TDOT Integrated Vegetation Management Program Guidelines

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Attachments

TDOT Integrated Vegetation Management Program Guidelines

The purpose of the **TDOT Integrated Vegetation Management Guidelines** is to provide information necessary to maintain the Department's roadsides that will help:

- Improve sign visibility to the traveling public.
- Improve sight distance.
- Keep roadways & intersections visible to the traveling public.
- Improve visibility of wildlife near state highways on public ROW.
- Provide pedestrians and bicyclists safer infrastructure on state highways.
- Keeping state highways free from overhanging vegetation.
- Manage and remove trees close to the state highways that endanger public safety.
- Remove vegetation to improve winter maintenance activities during snow and ice events.
- Protect paved surfaces.
- Improve clear zones.
- Maintain properly functioning drainage systems.
- The Control noxious weeds on state ROW.
- Improve aesthetics.

Each TDOT District is required to maintain an up-to-date Integrated Roadside Vegetation Management Plan by controlling vegetation through a variety of strategies including mowing, brush cutting (mechanical and hand) and use of herbicides.

Herbicides

Guidelines for Mixing, Storing, Transporting and Disposing of Herbicides Safely

- Read the label and follow instructions exactly. Always use the safety equipment specified on the label.
- All measuring or mixing equipment should be thoroughly washed (triple rinse) after each use and stored with the herbicides in a locked and secure area.
- Carry spill kits/containment materials in spray vehicle.
- Do not load or mix herbicides near waterways.
- Completely clean up any spills using an absorbent material, if needed.

- Always store herbicides in their original containers. Do not transfer or store herbicides in unmarked containers not intended for herbicide, such as soft drink bottles, jars or milk cartons.
- Keep herbicides in a locked, secure facility set aside and conspicuously posted for that purpose.
- Do not store safety equipment with herbicides.
- Check containers frequently for leaks. Should a leak occur, transfer the herbicide to a marked container meant to hold that herbicide. Completely clean up the leak.
- Keep an inventory of all stored herbicides.
- Triple rinse empty containers before discarding

The name and phone number of the nearest hospital and poison control center should be posted in a prominent location in the storage facility.

- When transporting herbicides, do not place them in the cab or passenger compartment.
- Never leave a vehicle unattended with herbicide containers exposed.
- Always have the labels and SDS (Safety Data Sheets) in the vehicle for the herbicides being used or transported.
- Use appropriate gloves, boots, clothing and respirators as required by the chemical being used.
- Never use leather gloves or shoes when spraying.
- When disposing of herbicide containers, follow the instructions on the label, including proper safety equipment and clothing.
- Learn, keep current with and strictly adhere to laws and regulations regarding use and disposal of all herbicides.

Environmental Regulations—the herbicides, pesticides and fertilizers used in roadside vegetation management are substances of concern due to their potentially harmful effect on people, animals and the environment. There are a large number of regulations that govern the use, transport, storage and disposal of these materials. Violations of these regulations may lead to federal, state or citizen enforcement actions that can result in significant penalties. It is important that roadway agencies be familiar with the requirements, particularly in terms of needed permits or licenses, training requirements and recordkeeping. Note that in addition to civil enforcement actions, federal and state agencies may criminally prosecute any person who knowingly violates certain provisions of the regulations. Knowledge of the requirements and good recordkeeping are the best defenses.

Records should be accurate and contain the following data:

- Date and time of application.
- Type of equipment used (including spray curtains and spray shields).
- Herbicide(s) used, including SDS.
- Formulation

- Mixing information etc.
- Rate of application.
- Total area treated.
- Location (route number, mile post or distance from nearest intersection, distance treated).
- Target vegetation.
- Weather conditions at time of application (temperature, humidity, and wind speed and wind direction).
- Name of applicator.
- Miscellaneous comments (including spray pressure, nozzle type, nozzle size, speed at which spraying and distance from spray nozzle to target).

ROW Spraying

Major reasons for highway right of way vegetation management practices include:

- To maintain the integrity of the paved surface;
- To prevent or reduce erosion;
- To provide for the safety of the traveling public;
- To provide for efficient maintenance practices;
- To maintain drainage;
- To provide beauty, and;
- To provide wildlife habitat.

Vegetation management along the transportation system consists of promoting and control of vegetation. Control of vegetative growth may be accomplished by a combination of physical and chemical methods. Physical methods of vegetation control include hand-pulling, hoeing, plowing, cultivating, trimming and mowing. Chemical methods include the application of approved herbicides to control specific vegetation problems. TDOT's herbicide program is based upon extensive research for chemicals which will provide the desired control of the target species while presenting the minimum possibility of harm to the environment, the applicator, or to the traveling public. The use of herbicides is a key element to be used in combination with physical vegetation control methods to manage right of way vegetation.

