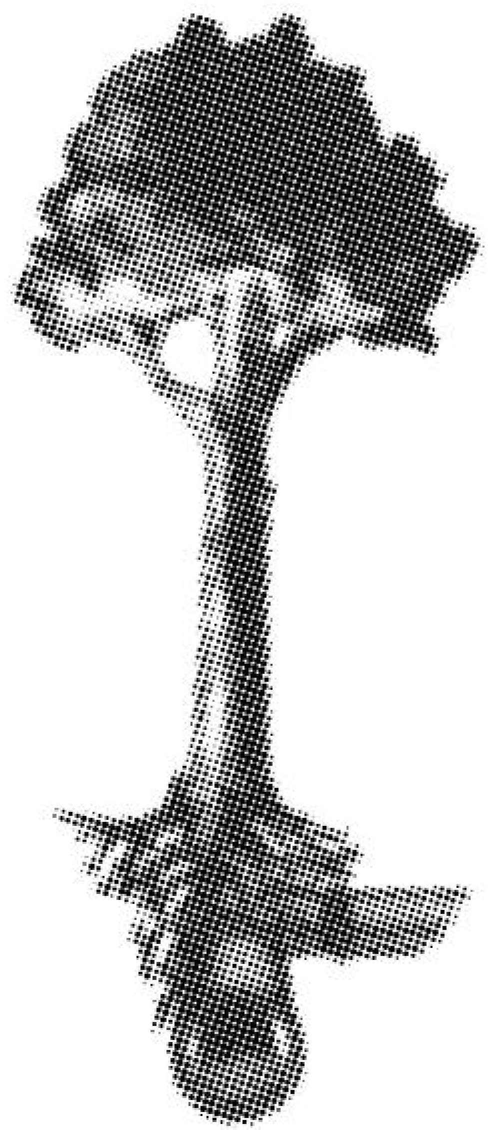
Dichlobenil is a residual-type pesticide formulated as a wettable powder (WP), a flowable soluble-concentrate liquid (F), and as granules (G). The chemical has been registered since 1964 as an herbicide to control broadleaf weeds, grasses, and aquatic weeds. Dichlobenil is also applied as an additive to chemical grouts to aid in the control of tree roots in sewer-lines. For sewer use it is formulated as a 50% or 85% wettable powder and is frequently used in combination with metam-sodium.

Dichlobenil kills weeds by impairing metabolic processes that are unique to plant life. For this reason its mammalian toxicity is low. Nonetheless care should be exercised when handling this and any pesticide or pesticide combinations. Consult the product's label and material safety data sheet (MSDS) for precautionary instructions.

SODIUM HYDROXIDE

Sodium hydroxide is a strongly alkaline chemical (lye) that has been used for many years to clean out plugged drains in buildings. This chemical softens or liquifies organic materials, helping to remove blockages. Sodium hydroxide is extremely caustic and will cause serious skin burns. It will also cause irreversible eye damage if splashed into the eyes. It may be fatal if swallowed or absorbed through the skin.

4 The Metam-sodium Label



The pesticide *label* is the information attached to the pesticide container. Labeling includes the label plus all other information you receive from a manufacturer about the product. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires that specific information be printed on container labels of all registered pesticides—therefore labels are legal documents. This requirement is made to protect people, animals, plants, and the environment. Some labels are easy to understand while others may be more complicated. But all labels will tell you how to use the product correctly and legally (Figure 4-1). This chapter explains the items that must be on a label.

Root control herbicides containing metam-sodium and dichlobenil are packaged as two parts because they consist of two types of formulations. The contents of the packages must be mixed together in the field just before application. In some cases, manufacturers also package the foaming agent separately rather than including it in the metam-sodium formulation. You will find product labels on each of the separately packaged containers that pertain to the specific ingredients. A general package label lists all the ingredients contained in the complete package. Each label contains the statement: *Only for use as a combination of metam-sodium, dichlobenil, and foaming agent as directed.*

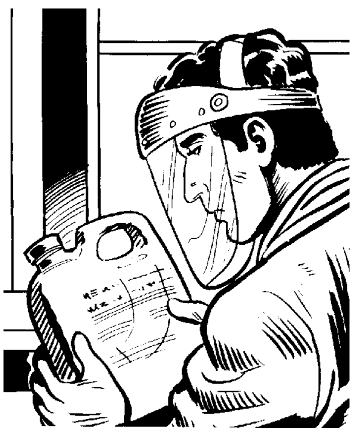


Figure 4-1. Pesticide labels are important sources of information and they describe how to use the product legally.

THE PESTICIDE LABEL

The Federal Insecticide, Fungicide, and Rodenticide Act requires that certain statements appear at specific locations on pesticide labels. These statements are described below. The letters that follow each of the statement headings correspond to the letters on the sample pesticide label illustrated on the following page.

Statement of Use Classification (A)

The statement *Restricted Use Pesticide* is placed prominently at the top of the front label. It also may include a brief statement why the pesticide is classified for restricted use. Metam-sodium root control products include the statement: *These products can only be purchased and/or applied by or under the direct supervision of a certified applicator.*

A

RESTRICTED USE PESTICIDE
FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

B

Root-Nip®

C

A nonsystemic fumigant solution for pruning roots in wastewater collecting systems

Only for use as a combination of metam-sodium, dichlobenil, and foaming agent as directed.

D

ACTIVE INGREDIENT	**% by weight**
Metam-sodium (sodium methyldithiocarbamate)	30%
INERT INGREDIENTS	70%
Total	100%

Contains 3.18 lbs. active ingredient per gallon.

I

EPA Reg. No. 64945-3 EPA Est. No. 44616-MO-1

KEEP OUT OF REACH OF CHILDREN

DANGER - PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
If you do not understand the label find someone to explain it to you in detail.

STATEMENT OF PRACTICAL TREATMENT

FIRST AID: ▪ Immediately start the procedures given below and contact a Poison Control Center, a physician, or the nearest hospital. Report the type and extent of exposure, describe the victim's symptoms, and follow the advice given.

IF ON SKIN: ▪ Immediately flush skin with large amounts of running water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately.

IF ON EYES: ▪ Immediately flush eyes with large amounts of running water for at least 15 minutes. Hold eyelids apart to ensure rinsing of the entire surface of the eye and lids with water. Get medical attention immediately.

IF INHALED: ▪ Remove to fresh air. If not breathing, clear the victim's airway and start mouth-to-mouth artificial respiration. If breathing is difficult, give oxygen, preferably with a physician's advice. Get medical attention immediately.

IF SWALLOWED: ▪ Immediately give several glasses of water but do not induce vomiting. If vomiting does occur, give fluids again. Have a physician determine if condition of patient will permit induction of vomiting or evacuation of stomach. Do not give anything by mouth to an unconscious or convulsing person.

FOR ADDITIONAL PRACTICAL TREATMENTS SEE INSIDE LABELING

In case of significant spills call
CHEMTREC 1-800-424-9300

ABC CHEMICAL COMPANY
1234 MAIN STREET
ANYTOWN, USA 00001
1-800-123-4567

NET CONTENTS: 2.5 gallons

Brand Name (B)

Manufacturers generally devise brand names for their products. This is usually the largest and most conspicuous wording on the label. Different manufacturers may use different brand names for the same pesticide active ingredients. Most companies register each of their brand names as trademarks and will not allow other companies to use those names. Brand or trade names are used in advertising and product promotions.

Type of Pesticide (C)

The type of pesticide is usually listed on the front panel of the pesticide label. This short statement indicates in general terms what the product will control. The sample label reads: *A non-systemic fumigant solution for pruning roots in wastewater collecting systems*.

Ingredient Statement (D)

Each pesticide label must list product ingredients. The percentage of each active ingredient and the total percentage of inert ingredients are included. Ingredient statements must list the official chemical names and, if they exist, common names for the active ingredients. Inert ingredients need not be named. *Active ingredients* are those chemicals in pesticide formulations that kill or otherwise control target pests. *Inert ingredients* are materials in the formulation that have no pesticidal effect.

Pesticide active ingredients usually have complex chemical names based on their molecular structures. Some pesticide chemicals have approved common names to make them simpler to identify. Although different manufacturers of the same pesticide may use different brand names they are only allowed by EPA to use approved common names. Metam sodium, for example, is the common name for the chemical *sodium methyldithiocarbamate*.

Precautionary Statements (E)

Precautionary statements must be grouped together on the front panel of the package label. These include the statement*: KEEP OUT OF THE REACH OF CHILDREN.* This statement must appear on all pesticide products regardless of classification or toxicity.

Signal Word (F)

One of these signal words—*DANGER, WARNING, or CAUTION*—must appear in large letters on the front panel of the pesticide label immediately following the *Keep Out of Reach of Children* statement

(Figure 4-2). Signal words indicate how acutely toxic the product is to people. Signal words are based not only on active ingredients, but on all the contents of the formulated product. Use signal words to help you determine the potential hazards of the pesticides you are using.

Figure 4-2. Signal words on pesticide labels provide an immediate indication of the potential hazards of the materials.

SIGNAL WORDS

DANGER (with skull and crossbones) - This includes all highly toxic pesticides that are very likely to cause acute illness through oral, dermal, or inhalation exposure. Labels carry the word DANGER along with POISON and a skull and crossbones symbol printed in red. TOXICITY CATEGORY I

DANGER - This word signals a pesticide is highly toxic or poses a dangerous health or environmental hazard. Metam-sodium labels display the DANGER signal word because the chemical is highly corrosive to the skin. TOXICITY CATEGORY I

WARNING - This word indicates that the product is moderately toxic orally, dermally, or through inhalation or causes moderate eye and skin irritation. TOXICITY CATEGORY II

CAUTION - This word signals that the product is slightly toxic orally, dermally, or through inhalation or causes slight eye or skin irritation. TOXICITY CATEGORY III

Statement Of Practical Treatment (G)

This statement provides instructions on how to respond to an emergency exposure situation. The instructions may include first aid measures and may advise seeking medical help.

Referral Statement (H)

If the *Statement of Practical Treatment* is not located on the front panel of the label or if other information is included this statement will refer you to the section of the label or labelling where the *Statement of Practical Treatment* or other information may be found.

EPA Registration and Establishment Numbers (I)

An EPA registration number indicates that the pesticide label has been registered by the EPA. This number identifies both the registrant and the product. Products registered in California will also include a California Department of Pesticide Regulation registration number.

Establishment numbers appear on either pesticide labels or containers. They identify the facilities that formulated the products and the locations of those establishments by state.

Company Name and Address (J)

The name and address of the manufacturer, registrant, or person or firm registering the product must appear on the label. If the registrant is other than the manufacturer, the label should indicate both parties.

Net Contents (K)

The front panel of the pesticide label tells how much material is in the container. This can be expressed as pounds or ounces for dry formulations and as gallons, quarts, or pints for liquids. Liquid formulations may also list the pounds of active ingredient per gallon of product.

Note that separately-packaged root control products have the weights of the individual container ingredients on separate labels. The overall package label has the combined weights of all the products.

Misuse Statement

A misuse statement must appear on all pesticide labels and state in general terms that it is a violation of Federal Law to use the product in a manner inconsistent with the label.

Other Important Statements On Pesticide Labels

Precautionary Statements

The precautionary statements section is a special part of a pesticide label used to describe the hazards associated with a chemical. Always read and follow the instructions given in a precautionary statement. Three areas of hazard may be included. Most important are the hazards to people and domestic animals. This section tells why the pesticide is hazardous, what adverse effects may occur, and describes the type of protective equipment that one must wear while handling packages and mixing and applying the pesticide.

The second part of a precautionary statement gives information on environmental hazards. It indicates if the pesticide is toxic to nontarget organisms such as honey bees, fish, birds, or other wildlife, and may contain information on how to avoid environmental contamination.

The third part of the precautionary statement explains special physical and chemical hazards, such as risks of explosion if the chemical is exposed to sparks, or hazards from fumes in the case of a fire.

Personal Protective Equipment (PPE) Statements. Metam-sodium root control labels are very specific on the PPE requirements. These statements tell you the minimum PPE that you must wear when handling the pesticide. An individual may wear more than required, but not less.

Environmental Hazards. Metam-sodium labels contain the statement *toxic to fish and aquatic life*, indicating the chemical is hazardous to aquatic life if not used correctly.

Environmental Statements. Some environmental statements appear on nearly every pesticide label. They are reminders of common sense actions to follow to avoid contaminating the environment. The metam-sodium root control label follows these general statements with specific statements and practical steps to take to avoid harming wildlife. Root control labels contain the following wording:

> *Disposal of equipment wash water and wastes*: Equipment wash water and wastes resulting from the use of this product may be disposed of on-site according to label directions for use by flushing the wastes into the sewer line just treated, or wash water and wastes may be transported to an approved waste disposal facility.
> *Precautions regarding product use*: Do not to use this product in storm, field, or other drains unless the effluent is treated in a sanitary sewer system. Keep off lawns and plants, as they may be severely injured.
> *Cleaning up spills*: Foam should be shoveled off planted areas immediately rather than washing off with water.

Specific Use Precautions

Metam-sodium root control products contain two special use precaution sections:

Use Precautions Around Buildings. Due to the health risks involved in using metam-sodium products, special precautions must be used around people. Take special consideration of sewer service lines, buildings, and basements. The major concern is that the root chemical foam will be inadvertently forced up service lines and into homes, jeopardizing the health and safety of the inhabitants.

Explicit directions for avoiding backups are included in this section. Building drains may be plugged to protect against backup and flooding. Follow the directions for measurement and apply carefully to avoid using excess foam that may be forced up lateral lines into building drains.

Specific directions are given if the situation should arise that a building has been penetrated with metam-sodium fumes: “Building occupants should exit structures if the pungent, rotten egg odor of metam-sodium is detected. Open windows and ventilate with fans. Flush drains with ample water if the odor comes from them.” Also included are specific directions for cleanup: “Use squeegee, dust pan, or wet vacuum and garbage bags for spills of backups and dispose of foam and liquid in an open drain or manhole. After removal of foam and liquid, wash area of spill or backup with water and detergent and flush down the drain. If rugs or cloth are contacted, take them outside to dry before laundering them separately.”

Use Precautions Around Wastewater Treatment Plants. Because high concentrations of metam-sodium root control chemicals in the waste water may adversely affect the biological sewage breakdown process in the wastewater treatment plants, a special use precaution statement is on this product label. Specific preventative application procedures are mentioned: “Large scale applications to sewage collection systems in proximity to a sewage treatment plant should be divided into smaller sectional treatments done at one or two day intervals to minimize effects on the sewage treatment process.”