What affects Herbicides:

- Rainfall
- Temperature
- Wind
- Soil Type
- Timing & Procedures of Herbicide Application
- Humidity

- Calibration
- Equipment & Nozzles

Rainfall
Do not spray herbicides during rainfall or when rainfall is predicted within 1–2 hours after application. Rain will wash herbicide off the foliage of target species before it can be absorbed by the plant. This is a concern due to runoff and the possible effects on non-targeted organisms in receiving environments. Conversely, after a rain, dust on the foliage will have been washed off and foliar-applied herbicides can be easily absorbed by the plant. Allow the foliage time to dry after a heavy dew or rain before conducting spraying operations as wet foliage may also yield poor results.

Note: Under drought conditions, plants may become semi-dormant or produce a wax layer to protect against excessive moisture loss. Herbicides generally work their best when moisture conditions allow the plants to be activity growing and taking up nutrients. These conditions are generally found in the spring and fall.

Temperature
Temperature at the time of an herbicide application can have a dramatic impact on the level of weed control achieved. Temperature affects the action of herbicides and the degree of control achieved as well. Do not apply herbicides when the soil is frozen, when rain or snow is falling, or when there is snow on the ground. High temperatures, typical during the hot-dry summer months, causes many plant species to become dormant. When these conditions occur, plants will not absorb the herbicide and control will be reduced.

Note: Extremes of excessive cool or hot conditions will decrease herbicide performance. Herbicides that can become volatile usually do so as a result of high temperatures (usually in excess of 80^{o} F).

Wind
Wind speeds over 10 mph greatly increase the risk of herbicide drift and potential off-target spraying. It is recommended not to spray when wind speeds are in excess of 10 mph. When mixing herbicide formulas drift control shall be added to the mix. Always consult the label for further information concerning the herbicide application.

Soil Type
Soil type and condition can have an impact on plant growth and herbicide performance. Soils are made of organic and inorganic materials. Soil texture and structure is the relative portions of sand, silt and clay particles present in the soil along with the shape or arrangement of the particles. Sandy soils are more prone to pesticide movement, and leaching may occur in clay and silt soils. The herbicide label will give recommended application rates depending on soil type and clay and organic matter content.

Timing & Procedures of Herbicide Application
Proper selection of herbicides and proper application rates are dependent upon the type and species of vegetation to be controlled, as well as the condition of the plant species itself. Some plant species are more resistant to certain herbicides than are other more sensitive plants. The plant may be in either an active growth or a dormant growth stage. The plant may be a seedling or a mature plant. The plant may be in the process of budding, leafing, flowering or fruiting. Each of these conditions has a bearing upon how herbicides work and should be considered when deciding where and when to use herbicides.

Humidity
Relative humidity is defined as the percent of moisture in the surrounding air relative to the maximum amount the atmosphere could hold. Generally, the higher the relative humidity at the time of application, the quicker plants will absorb foliar-applied herbicides. However, when relative humidity approaches 100 percent, rainfall will likely occur and the chance that the herbicide will be washed from the foliage increases. Consequently, herbicides should not be applied when rainfall is imminent. Consequently, applications made during the early evening, night or morning hours under what appear to be ideal conditions can result in highly damaging drift that can move long distances. This is especially true if the humidity is high.

Calibration (Annual)
Calibration is the process of measuring and adjusting the amount herbicide your equipment applied or delivered to a specific area. The purpose of calibration is to ensure your equipment is applying the correct amount of material uniformly over a given area. The time invested in calibrating your equipment is time well spent. Accurate calibration to determine the application rate under your operating conditions is important for cost, efficiency and safety. Upon completion of annual calibration a decal will be attached to each piece of equipment in the following locations. (Spray Trucks top left corner of windshield, Tractors with cabs top left corner of windshield, and open cab tractors on left rear fender.)

Equipment & Nozzles
Proper operation and maintenance of spray equipment is essential for safe and effective herbicide applications and will significantly reduce repair costs and prolong the life of the sprayer. All equipment shall be inspected and maintained to ensure excellent working condition. This is vitally important to the success of your spray program. Pre-trip and post-trip inspections shall be made on all equipment, trucks and sprayers to ensure proper working conditions. Nozzles are very important part of a sprayer. They control the amount of material applied, the formation of the droplets and their size, and the distribution and pattern of the droplets. The size of the nozzle opening (orifice) affects the droplet size and the flow rate. Worn nozzles higher flow rate and a greater concentration of spray directly below the nozzle. Nozzles shall be changed every two years to ensure the proper spray patterns and droplet sizes are correct.

Right-of-Way Spraying Guidelines

Note: Only the first 60' foot of Right-of-Way shall be maintained on all interstate or state routes except site specific issues.