To protect the treatment plant and the plant operators, specific directions are given to communicate with the plant operators. Directions are given for detecting the presence of metam-sodium in the plant: “Inform appropriate wastewater treatment plant officials prior to use so they may check for any unusual, pungent, rotten egg, or sulfur-like odor of metam-sodium above that of sewage and monitor the performance of filter beds or digesters. If the odor is detected at the sewage treatment plant or the biological breakdown process is adversely affected, root control applications should stop until normal conditions are established.”

Applicator Category

A statement restricting the handling and application of this product to a certified applicator or under the direct supervision of a certified applicator appears on metam-sodium root control labels.

Storage and Disposal Statement

All pesticide labels contain general instructions for the appropriate storage and disposal of the pesticide and its container.

Directions for Use

Pesticide labeling includes directions for safe product use and ways to protect handlers and the public (Figure 4-3).

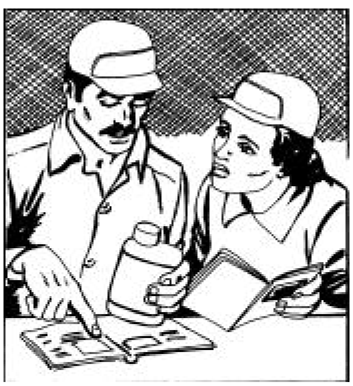


Figure 4-3. Read and follow the pesticide label directions for use. These will provide information on locations where the pesticides can be applied along with specific hazards to avoid.

READING THE LABEL

Before you buy a pesticide, read the label to determine:
- if it is the pesticide you need for the job
- if the pesticide can be used safely under the application conditions

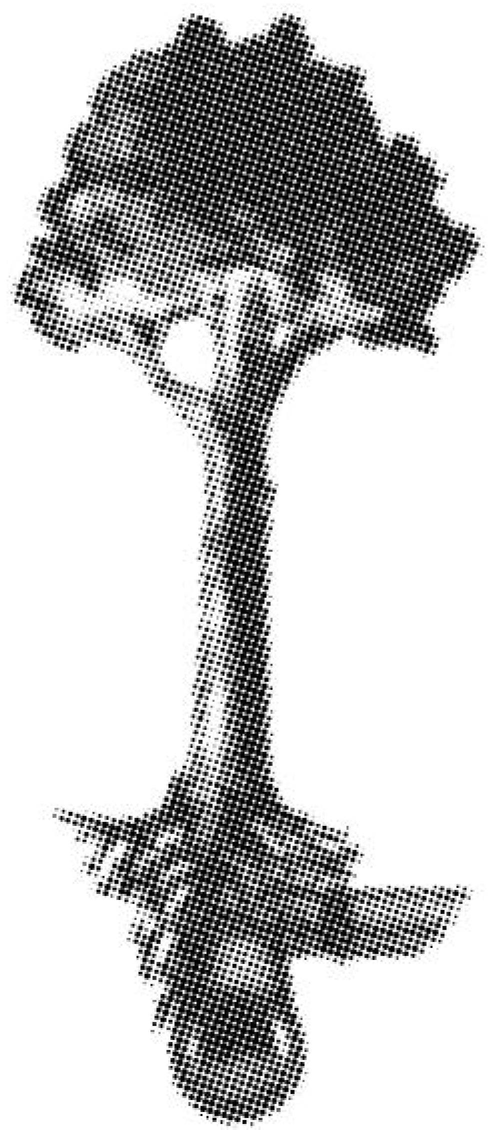
Before you mix the pesticide, read the label to determine:
- what protective equipment you should use
- what the pesticide can be mixed with (compatibility)
- how much pesticide to use
- the mixing procedure

Before you apply the pesticide, read the label to determine:
- what safety measures you should follow
- where the pesticide can be used
- how to apply the pesticide
- whether there are restrictions for use

Before you store or dispose of pesticides or containers, read the label to determine:
- where and how to store the pesticide
- how to decontaminate and dispose of the pesticide container
- where to dispose of surplus pesticides

Labels generally list other precautions to take while handling the product:
- remove and wash contaminated clothing separately from household clothing
- wash thoroughly after handling and before eating or smoking
- wear clean clothes daily
- not for use or storage in and around the house
- do not allow children or domestic animals into the treated area

5 Application Concerns



Raw wastewater quantities vary among communities, and at particular treatment plants volumes vary at different periods of time. Efficiencies and types of treatment processes vary from plant to plant as well. This chapter provides information about the basic operation of sewage systems and treatment plants and will help you understand why you must take certain precautions when making metam-sodium herbicide applications for sewer line tree root control.

WASTEWATER TREATMENT

Figure5-1. Sewer line root control pesticide applications can have serious impacts on wastewater treatment plants unless proper planning takes place before application.

Systems for handling wastewater usually have three major components: collection networks, treatment facilities, and disposal processes. An understanding of sewage handling and treatment is very important since you are introducing root control chemicals or grease eating bacteria into collection networks. The root control chemical metam-sodium, for example, is a general biocide. Therefore, this herbicide can interfere with sewage treatment processes and may have impacts on disposal processes (Figure 5-1). The extent of disruption is directly related to the concentration of chemicals reaching treatment plants and treatment process efficiencies.

Collection Systems

Complex networks of pipes and pumps of many sizes are involved in collecting and transporting wastewater from its sources to treatment plants. Typically, sewers coming into treatment plants carry municipal wastes from households, commercial establishments, and some industrial sites. These are called sanitary sewers. Storm runoff is collected separately by storm sewers, which normally discharge into water courses without treatment. In some areas, however, only one network collects both sanitary wastes and storm water into combined sewers.

Collection systems consist of interconnecting pipes of varying sizes ranging from 4-inch diameter pipes to tunnels large enough for maintenance personnel to float boats. The majority of pipes in areas serving buildings are 8 to 12 inches in diameter. Collection systems are designed to allow gravity flow from collection points to treatment plants. Sometimes it is necessary to augment gravity flow with pumps.

Sanitary sewers are normally placed at slopes sufficient to produce a water velocity (speed) of approximately 2 feet per second when flowing full. Pipes with greater slopes have higher velocities. A preferred velocity is 2½ feet per second, because this velocity will usually prevent deposition of solids that may clog the pipes or cause odors. The presence of roots in collection lines causes velocities to decrease.

Most gravity systems are broken up into sections by manholes. These openings allow maintenance personnel access to collection systems. Design criteria usually place manholes at pipe junctions or areas where pipes change grade or direction. Typically manholes are spaced at intervals ranging between 150 to 1,000 feet, with an average spacing of 250 feet.

Pumping stations are normally used in sewer systems having low areas or where pipes are deep under the ground. These pumping stations lift the wastewater to a higher point from which it may again flow by gravity. Sometimes wastewater is pumped under pressure directly to treatment plants.

Most treatment plants receiving volumes of less than 0.5 million gallons per day (MGD) have incoming pipe diameters ranging between 4 and 8 inches or occasionally between 10 and 12 inches. In areas where plant capacities are higher than 0.5 MGD, incoming pipe sizes increase in diameter as lateral flows are collected and approach the treatment plant.

Treatment Plants

When sewage reaches wastewater treatment plants it flows through a series of treatment processes which remove solids from the water. This reduces potential public health threats before wastewater is discharged from plants. The number of treatment processes and the degree of treatment usually depend on the ultimate uses for the treated water.

Although not all treatment plants are alike there are certain typical flow patterns that are similar from one plant to another. The differences in treatment process, daily flows, and treatment plant operating efficiencies all affect the treatment plants' abilities to tolerate pesticides such as metam-sodium.

When wastewater enters treatment plants, it usually flows through a series of pretreatment or preliminary treatment processes—screening, shredding, and grit removal. These processes separate coarse materials from the wastewater. Flow-measuring devices are usually installed after pretreatment processes to record flow rates and volumes of wastewater treated by the plants. Pre-aeration is used to freshen wastewater and to help remove oils and greases.

Next the sewage generally receives primary treatment. During primary treatment, some of the solid matter settles out or floats to the surface where it can be separated from the wastewater being treated.

Secondary treatment usually follows primary treatment and commonly consists of biological processes and aeration. Micro-organisms living in the controlled environments of the processing facilities are used to partially stabilize (oxidize) organic matter that was not removed by previous treatments. This stabilizing converts organic materials into solids which are easier to remove from the wastewater. Generally, secondary treatment plants provide 3 to 30 hours of holding time in the aeration portion of this process. The holding or retention time is a function of plant size and plant type. For example, a small extended aeration plant probably requires 24 hours while a 5 to 10 MGD plant uses 6 to 8 hours. Solid materials removed by these processes go to solids handling facilities and then to ultimate disposal.

Treatment ponds, called lagoons, may be used to remove solids remaining in wastewater after pretreatment, primary treatment, or secondary treatment. Lagoons are frequently constructed in rural areas where sufficient land is available. Flow-through time for lagoons is between 4 to 60 days depending on the design.

Advanced methods of solids removal have been developed for general clean up of wastewater or to remove substances not removed by conventional treatment processes. These methods may follow the treatment methods previously described, or they may replace them.

Before treated wastewater is discharged it is disinfected to kill disease-causing organisms. Chlorine is usually used for this purpose. Sulfur dioxide (SO2) may then be added to the effluent to neutralize the chlorine.

Wastewater Treatment Plant Size

The physical size of wastewater treatment plants is often the most important factor in determining what effect chemical root control treatments will have on them. It is essential that you know the size of the wastewater treatment plant downstream from the application you will be making. Wastewater treatment plant sizes are measured in terms of daily capacities. Be sure to distinguish between design flows and actual flows. Design flows are the amounts of wastewater that treatment plants are designed to handle on a daily basis. Actual flows are actual volumes of wastewater that enter treatment plants on a given day. If the design capacity of a particular plant is exceeded, excess flows are by-passed around the treatment plant and dumped directly into the receiving waters or temporarily stored in holding ponds for later treatment. Plant operators must avoid any conditions that cause them to bypass normal treatment processes, because municipal treatment facilities face $25,000 per day penalties for violating National Pollutant Discharge Elimination System (NPDES) permit requirements.

A typical residence uses 80 to 85 gallons of water per person per day. Therefore, the daily flow for a community of 20,000 people would be approximately 1,600,000 gallons. This figure does not include industrial discharges which may increase the per-person daily use by about 15 gallons. Daily flows are referred to as million gallons per day (MGD) so a treatment plant for a community of 20,000 would be a 1.6 MGD plant. If industrial flows were added then the plant capacity would need to accommodate around 2.0 MGD. Other factors, including groundwater infiltration, may increase total daily flow.

Generally, most flows in sanitary sewer systems occur during daytime hours with one-half or more occurring during two peak periods of 6:30 to 8:30 am and 4:00 to 9:00 pm. These estimates vary depending on industrial uses and other local factors.

Wastewater treatment plant operators can provide you with information about the amount of flow entering wastewater treatment plants at any given time. Rates can also be estimated using the calculations shown here. In practice, do not estimate hourly flows for low volume plants. It is more accurate to ask the treatment plant operator for this hourly flow rate.

ESTIMATING HOURLY FLOW RATES

Example: Calculate a reasonable estimate of the 8 am to 5 pm hourly flows for a wastewater treatment plant with a design capacity of 10 MGD and an actual flow of 7 MGD.

Answer: (Note: design flows should not be used when calculating actual flow rates. The figure 7 MGD actual flow should be used. Assume that half the flow occurs during the 8 am to 5 pm period)

(1) Calculate the flow between 8 am and 5 pm:

7 MGD ÷ 2 = 3.5 MGD

(2) Divide this number by the 9 hours of flow between 8 am and 5 pm:

3.5 MGD ÷ 9 hours = **0.38 MGD/hour (380,000 gallons per hour)**

Disposal Processes

Once solid wastes have been separated from wastewater, the treated water is returned to the environment either through existing water sources or by using it for special types of irrigation. This water must meet health and contaminant level standards. Solid wastes must also meet contaminant standards before disposition. High concentrations of root control chemicals in treated water or solid wastes may impair treatment plant managers from disposing of these sewage treatment byproducts and cause serious disruption of normal treatment plant operations.

VARIABLES AFFECTING ROOT CONTROL

Several factors influence the effectiveness of wastewater collection systems and affect the application of root control chemicals in these systems. These factors include pipe slope, grade, and flow velocity.

Pipe Slope

Pipe slope is a major design criteria of wastewater collection systems because the systems depend mainly on gravity to produce flow. Slope is calculated by measuring the change in elevation between two manholes, then dividing this measurement by the distance between the manholes. Pipe slope and flow velocity will affect the application and retention time of metam-sodium. If retention time is too short, higher amounts of the root control chemicals will flow into treatment facilities.

Grade

Grade is an important consideration when applying root control chemicals, but is not a factor of pipe slope. Grade refers to the elevation at one location in relation to the elevation at another. A building's sewer is termed below grade if the elevation of its floor drains is below the invert elevation of the nearest upstream manhole.

Flow

As pointed out in Chapter 2, flow can affect root growth patterns. Flow is also an important consideration in sewer line treatment. The rate and quantity of flow may dictate treatment methods, the rate of root decay after treatment, the rate at which chemicals drift toward treatment plants, and the rate of dilution of chemicals in wastewater streams. Flows may change during peak periods of residential or industrial use. Pumping stations coming on line may cause sudden increases in flows. In some situations, flow rates can be influenced by groundwater infiltration.

The rate of flow can affect the dilution of root control chemicals before they reach treatment plants. High flows may dilute root control chemicals too much and therefore decrease their effectiveness at sites where they are applied. Therefore, foams should be injected above flow surfaces to reduce the amount of chemicals carried downstream. Pipes with particularly heavy or swift flows should be treated at night or during other periods of low flows to increase the effectiveness of the chemicals and to reduce the amount of chemicals flushed toward treatment plants. Chemicals flushed from treated pipes by heavy or swift flows not only lower root control effectiveness but may cause serious impacts on sewage treatment plants.

Impact of Root Control Chemicals on Treatment Plants

In order to determine the probable impact of a metam-sodium or other root control products on a specific treatment plant you must consider many factors including: (1) the type of application; (2) the length of pipe being treated; (3) the diameter of the pipe; (4) the slope of the pipe; (5) the distance from the application site to the sewage treatment plant; (6) the slope to the treatment plant; (7) the type of treatment; (8) the capacity of the treatment plant and its method of operation; and (9) the status of the existing biological stability within the treatment plant.