- Daily accurate spraying documentation (shot records) shall be recorded in MMS and documented shot records kept in the chemical room and with the vehicle when in use, see attachment "F".
- Vegetation in sight distance areas shall be controlled and maintained as necessary on all routes. Use standard drawing RD01-SD-2 for Intersection Sight Distance Landscape and obstructions as needed if necessary.
- All guardrail and cable rail in the swath mowing areas shall be sprayed with the herbicide formula provided in this document and with the intent of having a bare ground area from the edge of the pavement in front of the guardrail to two foot behind the guardrail post, see Diagram. All cable rails shall be sprayed two foot in front and behind all cable rail post except for urban/city.

Spraying Areas

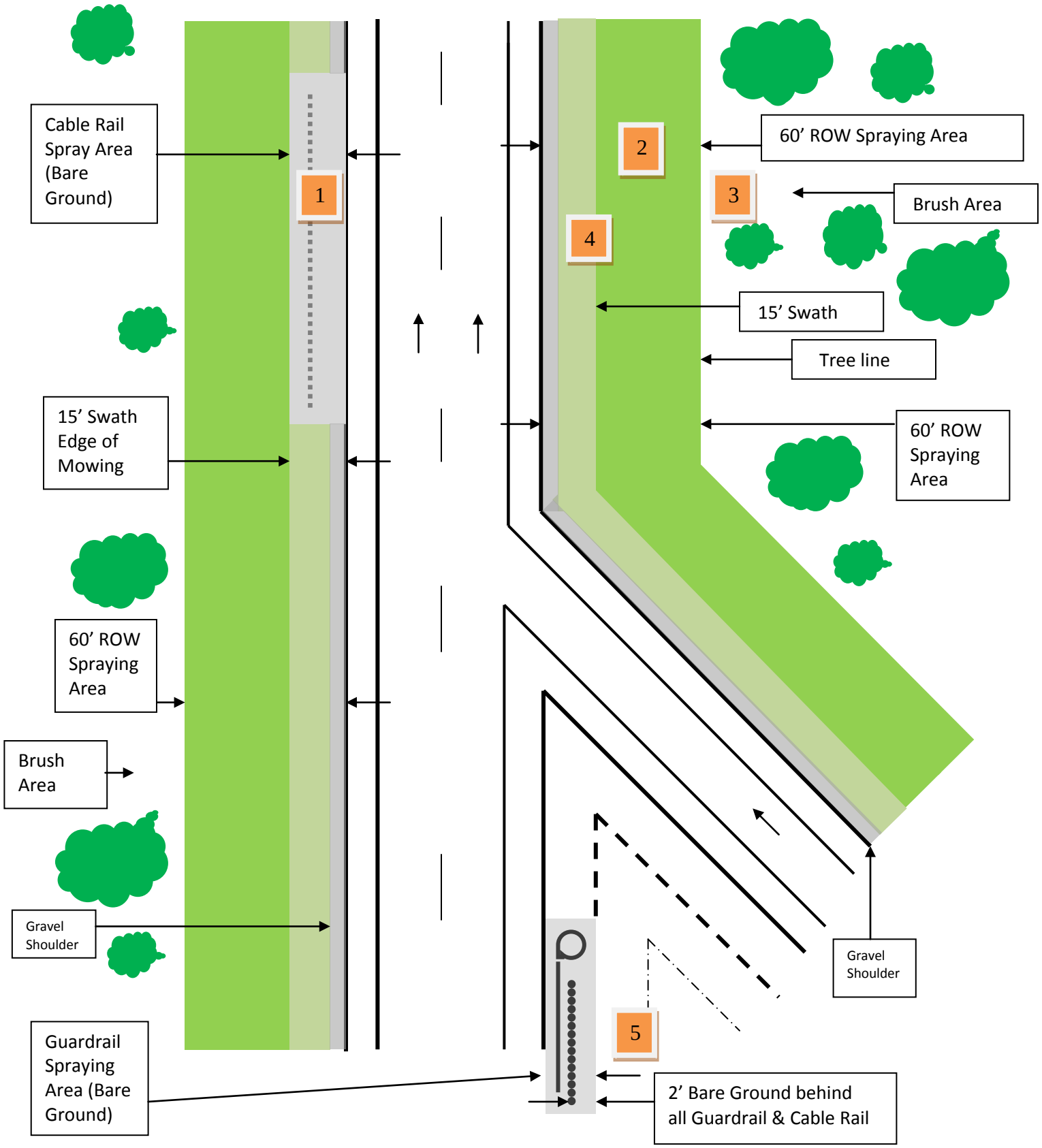


Diagram 1

- The first 60’ of Right-of-Way in all swath mowing areas and/or controlled access areas except for urban/city can be chemically sprayed twice a year, starting at the edge of the paved shoulder, see diagram “A”.
    - **I.** The first spraying should begin March 15th and end no later than April 15th of each year. This spray formula shall consist of a seed head suppressant, broadleaf control, pre-emergent Johnson grass control and woody vegetation control herbicides. The herbicide formulas are provided in this document and can be adjusted as needed. Always read the label prior to using any herbicide.
    - **II.** The second spraying should begin by June 15th and be completed by July 15th of each year. This spray formula shall consist of a broadleaf control, Johnson grass control, ornamental grasses and woody vegetation control herbicides. The herbicide formulas are provided in this document and can be adjusted as needed. Always read the label prior to using any herbicide.
- All areas that have been cleared of woody vegetation and brush on state right-of-way either by using SWC or state operations forces shall be sprayed in the same calendar year to prevent regrowth of the same species in these areas. The formulas for this spraying shall consist of a woody vegetation herbicide, brush control herbicide and Johnson grass control herbicide and is to be sprayed during the fall of the year, September 1st through October 15th. Woody vegetation management by the TDOT is driven by roadside safety and winter operations. The preservation of a safe recovery area for errant vehicles is a high priority. Several methods are available and have been used by the Department as noted.
        - **I.** All woody vegetative debris occurring on state right-of-way that is adjacent to property where a residence or business exists must be removed from the right-of-way within seventy-two hours of performing the vegetation work.
        - **II.** All woody vegetative debris occurring from vegetation removal work that is not adjacent to property where a residence or business exists must either be removed from the right-of-way within five business days or mechanically, shredding/chipping to less than one foot in length and less than three inches in diameter and scattered to a maximum depth of six inches within the right-of-way within five days of the vegetation removal activities. All stumps are to be left flush with the ground.
        - **III.** Where work is performed on bluffs or slopes, all debris shall be mechanically, shredding/chipping to two inches (2”) or smaller and scattered to a maximum depth of six inches (6”).
- Johnson grass control shall be priority in the first 60’ of state right-of-way. In all areas outside of the first 60’ Johnson grass shall be controlled using a chemical herbicide application that is applied be a weed wiper once the Johnson grass has reached 12’’-18’’ or taller. The herbicide must be allowed to move through the grass to the root system. Once the herbicide is applied the Johnson grass is not to be mechanically mowed.

Mowing

Mechanical mowing is an important tool used to maintain a Clear Zone which is an unobstructed, traversable roadside area that allows a driver to stop safely, or regain control of a vehicle that has left the roadway. Mowing also helps maintain clear zones (see attachment "E"), adequate site distances, to maintain shoulders, guardrails, drainage, roadside ditches, and to maintain the integrity of structures, such as end walls and fences. Mowing is also important in maintaining an aesthetically pleasing appearance of roadsides for the traveling public. The following types of mowing are currently recognized:

- Brush Control
- Slope Mowing
- Hand Trimming
- Machine Mowing
- Safety Mowing
- Swath Mowing

All mowing operations shall be carried out in accordance (excluding recognized city limits) with Chapter 54-552, Tennessee Code Annotated; The Department of Transportation assumes responsibility for maintaining everything inside right-of-way fences on the Interstate System of Defense Highways with its own forces, except lighting systems. The work in maintenance activity 435 consists of scheduled mowing along state rights-of-way.

All mowing is accomplished with tractors equipped with standard rotary mowers, batwing mowers, or side mounted mowers. Hand grooming around fixed objects may be required if an area has not been treated with an approved herbicide. The objective of mowing is to maintain vegetation to a condition that assures visibility of traffic control devices, guardrail, and signs, and provides adequate site distance at the junction of intersecting roads, around curves, and at interchanges, meeting safety requirements for the facility and producing aesthetically pleasing roadsides.

The number of mowing cycles will vary according to the growing season and resources, between the months of April and November. Mowing heights shall be uniform at no less than 4-6 inches.

Mowing slopes steeper than 2:1 is not recommended with a standard rotary mower. If mowing is performed, slopes with a grade steeper than 2:1 shall be mowed with hand-held trimmers or boom/slope equipment.

All mower blades shall be maintained in a sharp, good cutting condition. Mowers shall be equipped with shields to preclude foreign objects from being ejected from under the cutting unit housing.