Characteristics of sewage collection systems and variability among users connected to these systems can affect the efficiency of wastewater treatment plants. Large water users such as industries may cause periodic flow increases. For example, canneries are highly seasonal and may generate large quantities of waste during peak periods but little or no waste during the rest of the year.

The time required for wastes to reach plants can also affect treatment plant efficiency. Hydrogen sulfide gas (having the odor of rotten eggs) may be released by anaerobic bacteria feeding on the wastes if the flow time is quite long and the weather is hot. In addition to serious odor problems, this gas can damage concrete structures in the plant and make wastes more difficult to treat—solids won't settle easily, for example. Wastes from isolated subdivisions or other areas located far away from the main collection network often exhibit such "aging" problems.

Dilution

Root control chemicals arriving at treatment facilities in wastewater will undergo large amounts of dilution as a result of the treatment processes—capacities of wastewater treatment facilities determine to a great extent the amount of dilution. No two treatment plants are exactly

Calculating Metam-Sodium Concentrations

EXAMPLE 1. Label instructions say to mix 10 gallons of a 25% AI root control product with 200 gallons of water. This solution is converted into a 20:1 foam (20 parts foam to 1 part solution). This foam is applied over the course of two hours into a sewer system having a flow rate of 380,000 gallons per hour (gph).

Note: The 200 gallons of water used in the mix and the foam expansion ratio are not relevant to the answer.

(1) 10 gallons of product is applied over two hours = 5 gallons per hour (gph) = the application rate. 5 gallons of product containing 25% AI is applied in one hour. Therefore:

$$\frac{5\text{ gph} \times 0.25\text{ AI}}{380{,}000\text{ gph}} = \frac{\text{Parts Product (X)}}{1{,}000{,}000\text{ gallons}}$$

(2) 1.25 x 1,000,000 ÷ 380,000X

(3) 1,250,000 ÷ 380,000X = **3.289 ppm AI**

EXAMPLE 2. An applicator learns from the treatment plant operator that average day-time flows are 5 million gallons and that this is spread evenly over the 8 hour day in which the applicator intends to work. What amount of product can the applicator apply over the 8 hour day to stay under 7 parts per million?

Solution: 5,000,000 gallons x 7 ppm ÷ 0.25 AI

3,500,000 ÷ 0.25 = 140 gallons of product

140 gallons ÷ 8 hours = **17.5 gallons per hour of 25% AI product**

the same, therefore several plants with similar flows may dilute root control chemicals differently. These differences occur because biological process at some plants may be under more stress than at other plants.

Conditions that may cause stress to biological processes taking place in sewage treatment plants include lack of oxygen, high levels of chemical pollutants, excessive organic loading, equipment malfunctions, and operational errors. Treatment plants functioning under one or more of these stresses may be thrown totally off balance by the addition of very small quantities of chemicals such as metam-sodium. Once adverse changes in biological decomposition processes occur they can last from several hours to several days. Similar treatment plants, operating unstressed, may be able to tolerate several parts per million of metam-sodium without adverse effects.

Concentrations of pesticides are measured in terms of percent of active ingredient (AI) per unit of measure. Therefore, one gallon of 100% AI mixed with 999,999 gallons of water represents a one part per million (ppm) solution. Laboratory tests indicate that in wastewater treatment plants the no observable effect level (NOEL) for foaming root control products containing metam-sodium and dichlobenil is a concentration of 10 ppm AI of metam-sodium. To provide a margin of safety, treatment plant managers lower this level to 7 ppm AI.

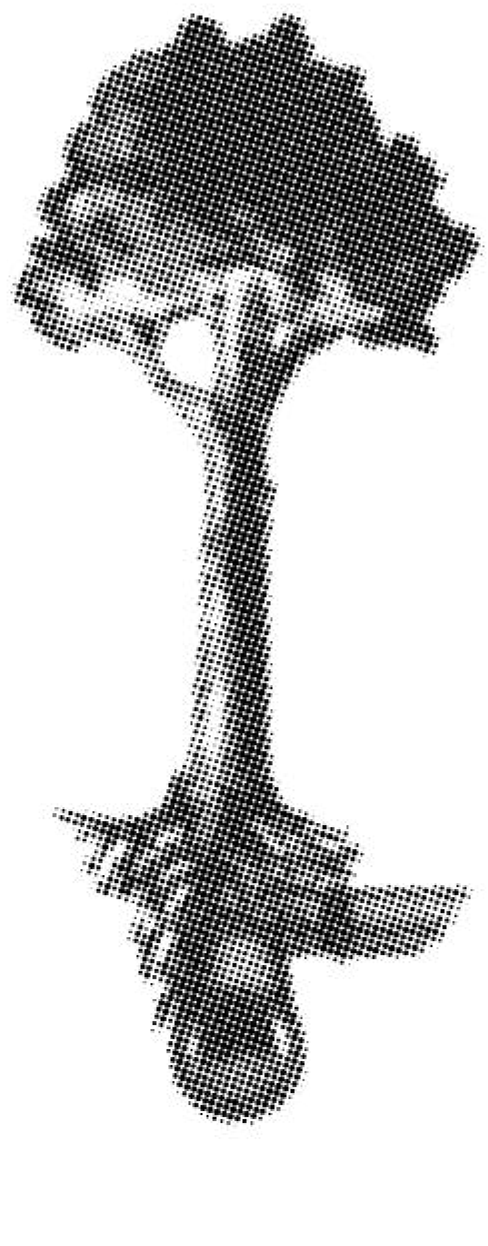
By using known information about specific sewer line flows, you can calculate appropriate application rates that will not exceed 7 ppm metam-sodium levels at the downstream treatment facility.

Never exceed the recommended dose given on the pesticide label. However, recommended doses may have to be reduced to accommodate treatment plant conditions. The best source of information about a given plant and how it is responding to root control treatments is the wastewater treatment plant operator. All root control activities need to be cleared and coordinated not only with treatment plant operators but also with line maintenance and pretreatment personnel.

Disposing of Leftover Chemicals

Dichlobenil and metam-sodium have certain physical properties which lend them to either absorption or degradation in pipe sections being treated. The foaming method of application increases the retention of these herbicides in pipes. This allows time for greater breakdown to take place, thus reducing impacts on treatment plants. Small quantities of leftover concentrated or diluted solutions can be dumped into sewer lines, but be sure they time to break down sufficiently before reaching treatment plants. Otherwise, these materials may temporarily upset normal plant functions. The safest and most economical way to use leftover root control chemicals is to apply them according to label instructions to sewer lines. Avoid having leftover pesticides by planning your applications carefully and by mixing only the amounts of chemicals needed for each job.

6 Safe Handling Procedures



Pesticides are chemicals that are capable of destroying pests. Some pesticides work by interfering with biological processes while others physically block the uptake of oxygen or nutrients or they destroy living tissues. Because some animal pests have biological systems similar to human biological systems, certain types of pesticides can be very harmful to people who have been exposed to them. Those pesticides in the toxicity category 1, with the signal word danger, are highly toxic and likely to cause serious injury to people who have received a certain amount of exposure. The hazard posed by any pesticide is a function of its toxicity and the degree of exposure. Like other chemicals, with pesticides it is the dose that makes the poison.

PESTICIDE EXPOSURE

There are four routes through which pesticides enter the body: the skin; the eyes; the mouth; and by inhalation (Figure 6-1). The toxicity of a particular pesticide depends on a number of factors including the:

- types and amounts of active ingredients
- types and amounts of carriers
- types and amounts of inert ingredients
- type of formulation

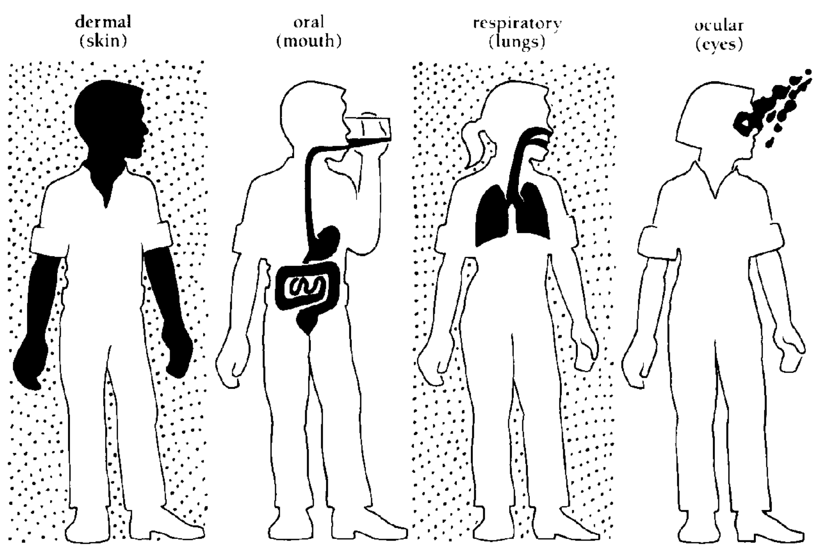


Figure 6-1. The most common ways for pesticide exposure to occur are through the skin (dermal), through the mouth (oral), through the lungs (respiratory), and through the eyes

Overexposure to certain pesticides can result in acute injuries or illnesses, delayed illnesses, or allergic reactions. The onset of acute effects usually occurs within 24 hours after exposure to a pesticide and is likely the result of a single, high level exposure incident. Delayed effects often do not appear until weeks, months, or years after exposures take place. Usually these effects are the results of repeated exposures to low levels of certain pesticides over extended periods of time. These illnesses, such as cancer, reproductive disorders, or neurological impairments, are much more difficult to associate with pesticide exposure incidents because of the long delay in onset. Allergic reactions are brought about by individuals becoming sensitized to certain pesticides much in the same way as people become sensitized to other materials. Once sensitization takes place, subsequent exposures may result in increasingly serious reactions. Examples of allergic reactions include skin irritation, eye and nose irritation, breathing disorders such as asthma, and anaphylactic shock.

RECOGNIZING POISONING SYMPTOMS

Overexposure to some kinds of pesticides may result in identifiable symptoms such as nausea, headache, muscle weakness or impairment, profuse sweating, and other conditions indicating the involvement of internal biological systems. Other pesticides cause more generalized symptoms related to chemical irritation.Metam-sodium and sodium hydroxide are chemical irritants.

Skin Contact. Metam-sodium and sodium hydroxide are severely irritating to the skin and may cause burns. Prolonged or repeated exposure to metam-sodium may cause a hypersensitivity-type of dermatitis or skin irritation. This is a form of an allergic reaction.

Eye Contact. Metam-sodium causes moderate eye irritation. Sodium hydroxide will cause irreversible eye damage.

Ingestion. Metam-sodium is classified as slightly toxic by ingestion. Sodium hydroxide may be fatal if swallowed.

Inhalation. Inhaling vapors of metam-sodium can irritate the nose and respiratory passages.

FIRST AID

Read and follow the first aid instructions on the label of the metam-sodium or sodium hydroxide root control pesticide product you are using. Recommended first aid procedures are listed below. Exposure to the skin or eyes requires immediate decontamination by washing with water. Contact a poison control center, a physician, or the nearest medical facility. Inform the person contacted of the type and extent of exposure, describe the victim's symptoms, and follow the advice given.

Figure 6-2. Immediate decontamination with water is the first aid procedure for skin exposure to pesticides. Remove contaminated clothing.

On the Skin

Immediately flush the skin with large amounts of running water for at least 15 minutes while removing contaminated clothing and shoes (Figure 6-2). Get medical attention at once.

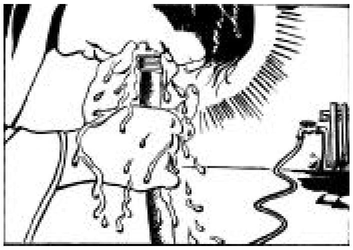


Figure 6-3. Hold the eyelids apart and rinse the eyes for 15 minutes. Use fresh, running water at low pressure.

In the Eyes

Immediately flush the eyes with large amounts of running water for at least 15 minutes. Hold eyelids apart to ensure adequate rinsing of the entire eye surface and lids (Figure 6-3). Transport victim to medical facility.

If Inhaled

Remove the victim to fresh air. If breathing has stopped, clear the victim's airway and start mouth-to-mouth artificial respiration. If breathing is labored give oxygen, preferably under a medical expert's advice. Get medical attention immediately.

If Ingested

Immediately give several glasses of water but do not induce vomiting. If vomiting does occur, give fluids again. Do not give anything by mouth to an unconscious or convulsing person. Seek immediate attention.

PERSONAL PROTECTIVE EQUIPMENT

PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) must be worn by root control personnel whenever performing any of these tasks:

- mixing - loading
- equipment calibrations or adjustments
- cleaning and repair of application equipment
- entering into treated areas
- sampling
- cleanup of spills
- rinsate disposal
- any other activity likely to result in direct contact with the product

While handling root control pesticides containing metam-sodium, prevent pesticide exposure to your body by selecting adequate personal protective equipment (Figure 6-4). Refer to the label of the metam-sodium product you are using for requirements for minimal personal protective equipment. Employers must provide clean personal protective equipment at the beginning of each work period. Use the following information to select personal protective equipment when mixing, loading, or applying these products.

Bodywear

Metam-sodium labels for sewer line root control contain the precaution to not get the pesticide on skin or clothing. This means that outer protective clothing, covering the arms, legs, and torso, must be worn over regular clothing while performing mixing and loading and during an application (Figure 6-5). Different styles of protective bodywear may be selected based on your personal preference and the job you are performing (mixing, loading, or applying). Common styles of bodywear include disposable coveralls, cloth coveralls, and chemical resistant suits.

Figure 6-4. Proper personal protective equipment is needed to protect yourself from exposure to root control pesticides.This handler is wearing protective bodywear, waterproof gloves and boots, and a faceshield.

Figure 6-5. Outer protective clothing, covering the arms, legs, and torso, must be worn over regular clothing while performing mixing and loading and during an application of root control pesticides.

Disposable Protective Clothing. Disposable protective clothing is manufactured from several types of materials suitable for metam-sodium handling. Disposable fabric made from nonwoven, bonded fiber materials are superior to woven fabrics because they do not promote wicking and are more resistant to liquid penetration. Some nonwoven fabrics are laminated or bonded to other materials to further enhance waterproofing. Disposables are usually lightweight but remarkably strong and resistant to tearing or puncturing. Disposables have the major advantage of not requiring cleaning or decontamination after use. They can be thrown away at the end of the work period.

Cloth Coveralls. Cloth coveralls are suitable for use when applying metam-sodium root control products. They have the advantage of being able to be easily removed if contaminated. These should be worn over a long-sleeved shirt and long pants for added protection. Cloth coveralls must be laundered before being reused. The law requires that clean coveralls be used at the beginning of each work period.

Aprons. Metam-sodium product labels require the use of waterproof aprons in addition to the bodywear described above when mixing or loading. Aprons must be made of waterproof materials and be long enough to protect your clothing (Figure 6-6). Styles having a wide bib provide splash protection to the upper chest and are preferable for mixing and handling of containers. Disposable aprons, made for one-time use, are generally made of thin plastic materials that tear or puncture easily and therefore have limited use for metam-sodium handling. Reusable aprons are more durable, but require regular cleaning and decontamination; they should be discarded if they develop tears or holes.

Figure 6-6. A waterproof apron is required when mixing metam-sodium root control products.

Headwear. Plastic hard hats with plastic sweatbands are chemical resistant and are cool in hot weather. Hard hats are normal requirements for sewer technicians and should be worn when entering confined spaces (Figure 6-7).

Gloves

Waterproof gloves are an essential part of your safety equipment, and must always be worn when mixing, loading, and applying metam-sodium and other root control products (Figure 6-7). Leather or fabric gloves should never be used because they absorb water and pesticide, and may actually increase exposure. Suitable gloves are made of natural rubber, nitrile, latex, butyl, or neoprene. The thickness of the glove material also determines the amount of protection; thicker materials are better. Choose materials that resist puncturing and abrasion. Gloves must not be lined, since fabrics used for linings may absorb pesticides, making them dangerous to use and difficult to clean.

Metam-sodium labels require the use of gauntlet-length gloves that extend at least to the mid-forearm. Sleeves of your bodywear should be worn on the outside of your gloves to keep pesticide chemicals from getting in.

Footwear

Figure 6-7. Hard hats should have plastic sweat bands which are chemical resistant. Waterproof gloves must always be worn when handling root-control pesticides.

Leather or fabric shoes must never be worn while mixing, loading, or applying metam-sodium products. Waterproof protective footwear is required and should be made of rubber or synthetic materials such as PVC, nitrile, neoprene, or butyl. Waterproof footwear is available in conventional boot and overshoe styles; some boots have internal steel toe caps for protection against falling objects. Select footwear that fits well and is comfortable to wear. Protective footwear should be calf-high, and worn with the legs of your protective pants on the outside to prevent pesticides from getting in (Figure 6-8).

Eye Protection

Eye protection must always be worn during mixing and loading, while adjusting, cleaning, or repairing contaminated equipment, and during application of metam-sodium and sodium hydroxide products. Acceptable eye protection includes safety glasses having brow pieces and side shields, safety goggles, and faceshields. Goggles are the most suitable form of eye protection for metam-sodium handling operations since metam-sodium is highly irritating to the eyes (Figure 6-9). Safety glasses do not provide protection against vapors because they do not have a tight face seal. Faceshields are highly recommended for mixing and loading operations because they prevent liquids from splashing onto your face. Like safety glasses, faceshields have limited use during application since they do not provide protection against vapors.

Respiratory Protection

NIOSH-approved TC-23C cartridge respirators must be available for all handlers at mixing, loading, and application sites where people are working with metam-sodium root control chemicals. These respirators must be worn when the pungent sulfurous odor of metam-sodium products persists (Figure 6-10). Cartridge respirators include a fitted rubber facepiece and cartridges that contain pre-filters and organic vapor filters (Figure 6-11).

Figure 6-8. Always wear waterproof footwear, such as these rubber boots, when applying root control pesticides. Protective footwear should be calf-high and worn with the legs of your protective pants on the outside to prevent pesticides from getting in.

Figure 6-9. Goggles are the most suitable form of eye protection for metam-sodium handling operations since metam-sodium is highly irritating to the eyes.

Figure 6-10. Respiratory protection must be available to all handlers involved in the application of metam-sodium root control products. Replace respirator cartridges according to manufacturer's instructions. If no guidelines are available, replace cartridges daily.

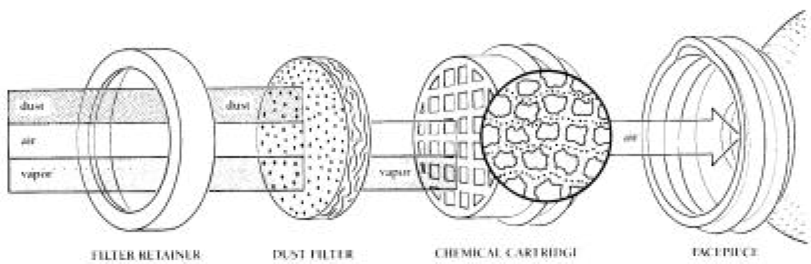


Figure 6-11. Pesticide cartridges consist of two stages. This diagram illustrates the mechanical dust filter which removes dust and droplet particles and the activated charcoal chemical cartridge which removes vapors.

Figure 6-12. A self-contained supplied air respirator provides uncontaminated air from a compressed air tank.

Cartridge respirators need to fit properly to be effective and safe. They should be in good working condition and be cleaned after each use. Beards and long sideburns affect the way cartridge respirators seal around the face, and will prevent them from giving adequate protection. Regulations prevent pesticide handlers with beards or long sideburns from wearing cartridge respirators.

Supplied Air Respirators. Supplied air respirators (Figure 6-12) must be worn when working in confined spaces, such as man-holes and sewer line tunnels. The cartridge respirators described above are not suitable for use in these situations. Self-contained supplied air respirators (often called a self-contained breathing apparatus—SCBA) provide clean air from pressurized tanks that the user wears, similar to a scuba diver.

Care of Personal Protective Equipment

Wear clean bodywear and personal protective equipment daily. If clothes get wet with pesticides change them immediately. Always keep a clean change of clothing on the work site for such emergencies. Employers are responsible for cleaning personal protective equipment.

Wash goggles or face shields at least once a day. Wear neoprene headbands, if possible. Elastic fabric headbands often absorb pesticides and are difficult to clean. Have some spares available so you can replace them as necessary.

Change filters, cartridges, and canisters of respirators according to manufacturers' instruction. If no guidelines are available, change cartridges daily—sooner if you can smell the metam-sodium or if cartridges have been damaged. Replacement filters, cartridges, or canisters should always be available at the work site. Remove filters, cartridges, and canisters after use, then wash the facepiece with detergent and water, rinse it, and dry it with a clean cloth. Put in an airtight bag and store it in a clean, dry place away from pesticides. Store cartridges in airtight bags when not in use.

Figure 6-13. Shower and wash your hair after working with root control pesticides.

Personal Hygiene

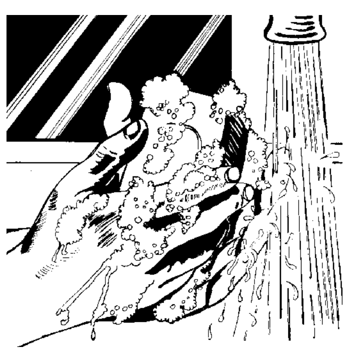


Figure 6-14 While handling root control chemicals, wash your hands before eting, drinking, smoking, chewing gum or tobacco, and before using the bathroom.

Since pesticides can be absorbed through the skin, it is important at the end of every day you have been working with root control pesticides to shower (Figure 6-13). Wash your body and scalp thoroughly with soap and water. In addition, wash your hands before eating, drinking, smoking, chewing gum or tobacco, and before using the bathroom (Figure 6-14). Always have soap, water, and paper towels available on the job site in case you contact the pesticide.

SAFETY PROCEDURES

In the wastewater industry the dangers of working with pesticides are coupled with the dangers inherent in the working conditions of wastewater systems. It is very important that application firms and municipalities have procedural policies for safety that each employee is aware of and is required to follow.

Company policies should include basic statements noting that no worker is required to undertake a task if the worker: 1) does not feel that the job is safe or healthful; 2) was not provided with adequate training or necessary safety equipment; or 3) is not provided with the proper job instructions. Workers should be aware that these basic rights are protected by the Occupational Safety and Health Administration.

Confined Space Entry Procedures

Be sure you always follow your company or municipality's policies regarding entering confined spaces. These policies should include specific instructions on testing for toxic gases, monitoring air quality, ventilating work areas, and using a safety harness for emergency ascent.

TRANSPORTING PESTICIDES

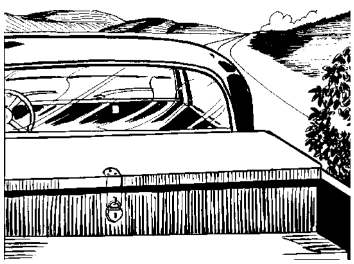


Figure 6-15. Keep pesticides in a locked container on the transporting vehicle if the vehicle is ever left unattended.

You are responsible for the safe transporting of root control pesticides in your possession. Pesticides should be transported in the back of a truck and all containers should be secured to prevent breaking or spilling. Never leave pesticides unattended in a vehicle unless they are in a locked container (Figure 6-15).

Pesticides should be transported only in correctly labeled containers. Be sure to keep paper and cardboard packages dry. If any pesticide is spilled in or from the vehicle, clean it up right away using correct cleanup procedures. Refer to specific product labeling and Material Safety Data Sheets (MSDS) for cleanup procedures.

PESTICIDE STORAGE

All pesticides must be stored in a locked building or area located away from where people and animals live (Figure 6-16). This will avoid or minimize any harm to them in case of fire or flooding. For Category 1 and 2 pesticides you are required to post warning signs on the storage building. The storage area should be in a cool, dry, well-ventilated, and well-lighted room or building that is insulated to prevent freezing or overheating. Be sure that the area is fireproof, with a cement floor. As soon as pesticides arrive check the product labels for special storage instructions. Store all pesticides in the original containers. Do not store them near food, feed, seed, bulbs, tubers, nursery stock, or other vegetation. Store paper containers off the floor. Check every container for leaks or breaks. If one is leaking, transfer its contents to a container that has held exactly the same pesticide. If one is not available, use a clean container of similar construction and label it correctly. Clean up any spills. Keep an up-to-date inventory of the pesticides in the storage area.

Figure 6-16. Store all pesticides in a locked building or area located away from people and animals.

Keep a spill kit available at the storage facility. A spill kit should include: detergent, hand cleaner, and water; absorbent materials, such as absorbent clay, sawdust, and paper to soak up spills; a shovel, broom, dustpan and chemical resistant bags to collect contaminated materials; and a fire extinguisher rated for ABC fires.

MIXING AND LOADING ROOT CONTROL CHEMICALS

Studies have shown that pesticide handlers are most often exposed to harmful amounts of pesticides when they are handling concentrates. Pouring concentrates from one container to another is the most hazardous activity. By observing some simple precautions when making root control applications, you can reduce the risks involved in this part of the job. It is important to keep out of work areas animals, pets, and people who are not involved in the mixing and loading. Do not work alone when handling root control pesticides. Choose a place with good lighting and ventilation for mixing operations.

Figure 6-17. Never tear open a paper pesticide container. It is much safer to use scissors or a knife to cut bags open.

Before handling a pesticide container, put on protective clothing and equipment. Each time you use a pesticide, read the directions for mixing. Do this before you open the container. This is essential because labels can change.

Do not tear paper containers to open them. Use a sharp knife or scissors dedicated for this use (Figure 6-17). Clean the knife or scissors afterwards and do not use them for other purposes. When pouring pesticides from containers, keep the containers below eye level. Stand so the wind is at your back to blow pesticide dusts or vapors away from you. To prevent spills, close containers after each use. If you are splashed or spill a pesticide on your body while mixing or loading, immediately stop, remove contaminated clothing, and wash thoroughly with soap and water. Then contain and clean up the spill.

When mixing pesticides, measure carefully. Use only the rate called for on the label and calculated for the job. Mix only the amount you plan to use immediately.

Figure 6-18. The safest way to transfer hazardous pesticides from their containers into mixing tanks is with a closed handling system. Many closed handling systems will rinse the empty containers.

Closed Handling Systems

Closed handling systems can reduce your exposure to concentrated pesticides during the mixing process. A closed handling system allows you to measure and transfer pesticides from their original containers into mixing tanks through hoses rather than by pouring. Some systems rinse empty containers and transfer rinse solutions to mixing tanks (Figure 6-18).

There are two systems to remove the pesticide concentrate from the original container—gravity and suction.

Gravity systems are sometimes called punch and drain systems. The unopened pesticide container is inserted into a chamber, which is then sealed. A punch cuts a large opening in the container, allowing all of the material to drain into the mixing tank. A water nozzle attached to the punch sprays the inside of the container to rinse it thoroughly. The rinse water also drains into the mixing tank. The rinsed container is then removed for disposal. A limitation of this system is that only full container quantities can be used. It is not possible to use part of the pesticide in a container and store the rest.

Suction systems use pumps to remove pesticides through probes inserted into the containers. Some containers are equipped with built-in probes. Pesticides are transferred to mixing tanks by hoses and pipes. When containers are empty, these systems rinse them and transfer the rinsate to the mixing tanks.

Most currently available closed mixing systems work only with liquid formulations. A problem with metam-sodium root control products is introducing the dry formulated ingredient, dichlobenil, to the mixture. One technique under development is packaging the dry ingredient in a soluble bag. This allows the applicator to put the entire package into the tank where it will dissolve.

CLEANING APPLICATION EQUIPMENT

As soon an application is finished it is important to clean the application equipment. Aside from the fact that dirty equipment is a source of potentially hazardous pesticide residue, dirty equipment can cause equipment malfunctions that could be the source of incorrect applications or hazardous equipment failures at the job site. Clean both the inside and outside of the application equipment, including all hoses and nozzles. Cleaning should be performed by or under the supervision of a certified handler. Wear all the required personal protective equipment and follow the equipment manufacturers' cleaning instructions.

If using application equipment that has a small chemical mix vessel the equipment can be flushed with water and emptied into the treated manhole. Only cleaning rinsate should be disposed of in this fashion. Be sure the cleaning procedure does not include unused product remaining in the mixing or application equipment.