Swath Mowing on the Interstate System

Mowing the area 15 feet from the edge of the shoulder (whether paved or unpaved) is called swath mowing. In addition to the swath along the shoulder, all swath mowing operations will include:

- All mowing necessary to maintain adequate sight distances for intersections, private entrances, curves, off-ramps, on-ramps, signs, delineators and other appurtenances.
- All interstate gore areas from the beginning of the off-ramp taper to the end of the on-ramp taper should also be completely mowed during the swath mowing cycle from Right-of-Way fence to Right-of-Way including the median.
- Mowing around all appurtenances (signs, delineators, guardrail, culvert headwalls, etc.) that are within the designated swath width area.
- Mowing the entire width of narrow medians of 60 feet or less.
- Mowing full-width, from right of way to right of way where needed for drainage where appropriate.
- Mowing a smooth and gradual transition that will blend the designated strip width with other areas that require a greater or lesser mowing width.
- TDOT will spray all guardrail/cable rail as specified annually.

Calibration

The four factors that determine the volume of spray applied:

- Nozzle size (GPM) gallons per minute
- Truck or ground speed
- Nozzle spacing or spray width
- Pressure at the nozzle (PSI)

All herbicides must be applied at the specified rates and done uniformly for effective economical results. It is extremely important to calibrate the herbicide spray unit for the different spray operations. The pre-calibration phase involves the inspection of all parts of the spray system for proper operation and cleanliness, using the Herbicide Spray Equipment Check List; see attachment "A".

Methods of Calibration

Measured Distance Method

1. Prepare sprayer as described in the "Calibration Checklist" (Attachment "G"). Change as necessary for desired output.
2. Consult your nozzle manufactures catalog for your nozzle size. Set the desired pressure. Spray clean water through nozzles and collect output for 1 minute to check that each individual nozzle does not vary significantly from average or manufacturer's specifications. Replace nozzles that show a significant variance in output from average or manufacturer's specifications.
3. Determine the swath width for the desired coverage.
4. Determine the gallons per acre (GPA) of spray solution desired based on the equipment and product to be used for the specified application.
5. Calculate the distance the sprayer must travel to cover one acre.
   $\frac{43{,}560 \text{ sq. ft./acre}}{\text{Spray width in feet}} = \frac{\text{Distance sprayer must travel}}{\text{to spray one acre}}$
6. Fill tank with clean water. Operate sprayer over the distance calculated in Step5, using normal operating speed and pressure. Determine the amount of water sprayed by measuring the amount of water needed to refill the spray tank.
7. If the tank refill does not equal the amount of water sprayed for the desired distance then repeat step 5 and adjust the speed or change nozzles to obtain the desired output.
8. Always double check your results by repeating the calibration.
9. Divide the capacity of the tank in gallons (1,500, 1,000, 500 etc…) by the (GPA) gallons per acre to obtain the number of acres the tank will cover.
   Example: 1500 gal/25 gal per acre = 60 acres.

10. Multiple the capacity in acres the tank by the amount of chemical herbicide required per acre of each chemical to be added.
    Example: Milestone 4oz per acre.
    Using example 9 at 60 acres for the 1,500 capacity tank; then multiply 60 acres x 4oz = 240oz. to be added to the tank for the proper application.

Boomless Equipment Calibration

"See attachment "G"

Tables

Amount of Product Needed for Various Tank Sizes

Tank Size	500 gal.	1,000 gal.	1,500 gal.	2,000 gal.
Product Rate per acre	**Gallons of Product per Tank**			
8oz.	1.25	2.5	3.75	5.00
10 oz.	1.56	3.12	4.68	6.25
12 oz.	1.875	3.75	5.625	7.50
16 oz. (1 pt.)	2.5	5.0	7.5	10.0
24 oz.	3.75	7.5	11.25	15.0
32 oz. (1 qt.)	5.0	10.0	15.0	20.0
40 oz.	6.25	12.5	18.75	25.0
48 oz. (1.5 qt.)	7.5	15.0	22.5	30.0
56 oz.	8.75	17.5	26.25	35.0
64 oz. (2 qt.)	10	20	30	40
97 oz.	15.15	30.31	45.46	60.25
128 oz.	20	40	60	80

Formulas for Calculating Additional Rates:

1. Gallons in tank = acres/tank
Gallons/acre
Example: 1,000 gal. tank = 40 acres/tank
25 GPA

2. Acres per tank x Rate per acre = Amount of herbicide added to tank
Example: 40 acres/tank x 32 oz./acre = 1,280 oz. added to tank

3. Ounces per tank = Gallons per tank
128 oz./gallon
Example: 1,280 oz./tank = 10 gallons/tank
128 oz./gallon

Acreage Based on Spray Width:

	Length in Miles				
Width In feet	**0.2**	**0.4**	**0.6**	**0.8**	**10.0**
	Acres				
1’	0.02	0.04	0.07	0.09	0.12
2’	0.04	0.09	0.14	0.19	0.24
3’	0.07	0.14	0.25	0.29	0.36
4’	0.09	0.19	0.29	0.38	0.48
5’	0.12	0.24	0.36	0.48	0.60
6’	0.14	0.29	0.43	0.58	0.72
7’	0.17	0.33	0.50	0.67	0.84
8’	0.19	0.38	0.58	0.77	0.96
9’	0.21	0.43	0.65	0.87	1.09
10’	0.24	0.48	0.72	0.96	1.21
20’	0.48	0.96	1.45	1.93	2.42
30’	0.72	1.45	2.18	2.90	3.36
40’	0.96	1.93	2.90	3.87	4.84
50’	1.20	2.42	3.63	4.84	6.06
60’	1.45	2.90	4.36	5.81	7.27
70’	1.69	3.39	5.09	6.78	8.48
80’	1.95	3.87	5.81	7.75	9.69
90’	2.18	4.36	6.54	8.72	10.90
100’	2.42	4.84	7.27	9.69	12.00

Acreage Based on Spray Width:

Width In Feet	2.0	4.0	6.0	8.0	10.0
	Acres				
1’	0.24	048	0.72	0.96	1.21
2’	0.48	0.96	1.45	1.93	2.42
3’	0.72	1.45	2.18	2.90	3.63
4’	0.96	1.93	2.90	3.87	4.84
5’	1.20	2.42	3.63	4.84	6.06
6’	1.45	2.90	4.36	5.81	7.27
7’	1.69	3.39	5.09	6.78	8.48
8’	1.93	3.87	5.81	7.75	9.69
9’	2.18	4.36	6.54	8.72	10.90
10’	2.42	4.84	7.27	9.69	12.12
20’	4.84	9.69	14.05	19.39	24.24
30’	7.27	14.54	21.81	29.00	36.36
40’	9.69	19.39	29.09	38.78	48.48
50’	12.12	24.24	36.36	48.48	60.60
60’	14.54	29.09	43.63	59.15	72.72
70’	16.96	33.93	50.90	67.87	84.84
80’	19.39	38.78	58.20	77.57	96.96
90’	21.81	43.63	65.45	87.27	109.09
100’	24.20	48.48	72.72	96.96	121.21

Conversion Tables:

Square Measure	
144 q. inches	1 sq. foot
9 sq. feet	1 sq. yard
43,560 sq. feet	1 acre
4,840 sq. yards	1 acre
Linear Measure	
1 foot	12 inches
1 yard	3 feet
1 mile	5,280 feet
Fluid Measure	
8 fluid oz.	½ pint
16 fluid oz.	1 pint
32 fluid oz.	1 quart
128 fluid oz.	1 gallon
Weights	
1 oz.	28.35 grams
1 lb.	16 oz.
1 ton	2,000 lb.

TREATMENTS **APPLICATION DATE RANGES**

Column1	January	February	March	April	May	June	July	August	September	October	November	December
Bare Ground: Guardrails, Cable Rails, Rock lined diteches, Concrete Barriers, Gore Areas, Etc. Page 16			1-Mar	15-Apr								
Selective Weed Control: Right of way chemical mowing (Seedhead suppression) & broadleaf removal Page 17			1-Mar	30-Apr								
Brush Control: Woody, Brush & Vine Vegetation Treatment Page 18									1-Sep	15-Oct		
Non-selective: Bruch & weeds on rock bluffs Page 19									1-Sep	15-Oct		
Selective Weed Control: Cattail Page 20						1-Jun		1-Aug				
Selective Weed Control: Broadleaf weed & grass control behind guardrails Page 21					1-May				15-Sep			
Bare Ground: Spot Spraying Page 22					1-May				15-Sep			
Selective Weed Control: Johnson Grass Page 23						1-Jun			15-Sep			
Selective Weed Control: Right of Way - Weed Wiper application for Johnson Grass Contol Page 24						1-Jun			15-Sep			

Treatments

1. BARE GROUND: Guardrails, Cable Rail, Rock Lined Ditches, Concrete Barrier Wall, Rock Slopes, Gore Areas, Concrete Ramps and Rock Shoulders etc…

The objective of this treatment is to provide bare ground areas in a 5' – 6' wide strip including the guardrails along all four lanes of TDOT's Interstate system and four lane highways.

Treatment: Shall be completed between ***March*** *15th* ***through April*** **15*th*** (vegetation green up has occurred) and prior to the first swath mowing cycle of the calendar year. See Attachment "D"

Treatment ounce per year @ (25 gal./per acre)

East of the TN River;
- 10.0 oz. Perspective
- 5.0 oz. Esplanade
- 64.0 oz. (2 quarts) Glyphosate
- 16.0 oz. (1 pint) Non-Ionic 90 Surfactant.
- Add Drift Control Agent 0.25 oz.

West of the TN River;
- 16.0 oz. Viewpoint
- 5.0 oz. Esplanade
- 64.0 oz. (2 quarts) Glyphosate
- 16.0 oz. (1 pint) Non-Ionic 90 Surfactant.
- Add Drift Control Agent 0.25 oz.