Do not contaminate nearby bodies of water when disposing of equipment wash water. Equipment wash water and wastes resulting from the use of metam-sodium root control products may be disposed of on site by putting it in the treated sewer. It can also be disposed of at an approved waste disposal facility. Do not flush rinsate in potable water systems, storm drains, field drains, or other drains unless the effluent is treated in a sanitary sewer system.

If using equipment with a large chemical mixing tank return the equipment to the area designated for equipment cleanup and clean it according to the manufacturer's directions. Application equipment must be cleaned as soon as you finish using it to keep the equipment in good operating condition. Equipment cleaning areas must have provisions for preventing the contaminated water from leaving the area through runoff or percolation into the soil.

DISPOSING OF PESTICIDE WASTES

Pesticide wastes are potentially toxic and therefore must never be disposed of into the environment. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of through normal applications or according to label instructions, contact your local agricultural commissioner office for guidance.

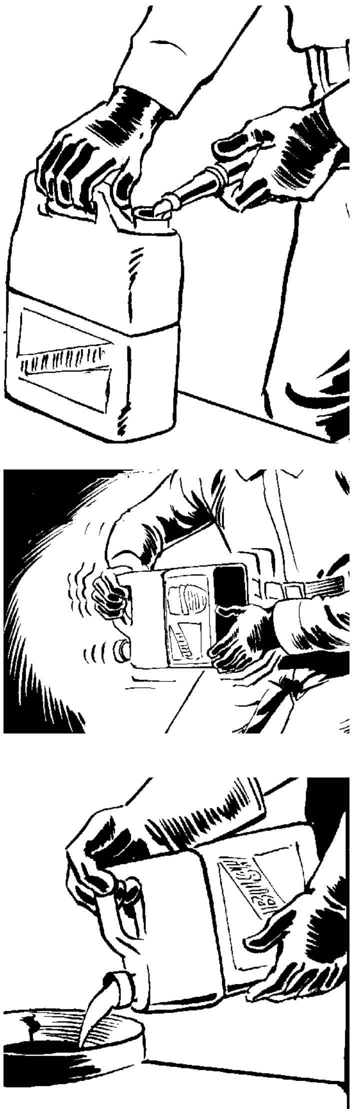


Figure 6-19. Empty pesticide containers must be triple-rinsed before disposing of them. Follow the instructions listed to the right.

Leftover Pesticides

Consult the pesticide label for disposal instructions if you have leftover pesticide materials. Suggested ways to deal with leftover pesticides include:

- use them up as directed on the label
- take the pesticides to a landfill operating under EPA or state permit for pesticide disposal (solid waste landfills are not suitable)
- if you cannot dispose of leftover pesticides immediately, store them in a secure storage area with similar pesticides

Pesticide Containers

Do not leave pesticides or pesticide containers at the application site. Never give pesticide containers to anyone for any purpose. Leftover pesticides should be kept in tightly closed containers in your storage facility. Always triple rinse empty containers of liquid pesticides as follows (Figure 6-19):

- empty the container into the tank—let it drain an extra 30 seconds
- fill container 1/10th to 1/4th full of water
- replace the closure and rotate the container—invert it so the rinse reaches all the inside surfaces
- drain the rinse water from the container into the tank; let the container drain for 30 seconds
- repeat steps 2 through 4 at least two more times for a total of three rinses—remember to empty each rinse solution into the tank
- rinsate from sewer use pesticides may be disposed of in the sewer system being treated

Offer empty containers for recycling or reconditioning, or puncture and dispose of in a sanitary landfill. Containers may require inspection by local agricultural commissioner offices before they can be offered for recycling or disposed of in a landfill.

PESTICIDE LEAKS OR SPILLS

Figure 6-20. Treat every pesticide spill as an emergency. Prevent the spill from spreading and keep people away.

All pesticide leaks or spills should be treated as emergencies (Figure 6-20). Concentrated pesticide spills are much more dangerous than pesticides diluted with water, but both types should be treated seriously and immediately. Leaks or spills can occur during transporting, storing, or while using pesticides. When spills occur on public roadways, immediately contact the California Highway Patrol and the State of California Office of Emergency Services. These agencies will take charge of coordinating the clean-up and protecting the public. When pesticides are spilled on public roadways, a report is required to be filed with the Office of Emergency Services. If leaks or spills should occur in areas other than public roadways, follow the emergency procedures listed below. All leaks or spills of pesticides, no matter where they occur, must be reported to the local agricultural commissioner as soon as possible.

Figure 6-21. Build a dam of soil, cat litter, or other absorbent around the spilled material to keep it from spreading.

Minor Spills or Leaks

Minor spills or leaks of a few gallons or less can usually be cleaned up easily. Be sure to wear all the personal protective equipment required for mixing and loading, including respiratory equipment if odor is persistent.

Control the Spill. Prevent further spill by shutting off equipment, righting tipped containers, or catching the leak in a pan or other container. Rope off the area and flag it to keep people away from the spilled chemicals. Do not leave the spill area unless someone is there to confine the spill and warn of the danger. If the pesticide was spilled on anyone, immediately follow appropriate decontamination procedures.

Confine the Spill. Prevent the spill from spreading by building a dike of soil, sand, or other absorbent around the spill (Figure 6-21).

Figure 6-22. Shovel all the spilled material and absorbent into a leak-proof container or chemical resistant bag. Foam spills can be placed into the nearest manhole of the sewer line being treated.

Clean Up the Spill. Use absorbent material such as soil, kitty litter, sawdust, or an absorbent clay to soak up the spill. Shovel all contaminated material into a leak proof container or chemical resistant bag for disposal (Figure 6-22). The disposal container must bear a label indicating its contents and the signal word of the pesticide. Dispose of material as you would excess pesticides at a hazardous waste disposal facility. Do not hose down the area because this spreads the chemical. Always work carefully and do not hurry. Do not let anyone enter the area until the spill is completely cleaned up. Refer to the pesticide product material safety data sheet (MSDS) for information on cleaning up and decontaminating small spill sites.

Special Procedures for Foam Spills

Foam spills act very similarly to liquids if left unattended because they gradually convert to liquids. Therefore clean up procedures to remove foam from surfaces should begin at once. For instance, foam should be shoveled off planted areas immediately to reduce damage and to prevent foams from liquifying. Clean areas contaminated with foam with minimal amounts of water. Do not hose foam spills onto planted areas.

Outdoors

Try to pick up the foam as quickly as possible before it liquifies. Scoop foam up with a shovel and transfer it to a manhole or place it into chemical-resistant plastic bags. Empty the foam into a manhole. Triple rinse the bags before disposing of them in a landfill. Place the rinsate into the manhole. For spills on the pavement, dispose of the foam in a manhole then rinse the area into the manhole. If the spill occurs on soil remove all contaminated soil and place it in sealed containers and dispose of it in accordance with local regulations.

Indoors

Spills will usually occur in bathrooms, basements, or laundry rooms where drains are connected to sewer lines. Evacuate the building if the pungent, rotten egg or sulfur-like odor of metam-sodium is detected. Open exterior doors and windows and ventilate with fans. Seal all heating and air conditioning vents to prevent contaminating the system. Scoop up foam with shovels or dust pans and place it in plastic bags. Seal the bags and remove them from the building. Dispose of foam in the nearest manhole. Triple rinse the plastic bags and dispose of them in a landfill. Pour rinsate into the manhole. On hard floors wipe up remaining liquid with rags or other absorbent material and dispose of as directed by local regulations. Wash the floor at least three times with detergent, flushing each down a drain. If rugs or cloth materials become wet with foam, take them outside if possible and dry them before laundering separately. On carpeting use a wet vacuum and flush foam down the drain. Shampoo with detergent at least three times. Ventilate area and allow to dry. If odor persists remove and replace the contaminated material.

Major Spills

Cleaning up major spills may be too difficult to handle without professional help. In these cases, keep people away from the spill and confine it if possible. Call the local fire department and the local agricultural commissioner’s office for assistance. Decontaminate anyone who contacted the spill and administer first aid if necessary, then arrange for medical help. Authorities may contact CHEMTREC for advice on cleaning up the spill. Do not leave the area until responsible help arrives.

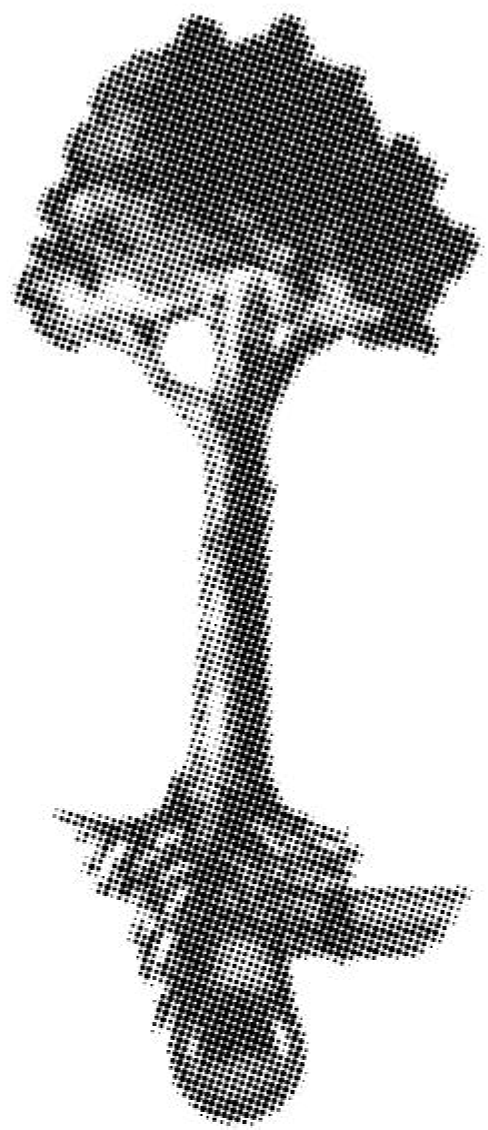
REPORTING SPILLS

Report all major spills by phone to your local Agricultural Commissioner. Also you may be required to notify other authorities. If:

- the spill is on a highway, call the California Highway Patrol.
- the spill is on a county or city road, call the county sheriff or city police.
- the spill is on a body of water or waterway, notify the Coast Guard if in coastal waters; the state health department; regional, state, or federal water quality or pollution office and state fish and game/wildlife agency.

Telephone numbers of emergency response agencies should be kept at the application site where they can easily be accessed in case of a spill or other emergency.

7 Application Methods



Using proper application methods and correctly calibrating equipment will assure the most effective use of root control chemicals. Careful planning and application minimizes chemical and operational costs and protects people, the environment, and sewer collection and treatment systems. Planning and carrying out an effective root control operation requires choosing the right methods of application, understanding the ways root chemicals work, and assessing conditions that exist in pipes being treated.

UNDERSTANDING THE ROOT CONTROL PROCESS

Root control is more accurately characterized as root management. Chemical root control cannot completely eliminate or permanently prevent root intrusions. The goal of sewer line root control programs is to reduce the number and size of root intrusions into sewer pipes thus reducing the frequency of sewer blockages and improving the efficiency of the systems. Knowing about the basic concepts of sewer pipe conditions and roots in sewer lines will help you understand what results can be expected from using root control chemicals.

General Concepts About Pipe Conditions

Following are some assumptions about sewer pipe conditions that you must consider when planning a root control treatment:

- under normal conditions sewer pipes are not filled with water
- pipe sections with sags or depressions may contain more water than other sections—these sections may even be completely filled with water
- solids may build up and fill a portions of sewer pipes

General Concepts About Roots In Sewers

Roots which invade sewer pipes exhibit certain characteristics. Understanding these characteristics is helpful in planning root control applications.

Roots enter sanitary sewers through crack joints and other pipe imperfections from the tops and sides, but not from below flow lines except under certain conditions. Root growth is most common in the moist atmospheres of the voids above sewer flow lines.

Root Control Chemicals in Sewers

Effective root control requires that herbicides contact the invading roots. It is important, therefore, to understand the conditions that prevent this contact.

Root masses are excellent collectors of grease and other solids, and such buildups inhibit root control chemicals from contacting roots. For this reason degreasers are added to most foaming root control products. The foam process also helps in degreasing root masses. Root control products containing sodium hydroxide will saponify greases and convert them to soap. These products are combined with 2,6-D, a root inhibiting herbicide.

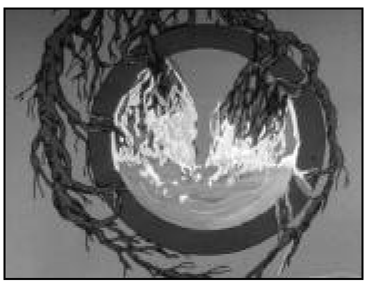


Figure 7-1. Although roots may be killed by pesticide treatment, it may take months or years for them to decay and leave sewer pipes.

Chemical Root Control Results

You need to understand the limitations as wells as what results can be expected from a root control treatment (Figure 7-1):

- effective chemical root treatments kill roots but do not immediately eliminate blockages—it may take weeks, months, or even several years for killed roots to decay and leave sewer systems
- it can be very difficult to determine through video inspection if root masses are dead
- effective chemical root control depends on proper application methods
- chemical root control does not usually produce the “gun barrel” look of new pipes

ROOT CONTROL CHEMICAL APPLICATION EQUIPMENT

Application equipment may vary according to the type of root control pesticides being applied. Foam application of metam-sodium, for instance, requires specialized equipment. The design and specific components of foam-generating and application equipment for metam-sodium root control chemicals may vary, but the basic principles of operation are the same. This process involves: (1) diluting chemicals and wetting/foaming agents with water according to chemical manufacturers’ instructions; (2) using compressed air to create foam of the proper consistency; and (3) pumping foam through hoses into sewer pipes.

One type of foam application equipment consists of a trailer-mounted mixing tank for diluting chemical ingredients with water. Solution tank sizes vary from 30 to 300 gallons. This mobile equipment is used for transporting root control chemical mixes. At treatment sites the chemical-water solution is metered into a foam production chamber. The foam is then laid into sewer lines as the hose is retrieved. A 200 gallon tank can treat approximately 1,600 feet of 8-inch pipe (Figures 7-2 and 7-3).

Figure 7-2. There are several types of equipment available for injecting foam root control pesticides into sewer systems.

Figure 7-3. Small mixing equipment, such as the unit shown here, is used for foam treatment of lateral lines.

A second type of equipment uses a small (3 to 6 gallon capacity) chemical tank where root control chemicals are combined without water. At the application site pressurized water is forced through a venturi tube and mixes with the root control chemicals. This mixture goes into a foam production chamber and is diluted to the proper ratio of water to chemical as it is pumped into sewer lines.

METAM-SODIUM FOAM APPLICATION

The checklist on the following page will help you prepare for a metam-sodium foam application. Review this checklist before each application.

APPLICATION CHECKLIST ☑

This checklist should be reviewed before applying root control chemicals containing metam-sodium to a sewer section.

- ☐ Have you read the chemical product label thoroughly?
- ☐ Have you notified the wastewater treatment plant operator and maintenance workers of date, time, and location of treatment?
- ☐ Do you know the distances between buildings and the sewer line being treated?
- ☐ Do you know the depths of the sewer lines compared to the drains in buildings connected to these lines?
- ☐ Are there any obstructions in the lines?
- ☐ Are there broken or empty traps?
- ☐ Are there drains without traps that would allow easy emergence of foam? (Building drains may be plugged to protect against back-up and flooding.)
- ☐ Are product labels and Material Safety Data Sheets available at the job site for quick reference?
- ☐ Does the job site have all necessary equipment for proper traffic control (i.e. barricades, cones)?
- ☐ Is there the proper equipment at the job site for safely opening manholes?
- ☐ Does the job site have all the required equipment for conforming with OSHA standards for confined space entry (including but not limited to air monitor, harness, and retrieval systems)?
- ☐ Is the proper personal protective equipment available?
  - gauntlet type chemical resistant gloves
  - rubber boots
  - chemical resistant, full length, plastic or rubber apron
  - respirator and goggles or a full face respirator with cartridges approved for pesticide use, or, if required, air-supplied respirator or SCBA
  - long pants and long sleeved shirts
  - hard hat

Communicate with Wastewater Treatment Plant Personnel

Coordination and cooperation with wastewater plant operations is very important when making metam-sodium root control treatments. Communicate with plant operators well in advance of the treatment date. Treatment plant personnel should be made aware of any unusual side effects of metam-sodium.

Obtain as much information about the treatment area as possible. For example, find out the times of high flows, the size of the sewer lines being chemically treated, and the distance of the sewer line from the nearest lift station and sewage treatment plant. These are important factors in understanding the effects of chemical root control on wastewater treatment plant processes. Sewer line size is an important consideration because this determines the amount of root control chemicals required. For example, depending on the application method used, it can take up to

9 times as much chemical per foot to treat a 24-inch sewer pipe as it does an 8-inch pipe.

CALCULATING THE AMOUNT OF FOAM TO MIX

Use the following worksheets to calculate the amount of foam mixture to use for various sizes of pipes. Worksheet 1 on page 73 provides the calculations you will need if you are using the foam fill method. Worksheet 2 on page 74 provides calculations for the foam coat/spray method used for coating walls of larger pipes. You need to supply the number of feet of each pipe size that will be treated and the dilution ratio required.

To determine a dilution ratio, refer to the label of the product being used. For example, if the label states “mix 25 parts water to 1 part chemical” then add these numbers together and enter the result—26—in the dilution ratio required column.

In order to minimize the effects of root control chemicals on a sewer system it may be necessary to reduce the volume of material to be applied. Knowing the volume and hourly flows for the system and manufacturers’ recommended maximum concentrations, you can determine the maximum amount of product that can be injected into the system for any given day or hour.

If adverse effects are indicated at the treatment plant (i.e. the rotten-egg odor of metam-sodium is detected or biological upset is beginning) the application process should be immediately discontinued. When applications are restarted reduce application rates to fewer total gallons of concentrate per hour or day. Treatment plant operators should continue to monitor for any further adverse effects.

When mixing metam-sodium with water remember that metam-sodium begins to decompose to the more volatile and toxic MITC. This process starts immediately and proceeds rather rapidly upon aeration. Therefore, plan to use the solution soon after mixing, otherwise the material will be less effective.

FILLING MIXING TANKS

When filling chemical mix tanks certain precautions must be followed. Mixing water often comes from fire hydrants, garden hoses, or other fresh water sources. If there is a pressure drop in the water system any solution in the mixing tank could back-siphon and contaminate the water supply. Whenever a tank is being filled with water it should never be left unattended. Back-siphoning must be prevented with one of the following measures:

- use an air-gap
- use back flow prevention device such as a double check valve
- use an intermediate water source, such as a jetter

Use this worksheet to calculate the total gallons of foam to mix* (D). *This worksheet will help you determine the amount of root control product to add* (J) *to the water. You need to supply the pipe length* (C) *and the sum of the dilution ratio* (I) *(see text for instructions).

FOAM FILL APPLICATION

A Pipe Size	**B** Gallons per/foot	**C** Length of Pipe	**D** Gallons of Foam Required (B x C)	**E** Service Laterals 10% (or less)	**F** Total Foam Required (D + E)	**G** Expansion Ratio 1:20 Required	**H** Chem/Water Solution (gallons) (F ÷ 20)	**I** Sum of the Dilution Ratio Required	**J** Total Product to Use (H ÷ I) (round up)
4"	0.7	x	=	+	=	÷ 20	=	÷	=
6"	1.5	x	=	+	=	÷ 20	=	÷	=
8"	2.5	x	=	+	=	÷ 20	=	÷	=
10"	4.0	x	=	+	=	÷ 20	=	÷	=
12"	6.0	x	=	+	=	÷ 20	=	÷	=
Example: **8"**	**2.5**	x **5000'**	**= 12,500 (10%)**	**+ 1,250**	**= 13,750**	÷ **20**	= **687.50**	÷ **21**	= **33**

Worksheet #1

Use this worksheet to calculate the total gallons of foam to mix* (D)*. This worksheet will help you determine the amount of root control product to add* (H) *to the proper amount of water* (I)*. You need to supply the pipe length* (C) *and the sum of the dilution ratio* (G) *(see text for instructions).

FOAM SPRAY APPLICATION

A Pipe Size	B Gallons per/foot		C Length of Pipe	D Gallons of Foam Required (B x C)	E Expansion Ratio 1:15 Required	F Chem/ Water Solution (gallons) (D ÷ 15)		G Sum of the Dilution Ratio Required	H Total Product to Use (F ÷ G) (round up)	I Water to Use (gallons) (H – F)
12–14"	3.0	x		=	÷ 15	=	÷		=	
15–16"	3.5	x		=	÷ 15	=	÷		=	
18"	4.3	x		=	÷ 15	=	÷		=	
20"	4.5	x		=	÷ 15	=	÷		=	
21"	4.75	x		=	÷ 15	=	÷		=	
22"	5.0	x		=	÷ 15	=	÷		=	
24"	5.5	x		=	÷ 15	=	÷		=	
26"	6.0	x		=	÷ 15	=	÷		=	
27"	6.75	x		=	÷ 15	=	÷		=	
Example: **20"**	**4.5**	x	**200'**	= **900**	÷ **15**	= **60**	÷	**26**	= **2.3**	**57.7**

Worksheet #2

Air-Gap

For an air-gap to be effective, the distance between the inlet line and the tank must be at least twice the diameter of the inlet line (Figure 7-4). If the water flow reverses, air will rush into the air-gap and prevent siphoning. It is difficult to use an air gap with foaming root control chemicals, as the residual material in the tank will foam and prevent the tank from being filled.

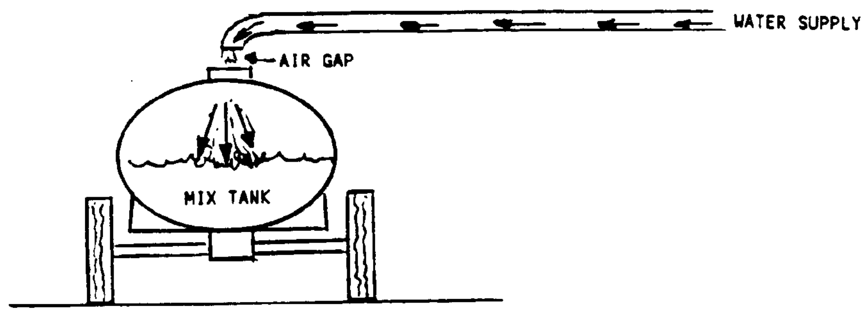


Figure 7-4. An air-gap twice the size of the water supply line must be provided at the tank being filled unless a backflow device is used. This air-gap prevents pesticide mixture in the tank from siphoning back into the water supply when the water flow into the tank stops.

Backflow Devices

Backflow devices are valves that prevent tank filling water from flowing back into the water source (Figure 7-5). Reduced pressure zone (RPZ) valves and double check valves are such devices. These valves connect between the water sources and filling hoses. When the pressure on the outlet side of a reduced pressure zone (RPZ) ever exceeds the pressure on the inlet side, relief valves discharge onto the ground, preventing back-siphoning. Double check valves are spring loaded and allow water to flow only in one direction from the source to the tank.

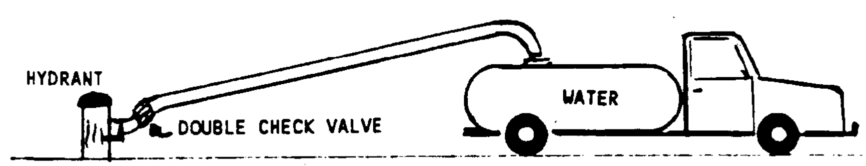


Figure 7-5. Backflow devices such as check valves prevent the siphoning of pesticide-mixtures into the water supply.

Filling from an Intermediate Source

It is often useful to fill mix tanks from an intermediate source, such as a sewer jetter. In these cases, of course, the sewer jetter must itself be filled using an air-gap or double check valve. The advantage is that in the event of back-siphoning from the mix tank into the intermediary source there is no danger of contaminating fresh water supplies (Figure 7-6). Obtaining water from a jet truck will also prevent back siphoning because the truck has built-in siphoning brakes.

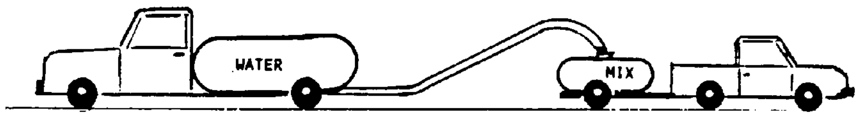


Figure 7-6. A sewer jetter provides a convenient source of water for filling application tanks and eliminates back-siphoning possibilities.

PREPARING TO MAKE THE APPLICATION

The three steps you should follow to prepare to make an application of metam-sodium root control chemicals are: (1) mix the chemicals or the chemical/water solution; (2) calibrate a 1 part chemical/water solution to 20 parts air; and (3) calibrate the hose retrieval rate or use charts proveded by product manufacturers.

Mixing the Chemicals

Due to the differences in packaged products, specific mixing instructions must be obtained from the label of the metam-sodium root control products being applied. Mixing information must also be obtained from the equipment manufacturer for the specific application equipment being used (Figure 7-7).

Figure 7-7. Refer to the pesticide labels and equipment manufacturers' instructions for correct mixing procedures.

The active ingredients, metam-sodium and dichlobenil, can only be used in combination with each other and with a foaming agent, as per the product label. Depending on the equipment being used the ingredients may be mixed with the proper amount of water in a mixing tank or they may be mixed only with themselves in a small chemical tank to be automatically mixed with water at the moment of application. Use chemical mixtures promptly after mixing and never mix more solution than can be used in one day.

Dichlobenil should be mixed with the other root control ingredients vigorously before mixing with water. Dichlobenil is formulated as a wettable powder, so mild agitation is necessary to keep it in suspension.

Calibrating Foam/Solution Expansion Ratios

Learn how to calibrate the application equipment to get proper foam consistency and volume. This section provides general guidelines for equipment and foam calibration. Consult with the equipment manufacturer for more specific calibration details.

Ingredients are mixed with water according to package instructions and then air is introduced with an air compressor. Foam quality is an important factor in achieving a successful root control application and it is obtained by having the proper chemical/water to foam ratio expansion. This expansion ratio is correct if 1-part of chemical/water solution expands to 20 parts of chemical/foam solution. The proper foam will be dense with small bubbles. It will cling to pipe surfaces, maintain its shape for a specified period of time, and contain the proper concentration of active ingredient per cubic foot of foam.

An expansion ratio less than 20:1 produces a wetter foam. Wet foam will be runny and will not stick properly to pipe surfaces. It will also be heavier and quickly collapse, not holding its shape in the pipes. Additionally, wet foams will not fill pipe volumes at normal retrieval rates or penetrate wye connections. An expansion ratio greater than 20:1 produces a drier foam, with large bubbles. This foam does not carry a sufficient concentration of active ingredient per cubic foot to be effective on tree roots. Foam quality can be adjusted by varying the flow rate of the water/chemical solution or air during the foam-making process. Follow the equipment manufacturers guidelines to make these adjustments.

A simple test of foam quality is to observe the foam discharging unobstructed from a hose into a manhole. The stream of good quality foam breaks into light balls and flakes of foam about 2 to 3 feet from the point of discharge.

Foam consistency can also be accurately measured. Discharge a small mound of foam onto a plastic sheet or similar surface. From this mound fill a 2000 ml graduated cylinder to the top. Place the cylinder in a location that is protected from wind (wind causes unnecessary breakdown of the foam). Over a period of time the foam will settle and become liquid. The desired result is to have the remaining liquid measure 100 ml or 1/20th of the original foam volume.

These tests for foam quality or equipment calibrations can be performed at a testing site by using the appropriate amount of wetting/foaming agent only. Do not add the root control product. This procedure reduces your risk of exposure while performing the tests. The wetting/foaming agents can readily be obtained from product manufacturers.

Each piece of equipment should be calibrated separately to determine its proper flow rate. If a piece of equipment shows wide variances in foam consistency, there may be a problem with the equipment. Service and adjust the equipment according to the equipment manufacturer's recommendations.

Calibrating the Hose Retrieval Rate

To determine the hose retrieval rate you must know the gallons of foam required per foot of sewer pipe and the output of the application equipment in gallons per minute. Dividing the output by the amount of foam required per foot gives you the retrieval rate. For application and hose retrieval rates follow the directions on the label of the material you are using. As a general guide for hose retrieval rates, use one of the tables below. Some types of application equipment have 10-second timers to aid in calculating retrieval rates. If you have this type of equipment, use Table 7-1. Otherwise, use Table 7-2 to determine the retrieval rates needed.