2. SELECTIVE WEED CONTROL: "RIGHT OF WAY" Chemical Mowing (seedhead suppression) & broadleaf removal (Can also be used over current mowed areas) the objective of this treatment is to eliminate the broadleaf weeds, annual grasses, thistle, and some perennial grasses and slowly release Bermuda grass.

NOTE: *This application is to only be used to eliminate or replace a mechanical mowing cycle in the* ***March/April*** *timeline at the discretion of the Engineer.*

First Treatment @ (25 gal./per acre)

"Same treatment statewide"

East of the TN River;
- 4.0 oz. Milestone
- 3.0 oz. (Plateau or Panoramic 2 SL)
- 3 oz. Perspective
- 16.0 oz. Surfactant.
- Add Drift Control Agent 0.25 oz.

West of the TN River;
- 4.0 oz. Milestone
- 3.0 oz. (Plateau or Panoramic 2 SL)
- 3 oz. Perspective
- 16.0 oz. Surfactant.
- Add Drift Control Agent 0.25 oz.

Second Treatment @ (25 gal./per acre)

NOTE: *This application is to only be used be to eliminate or replace a mechanical mowing cycle (due to Johnson grass or broadleaf) in the* ***June/July/August*** *timeline at the discretion of the Engineer.*

"Same treatment statewide"
- .50 oz. Escort XP, Patriot, AmTide 60 DF or Metcel VMF
- 1.0 oz. Outrider
- 16.0 oz. Surfactant.
- Add Drift Control Agent 0.25 oz.

3. BRUSH CONTROL - Woody, Brush & Vine Vegetation Treatment

The objective of this treatment is eliminating the woody growth and any vines along the slopes and TDOT ROW. Because of changing species, changes may be needed in the herbicide mix below each year. This treatment can be done by spray truck, hand gun, or backpack between ***September 1st and October 15th*****. (Timing will be prior to fall that will allow leaf color transition of application to blend with the fall leaf colors)**

Brush & Vine Treatment (25.0 gal/per acre)

Selective Weed Treatment:	10.0 oz. Streamline
(Does not kill grass)	7.0 oz. Milestone
	32.0 oz. surfactant.
	Add Drift Control Agent 0.25 oz.
Non-Selective Treatment:	16.0 oz. Viewpoint
(Kills all grass)	192.0 oz. Krenite
	32.0 oz. surfactant.
	Add Drift Control Agent 0.25 oz.

Apply to woody vegetation as a low volume target application (25.0 gal. /ac.). Spray vegetation to wet with maximum 70% coverage, focusing on the coverage on the crown of the brush. With application mix and timing, brownout of vegetation should coincide with fall foliage change. Keep mix agitated as much as possible.

4. Non-Selective: Brush & Weeds on the Rock Bluffs

The objective of this treatment is to control all of the woody brush & vine growth found on the many rock bluff faces along Interstate and four lane state routes. This treatment can be done by longshot boom or hand gun application.

NOTE: Apply with long shot boom @ 60' from shoulder

***September 1st and October 15th*. (Timing will be prior to fall that will allow leaf color transition of application to blend with the fall leaf colors)**

Brush & Weeds on Rock Bluffs Treatment (25.0 gal/per acre)

Treatment:	16.0 oz. Viewpoint
	192.0 oz. Krenite
	32.0 oz. surfactant.
	Add Drift Control Agent 0.25 oz.

Comments:

Timing and coverage are critical to the success of this treatment! Apply after full leaf expansion up until the beginning of fall coloration of hardwoods to chemically prune brush (Late September through October). When spraying, ensure good coverage of the foliage of the brush to be controlled; apply to the point of runoff. This application can also be used for low side trimming. When properly applied that portion of vegetation sprayed should not regenerate in the spring. Be aware that applications made during periods of dry weather may result in reduced control. Rainfall occurring within 24 hours of treatment may also result in reduced control. Refer to SDS sheet and the current label and follow instructions completely.

5. SELECTIVE WEED CONTROL: Cattail Control

The objective of this treatment is to control the scattered clumps of cattails found on Interstates and four lane highways in intermittent ditches where the contract mowing crews cannot mow. The approximate mileage of this work will be listed below. This treatment to be done between ***June 1st and August 1st*.**

Cattail Control (25.0 gal/per acre)

Treatment;	128 oz. AquaNeat
	32.0 oz. Arsenal
	Add surfactant as recommended on label (aquatic approved)
	0.25 oz. Drift Control Agent

Comments:

This treatment should only be used when these areas are creating a drainage issue. If approved by the District Operations Engineer.