RETRIEVAL RATES FOR EQUIPMENT WITH 10-SECOND TIMERS

Pipe Size	Time to Fill Main (seconds/10-feet)	Time to Fill Main and Part of Lateral (seconds/10-feet)
6”	9	10
8”	15	17
9”	20	23
10”	24	27
12”	36	39
15”	55	60

Instructions: select pipe size from first column. Find the *seconds* in the second or third column for the retrieval rate for 10-feet of pipe. For example, for a 10-inch diameter pipe allow 24 seconds to treat 10 feet of mainline only. Allow 27 seconds to treat 10 feet of mainline and parts of the lateral lines.

Table 7-1. Hose retrieval rate chart for equipment with 10-second timers.

CALCULATING HOSE RETRIEVAL RATES

Pipe Size	Foam Fill gal/ft	Feet per minute
4"	0.7	143
6"	1.5	67
8"	2.5	40
10"	4.0	25
12"	6.0	17

Instructions: Select pipe size from first column. The second column indicates how many gallons of foam are required for one-foot of pipe. The third colum indicates the hose retrieval rate in feet per minute. For example, a 10-inch diameter pipe requires 4 gallons of foam per foot. Therefore you should retrieve the hose at 25 feet per minute. This is a general guideline. Check the foam output rate and equipment manufacturer's instructions for more accurate calibration.

Table 7-2. Determining hose retrieval rate.

This same procedure can be used to determine hose retrieval rates when making surface coating applications. For example, to apply a 3-inch layer of foam to 300 feet of 24 inch pipe carrying 7 inches of flow requires 2,221 gallons of foam. This breaks down to 7.4 gallons of foam per foot. If the equipment is generating 90 gallons of foam per minute then the proper hose retrieval rate would be 12.16 feet per minute (90 ÷ 7.4).

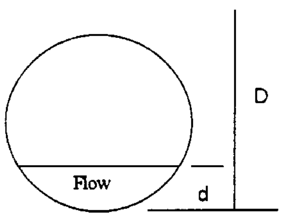


Figure 7-8. ***D** is the diameter of the pipe and **d** is the depth of the flow. The wetted perimeter is that portion of the circumference submerged with water and the dry perimeter is the portion of the circumference above the water line.*

If a pipe is partially full of water, the water takes up volume that must be subtracted from the calculated application amount (Figure 7-8). Proper application requires that the foam be discharged only above the flow line. Roots do not grow below this water level, and metam-sodium root control chemicals are not effective once they have been diluted in sewer flows. Use the calculations below to determine the percent of a pipe filled with water.

By comparing the wetted perimeter of the pipe to the entire perimeter (circumference) you can determine the percent by volume of the pipe filled with water.

The relationship between d/D and the wetted perimeter is illustrated in the chart below:

d/D	Wetted perimeter % of Circumference
0.1	20%
0.2	30%
0.3	37%
0.4	44%
0.5	50%
0.6	56%
0.7	63%
0.8	70%
0.9	80%
1.0	100%

APPLICATION TECHNIQUES

Hose Insertion Method

The hose insertion method is the most common way of applying foams to sewer lines (Figure 7-9). This technique has the lowest risk for unwanted foam traveling into laterals than other methods of foam application. A foam delivery hose is inserted through the section of pipe to be treated. Foam is then pumped from a foam generator through the hose while it is being retracted at a predetermined rate. Hydrojetters or rodding machines may be needed to move the hose into the pipe and position it before starting the foam application. If this is necessary, the foam generation equipment is adapted so it can be attached to a standard high-pressure hydrojetter. When using jetters it is recommended that a moderate pressure be used rather than very high pressure. High pressures and excessive cleaning may result in excessive root damage which can affect the effectiveness of the root control application. If a jetter is used, the end of the hose is fitted with a two stage nozzle. The first stage works with water pressure and uses this force to pull the hose through the pipe. Turning off the water causes the large portion of the nozzle to open. This provides an unrestricted flow of the foam which will be pumped through the hose while it is being retracted.

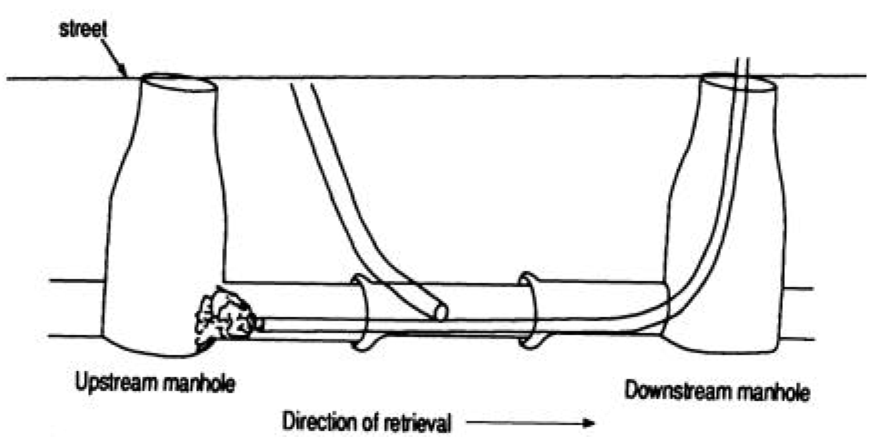


Figure 7-9. Hose insertion method of foam application. Care should be taken to avoid overfilling lateral lines. If buildings are close to the main, cleanout plugs should be used to prevent foam entry.

The insertion manhole may be upstream or downstream when using this technique. Whenever possible, use the upstream manhole for insertion as this avoids drift towards the applicator. Once the hose reaches the other manhole, start the equipment and wait for foam to appear. Retrieve the discharge hose at the desired rate.

Split Treatments. In some cases, the sewer stretch may be longer than the amount of discharge hose available. Or it may not be possible to get the discharge hose completely through the sewer line due to obstructions. In these cases, you may need to use two set-ups to treat a section (Figure 7-10). Treat the downstream portion first, as this reduces drift towards you and lowers your exposure to the chemical. Once the downstream section has been treated move to the upstream section and treat that.

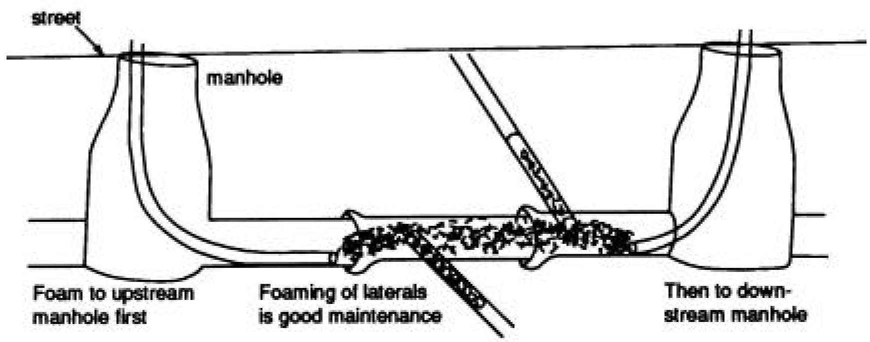


Figure 7-10. The split treatment method for foam application is used when the section of sewer line to be treated is longer than the available hose. Application is made from both the upstream and downstream manholes.

Treatment Method When There Is Inadequate Flow. Some sewer lines may have inadequate slopes so that the foam will slow or stop the wastewater flow, causing upstream ponding. Other lines may have dips or swales in which wastewater collects. Under these conditions it is often advisable to inject foam through the downstream manhole. Then, as the hose is retrieved, excess water is pulled toward the insertion manhole.

Treating Wye Connections and Lateral Branches. Normal treatment of mainline pipes is sufficient to kill roots at service connections. However, it is often desirable to treat service connections branching from the main sewer lines. This provides an important benefit to property owners whose buildings are connected to these lines. Generally, treating service connections from the main is only feasible when there are small-diameter (6-inch through 10-inch) mainline pipes. In larger diameter mainlines it is not possible to build up the pressures needed to penetrate service connections.

Don't ever attempt to treat more than the lower 10 to 20 feet of service laterals by this method. The greater the length of service laterals you attempt to treat by this method the greater is the risk of accidentally contaminating buildings connected to these lines. Refer to the following section on Treating Lateral Service Lines for safer methods of treating these pipes connected to buildings.

Risk factors to be aware if in buildings are:

- basements with below grade plumbing
- floor drains
- dry traps

- reduced sewer pipe volumes due to flow, low spots, or root masses
- unknown connections to the service lateral being treated

Additional foam per foot is required to use this method. Calculate the amount of additional foam required for the numbers and sizes of building laterals. Hose retrieval rates will need to be adjusted for this additional volume. USE EXTREME CAUTION to prevent foam from reaching building drains or outside sewer cleanouts.

Surface Coating Large-Diameter Pipes

When treating large-diameter pipes it is often impossible or too costly to completely fill them with foam. In addition, only the chemical that contacts roots is going to have any effect. Excess chemicals that drift downstream are wasted and could impact wastewater treatment plants. Surface coating is also used on small-diameter pipes with heavy flows where flow rates prevent filling the pipes with foam.

To coat interior sewer line surfaces an elevated nozzle must be pulled through the pipes (Figure 7-11). Foam is ejected through a nozzle positioned above the flow. Foam will contact and stick to upper pipe surfaces and roots. It is very important that nozzles be elevated because if the foam is ejected into the flow it will not reach the upper pipe surfaces. To calculate the volume of foam required to coat pipe surfaces refer to label instructions. If you have questions, contact your chemical supplier for instructions.

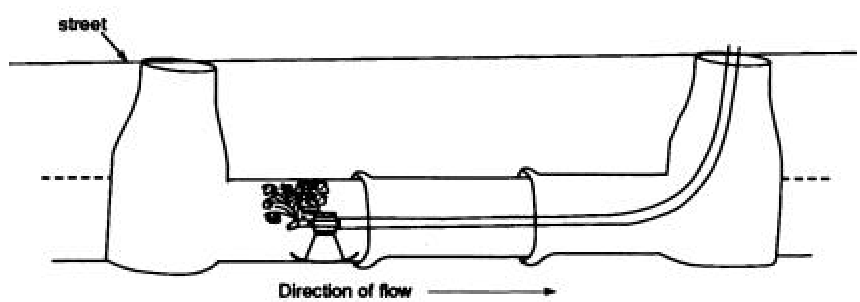


Figure 7-11. Surface coating applies foam to the inside surfaces of the pipe above the flow line. It does not fill the sewer line being treated.

Surface coating often does not yield the results obtained by totally filling the pipes since foam is not under pressure and will not penetrate root masses as effectively. Repeat treatments may be necessary as succeeding layers of root tissue are killed off. Also, surface coating will not result in foam penetrating service connections.

Spot Treatments

Spot treatments may be used with either foam filling techniques or surface coating techniques. Spot treatments involve treating only where roots are found. An advantage of spot treatments is that less material is required to treat given lengths of sewer pipe. The disadvantage is that it is first necessary to know exactly where the roots are—this requires video inspection. If the video inspection was not performed recently, additional root penetration may have occurred that would miss treatment. Also, early stages of root penetration are frequently missed by video inspection, so these areas would not be treated. Spot treatments are most useful in large diameter lines where increased costs for materials offset the costs of up-to-date video inspections. The amount of chemical which can be saved on small diameter pipe is usually negligible and does not justify cost of video inspections.

When using spot treatment techniques, allow an overlap of about 10 feet on either side of identified root intrusions.

Treating Lateral Service Lines

Treating lateral service lines that connect to buildings is done with small foamers and foam is pumped toward main sewer lines only. Some equipment manufacturers have developed specialized, portable equipment for treating lateral lines coming from buildings.

Treating lateral sewer lines should only be attempted if you are familiar with the design of building sewer systems or are under the supervision of a licensed plumber. Improper application may result in foam being discharged into buildings. Building occupants should be advised to exit any structure if the rotten egg or sulfur-like odor of metam-sodium is detected. If this should happen, buildings must be ventilated before occupants can be allowed back in.

Lateral service lines connect buildings to sewer mains which are usually located under nearby streets or alleys. These service lines are usually 4 to 6 inches in diameter. They may have been installed at various times as buildings were erected over the years. Records of where these lines go, which buildings are connected to specific lines, and condition of the pipes are usually non-existent.

The most common procedure for treating building lateral lines involves inserting a specially-designed air plug through a clean out. Be sure no fixtures or other clean outs are connected between the plug and the main sewer line. The plug is simply a 1" hose with an air bladder molded around the outside. The hose is inserted through a clean out into the down stream sewer pipe. The bladder is then inflated. Foam is pumped through the hose and is forced down the service lateral to the main. The inflated bladder blocks the foam from exiting the clean out or being forced back toward the building.

Treating service laterals is high-risk. If there are any questions as to the exact configuration of service laterals do not treat. Do not treat service laterals from buildings to which you do not have access at the time of treatment. Have a spotter in all buildings when service laterals are being treated.

Factors to Consider When Treating Service Lines with Foam

- foam follows the path of least resistance
- service laterals are normally small diameter pipe (4") and a small amount of foam goes a long way—for example:
  - 8-inch pipe requires 2.6 gallons of foam treatment per foot
  - 4-inch pipe requires 0.65 gallons per foot (a four fold difference)
- it is much easier for root masses entirely to block 4-inch pipes than 8-inch pipes
- what may look like simple service laterals from buildings to main lines may have other building laterals connected to them:

  As sewer technicians know, building areas were often smaller groupings of homes and commercial buildings built by different developers or individuals. After several growth years these have finally grown together into one developed community. You cannot be sure that all of these smaller building areas have underground utilities that fit today's designs and materials. There may be some surprise connections.
- never rely on memory or recollection as to how service laterals were constructed—if possible the lines should be inspected by video before treating to identify any areas that could cause concern during foaming operations
- conditions of lateral service lines are usually unknown—proceed with caution and do not treat if you have any doubts

Risk factors may include:

- unknown connections to the service lateral being treated
- inserting hose into an upstream pipe instead of the downstream section
- accidental spills on landscaping or in buildings while handling chemicals on private property

APPLYING SODIUM HYDROXIDE/2,6-D ROOT CONTROL MATERIALS

Effectiveness of sodium hydroxide combined with 2,6-D herbicide is increased when the mixture is retained for a period of time in the line being treated. For this reason, manufacturers recommend plugging the treated line at a downstream manhole if this can be done safely. Hazards to consider include low-lying lateral lines branching from the treated line. If these become flooded there is a serious risk that the pesticide may enter buildings attached to the lines.

Retention of sodium hydroxide combined with 2,6-D will increase the breakdown of grease and other organic deposits. It will also provide greater absorption by roots of the 2,6-D growth inhibitor. In addition, this herbicide will become adsorbed to clay particles and organic debris in pipes and pipe joints, providing a residual barrier against root regrowth.

If plugging is not an option due to steep slopes, low-lying laterals, or other reasons, this material will still have herbicidal activity through vapor action.

Sodium hydroxide with 2,6-D is applied as a granular material. Follow the manufacturer's application rate and method. The amount of material applied will depend on the volume of roots and other materials in the sewer line. Visual inspection is recommended before making an application.

DETERMINING EFFECTIVENESS OF ROOT CONTROL TREATMENTS

Determining the effectiveness of chemical root control treatments is an important issue for contractors and public works officials. The results of chemical root control are sometimes difficult to assess because they are not easily apparent. However, tracking results can be a learning tool for you and public works directors by pointing out deficiencies in application methods.

Conditions which may influence effectiveness of root control treatments include:

- improper application techniques such as poor contact and exposure or retention times
- high sewer flows or surcharging conditions soon after application
- severe hydraulic sewer cleaning before or after treatment
- heavy grease deposits which interfere with chemical contact
- old, ineffective, or improperly mixed chemical

Video inspection of treated sewer lines may provide some evidence of root control success. However, treating roots with root control pesticides kills the roots but does not make the roots disappear. A complex of decay organisms is constantly present in sewer lines, feeding on the dead roots. In addition, the build up of solids and ever constant pressure caused by wastewater flows breaks the dead roots off, sending them to treatment plants. This is a slow process that may take weeks, months, or even years. Live root masses in sewer lines look brown and dirty when viewed through video cameras. Dead root masses look the same.

With time root masses become smaller due to decay and breakage. The contents of dead root masses become soft or brittle and break off easily as the video camera passes. These factors all become part of the assessment of the success of a specific chemical root control treatment. The confidence level of these judgment calls can be significantly increased by removing a root sample from the pipe for a detailed visual inspection.

Like the trees above ground, roots grow in diameter by adding cells between the dead tissue in the root center and the dead bark on the outside. These healthy living cells create a light colored almost white layer under the bark. When a root is killed this layer turns brown. By stripping the bark layer off the individual roots in a root mass the effectiveness of a specific chemical treatment can be seen. When performing this visual test you need to remember that you are examining only one of perhaps hundreds of root masses from specific sections of treated line. Due to non-standardized conditions in a sewer system what you find in one root mass may not be what you find in the next.

Perhaps the most reliable method of judging the success of a chemical root control program is to observe the rate of reduction in sewer stoppages, overflows, emergency calls, and other root-related problems. If a municipality experiences 100 blockage problems per year before treatment and two blockage problems per year after treatment, the program can be considered successful. Such a program could be justified by weighing the cost of the root control program against the cost of relieving stoppages and subsequent damage caused by stoppages.

Although the ultimate goal of a root control program is to eliminate totally all root masses, in reality a successful program is one in which the roots are managed at a level below which the cost and risk of application is less than the cost and risks of unwanted sewer blockages and damaged pipes.

Note: The application of foam into sewer pipes involves the use of various conversion tables. To use these tables the certified applicators must be capable of calculating volumes and performibg basic mathematical functions such as multiplication, division, and use of percentages.

Glossary

absorb. to soak up or take in a liquid or powder.

activated charcoal. finely ground or granulated charcoal which adsorbs chemicals.

active ingredient. the chemical or chemicals in a product responsible for pesticidal activity.

acute oral toxicity. injury produced from a single exposure by mouth.

acute toxicity. short-term immediate effects of a pesticide exposure.

adherence. the ability of a pesticide or substance to stick to a surface.

adjuvant. a substance added to a pesticide to improve its effectiveness or safety. Examples include penetrants, spreader-stickers, and wetting agents.

adsorb. to take up and hold on the surface of soil or organic particles.

adsorption. the process where chemicals are held or bound to a surface by physical or chemical attraction. Clay, charcoal, and high organic soils adsorb pesticides.

agitation. process of stirring a pesticide solution so as to keep the components in suspension.

anti-siphoning device. a mechanism used to prevent the flow of a pesticide solution from a mix tank to a water source.

back-flow preventor. see *anti-siphoning device.*

bactericide. a pesticide that destroys or prevents the growth of bacteria.

basal application. application of a pesticide to plant stems or tree trunks just above the ground line.

building sewer line. that portion of a sewer system which lies between the building foundation and a main sewer line; . also called lateral sewer line.

bypass pumping. the process of temporary re-routing of sewer flows around a given section of sewer or sewage treatment plant.

calibration. the process of adjusting application equipment so that pesticides are applied at a known prescribed rate.

carrier. an inert ingredient used to dilute a mixture of pesticides, or to transport a pesticide to target surfaces.

chemical name. the scientific name for a chemical substance. For example: *sodium methyldithiocarbamate* is the chemical name for metam-sodium.

CHEMTREC. the chemical transportation emergency center. This organization operates a 24-hour information hot-line for pesticide spills, fires, and accidents. 1-800-424-9300.

chronic toxicity. the potential for long-term health effects as a result of exposure to a particular pesticide.

clean out. a capped opening into a lateral line providing access for cleaning equipment.

collector sewer. a sewer, typically small diameter, which collects wastewater flows from buildings and transports those flows to an interceptor sewer.

combined sewer. a sewer which is designed to carry both sanitary flows and storm water, either all or part of the time.

combined sewer overflow. see *overflow*.

commercial applicator. a person who applies pesticides for hire. Many states, including California, require commercial applicators to be certified applicators regardless of the types of pesticides they apply.

common name. a generic name given to an active ingredient in a pesticide formulation. Common names are different from chemical names or brand names. Examples include metham, dichlobenil, copper sulfate.

compatibility. the ability of two pesticides or substances to mix without reducing the effectiveness or usefulness of either substance.

contact herbicide. an herbicide that kills primarily by its contact with plant tissues rather than by being translocated to other parts of the plant.

decomposition/degradation. the process by which a chemical substance is broken down into simpler substances. This process can take place through chemical, biological, or physical means.

dermal exposure. the exposure of a pesticide to or through the skin.

dermal toxicity. the ability of a pesticide to cause injury to a human or animal when absorbed through the skin.

desiccant. a pesticide that destroys target pests by causing them to lose body moisture or to dry up.

detoxify. the ability of a substance or process to render a pesticide harmless.

dust. finely ground pesticide particles, sometimes combined with inert materials. Dusts are applied without mixing with water or other liquid.

easement. in sewer work, the location of a sewer line in backyards, parks, public lands, off-road locations, or other areas which are typically more difficult to access than sewers located beneath street surfaces. Also, the right of utility companies and municipal agencies to access manholes and sewer lines which are located on private property.

effluent. the treated wastewater that leaves a sewage treatment plant.

engineer. in sewer work, the designated official of a municipality who represents and is authorized to act on behalf of a municipality with respect to the municipality's dealings with a contractor.

exfiltration. the leakage of wastewater from a sewer pipe into the ground through joints, cracks, or defects.

EPA. the United States Environmental Protection Agency. The federal agency responsible for regulating and enforcing the registration, sale, and use of pesticides.

EPA registration number. the number assigned to a pesticide by the US EPA. This number must appear on all pesticide labels.

FIFRA. the *Federal Insecticide, Fungicide, and Rodenticide Act*. The federal law that empowers the US EPA to regulate pesticides in the United States.

foaming agent. an adjuvant used to convert a pesticide solution into a thick foam. Used in sewer line root control as a carrier and surface active substance that forms a fast-draining foam to provide maximum contact with the plant surface, to insulate the surface, and reduce rate of evaporation.

foam retardant. an adjuvant used to prevent foaming of a pesticide mixture.

formulation. a mixture of pesticidal chemicals and inert ingredients. The pesticide product as purchased.

French drain. a perforated or porous conduit used to remove groundwater from an area and convey it downstream.

fumigant. a pesticide which forms a vapor or gas, usually in a confined space or enclosed area. Fumigants are toxic when absorbed or inhaled.

fungicide. a pesticide that kills or controls fungi and other plant diseases.

general-use pesticide. a pesticide which can be purchased and used by the general public. (see *restricted-use pesticide*).

germicide. a pesticide that kills or controls pathogenic (disease carrying) bacteria.

gpm. gallons per minute.

groundwater. vast water reservoirs beneath the soil surface that are the sources of wells.

grouting. the process of sealing pipe joints or other open sewer defects against groundwater infiltration.

herbicide. a pesticide used to control weeds.

incompatible. two or more pesticides or substances that cannot be mixed together without adversely affecting their usefulness.

inert ingredients. materials in the pesticide formulation that are not the active ingredient. Some inert ingredients may be toxic or hazardous to people. See *adjuvant*.

infiltration. groundwater which enters sewer systems through joints or other defects.

infiltration/inflow control (i/i). in general, the process of abating or controlling the introduction of extraneous water in a sewer system. Examples include grouting, re-lining, manhole rehabilitation, etc.

inflow. distinguished from infiltration, extraneous water other than groundwater that enters a sewer system. Examples include surface water which enters through manhole covers, water coming from roof leaders, and foundation drains.

inhalation. exposure to a pesticide through breathing.

influent. water that is entering a structure. An example is a sanitary sewer flow entering a wastewater treatment plant.

inspector. a representative of the owner or municipality who is actually on the job site supervising the work being performed.

interceptor sewer. typically a large diameter sewer without service connections which receives wastewater from collector sewers and transports the flows to a wastewater treatment plant.

invert. the lowest point of a pipeline or conduit. The bottom part of a manhole that is rounded to conform to the shape of the sewer line.

joint. the connection between two contiguous pieces of sewer pipe.

lateral sewer. same as *building sewer*.

leaching. the process by which some pesticides move down through the soil, usually be being dissolved in water, with the possibility of reaching groundwater.

lineal feet. a measurement of distance, in a straight line, between two contiguous manholes in a sewer system.

LD_{50}. the lethal dose of a pesticide that will kill half of a test animal population. LD_{50} values are given in milligrams per kilogram of test animal body weight (mg/kg).

manhole section. same as *sewer section*.

mgd. millions of gallons per day. Used to express the design flow capacity or actual flow of a wastewater treatment facility.

nonsystemic. a contact pesticide which has a localized pesticidal effect; not transported through the plant or animal tissues.

nonselective. a pesticide that has an action against many species of pests rather than just a few.

oral toxicity. the potential for injury when a pesticide is taken by mouth.

overflow. an undesirable discharge of sanitary or combined sewer flow into a river, stream, or other surface waters.

owner. in sewer work, the municipality or public agency that maintains public sewers.

parts per million (ppm). a typical measure of the concentration of a pesticide in another substance. One gallon of active ingredient in 1,000,000 gallons of water represents a 1 ppm concentration.

persistence. the ability of a pesticide to resist chemical or biological degradation and therefore remain in the environment for an extended period of time.

pesticide. any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, or weeds, or any other forms of life declared to be pests; and any other substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

phytotoxic. injurious to plants.

receiving waters. the bodies of water into which wastewater treatment plants or storm sewers discharge.

residual pesticide. a pesticide which remains active for an extended period of time.

residues. traces of pesticide that remain on treated surfaces after a period of time.

restricted entry interval. the period between the application of a pesticide and the time when people can reenter the treated area without having to receive special training and wear personal protective equipment.

restricted-use pesticide. a pesticide, usually in toxicity Category 1, that can only be used by commercial applicators who have a valid Qualified Pesticide Applicator license or certificate or private applicators who have demonstrated to the local agricultural commissioner that they understand the proper methods of handling, using and disposing of these materials.

runoff. the liquid spray material that drips from the foliage of treated plants or from other treated surfaces. Also the rainwater or irrigation water that leaves an area—this water may contain trace amounts of pesticide.

sanitary sewer. a sewer designed to carry only residential or commercial waste, as opposed to a storm sewer.

saponify. to convert fat or grease to soap by reacting with an alkali such as sodium hydroxide.

selective pesticide. a pesticide that has a mode of action against only a single or small number of pest species.

sewer section. the length of sewer pipe connecting two manholes.

soil fumigant. a pesticide that forms a vapor or gas in soil, used to control pests in soil such as weed seeds, nematodes, bacteria, viruses, fungi.

soil sterilant. similar to soil fumigant, except that it kills all living organisms in soil usually for an extended period of time.

solution. a liquid that contains dissolved substances, such as a soluble pesticide.

spot treatment. a method of applying pesticides only in small, localized areas where pests congregate rather than treating a larger, general area.

storm sewer. a sewer designed to carry only rainwater, groundwater or surface water.

surcharge. the condition that exists when the volume of water exceeds the hydraulic capacity of a sewer.

surfactant. an adjuvant used to improve the ability of the pesticide to stick to and be absorbed by the target surface.

suspension. fine particles of solid material distributed evenly throughout a liquid such as water or oil.

swale. a dip or sag in a sewer pipe, in which water and debris often collects.

synergism. a reaction in which a chemical that has no pesticidal qualities can enhance the toxicity of a pesticide it is mixed with.

systemic pesticide. A chemical that is absorbed and translocated within an animal or plant to destroy it. Some systemic pesticides are designed to protect the plant or animal against other pests.

target. either the pest that is being controlled or surfaces within an area that the pest will contact.

translocation. the movement of pesticides from one location to another within the tissues of a plant.

trade name. a brand name of a pesticide. The same active ingredient may be sold under different trade names; for example, *Vapam*® is a trade name for metam-sodium.

volatility. the ability to pass from liquid into gaseous stages readily at low temperatures.

water table. the upper level of a groundwater reservoir or aquifer.

weed. any plant that interferes with the growing of crops or ornamental plants, endangers livestock, affects the health of people, interferes with the safety or use of roads, utilities, and waterways, or is a visual or physical nuisances.

wettable powder. a type of pesticide formulation consisting of an active ingredient that will not dissolve in water combined with a mineral clay or other inert ingredients and ground into a fine powder.