SPECIAL NOTE: DO NOT SPRAY INTO WATERS OF THE STATE

6. SELECTIVE WEED CONTROL: Broadleaf Weed & Grass Control behind Guardrails:

The objective of this treatment is control a wide variety of weeds and grasses behind all guardrails on I-40 where the mower is unable to reach. This will be a 25' pattern from the edge of the 4' bare ground treated strip down the slope. Caution will be taken to save as much crown vetch ground cover as possible. Creating bare ground slopes that are subject to washing will be unacceptable. This treatment can be done by Spray Truck, Tractor/Boom Buster/Boom or Hand Gun application to ensure proper coverage. Application timeline ***May 1st – September 15th***

First Treatment @ (25 gal./per acre)

First Treatment;	4.0 oz. Milestone 3.0 oz. Plateau 4 oz Streamline 1 oz. Outrider (IF JOHNSON GRASS IS PRESENT) 16.0 oz. (1 pint) Surfactant.
Second Treatment;	½ oz Escort 1.0 oz. Outrider 16.0 oz. (1 pint) Surfactant.

7. <u>BARE GROUND</u>: SPOT SPRAYING: *May 1st – September 15th*

Spot spraying around signs, post, delineators to eliminate the use of string trimming and provide season long residual control. Spot sprayer hand wand application.

All non-aquatic areas statewide 16 oz. **"Esplande EZ"** per gallon of water

Can be purchased from Forrestry and Agriculture Supplies SWC 537 Contract #44645

8. SELECTIVE WEED CONTROL (Seasonal): "RIGHT OF WAY" Spray Application for Johnson Grass Control: *June 1st – September 15th* Treatment

Johnson grass requires years of treatment in order to effectively manage established stands. In general mow before form to keep seeds from developing and spreading. Always be sure to thoroughly clean all equipment used in Johnson grass infested areas to prevent spreading.

June 1st – September 15th Treatment #1 (25.0 gal./per acre)

Fescue & Bermunda Areas; 1.33 oz. Outrider
32.0 oz. Surfactant
0.25 oz. drift control agent/acre.

9. SELECTIVE WEED CONTROL (Eradication: kill plant and root system): "RIGHT OF WAY" Weed wiper application for Johnson Grass Control: ***June 1st – September 15th Treatment***

NOTE: For swath mowing areas only

Treat for Johnson grass control rate: Mix 1 gallon glysophate to 10 gallons of water
(SYSTEM TO KILL JOHNSON GRASS ROOT SYSTEM)

SPECIAL NOTE: Once treated the Johnson grass must not be mowed until after frost that will allow the johnsongrass plant to absorb the glysophate into the leaf, stem, and through the root system. Mowing prior to frost will not allow the complete system and Johnson grass can assume regrowth through the root system the following year.

Comments;
These formulas can be sprayed or applied with a weed wiper. If applied with a weed wiper it is recommended to apply once the grass reaches 12"-18" in height. A dish washing detergent can be used in the mix for determining when chemical needs to be reapplied to the weed wiper and to observe the application on the plant.

10) CHEMICAL MIXING INSTRUCTIONS FOR TANK MIX (NON CHEMICAL INJECTION SYSTEM)

MIXING INSTRUCTIONS FOR TANK MIX APPLICATION:

1. Fill tank to ½ desired level, begin agitation.
2. Add drift control at 2.0 to 4.0 oz. per 100 gallons to the mixture.
3. Add chemical (pre-slurry the product first if required).
4. Fill tank to desired level .
5. Add surfactant.
6. Continue agitation during application to ensure uniform spray mixture
7. Begin spraying operation.
8. Triple rinse containers
9. All mixing must be done on TDOT facilities or approved municipal monitored sites.
10. Personnel must wear PPE (Personal Protective Equipment) during mixing process.

Attachment “A”

HERBICIDE SPRAY EQUIPMENT CHECK LIST

DATE:	DISTRICT/COUNTY:
EQ. LICENSE #	TYPE OF SPRAYER) (SKID MOUNTED OR TRUCK)

ITEM#	STEP TO PERFORM	YES	NO	REMARKS
1	Perform check and exercise on spray truck/skid mounted engine			
2	Perform Preventative maintenance (if necessary)			
3	Inspect water and chemical tanks for cracks, premature deterioration or missing lids			
4	Inspect all chemical and water hoses			
5	Inspect all hose clamps			
6	Inspect chemical injection pumps if applicable			
7	Inspect main water pump			
8	Inspect/clean fresh water inlet screen/filter			
9	Inspect/clean nozzle screens			
10	Inspect all nozzles for wear and correct orientation			
11	Inspect all wiring for spray system			
12	Inspect/clean all electrical connections			
13	Inspect all electrical solenoids			
14	Inspect skid for cracks in welds or other damage.			
15	Calibrate sprayer			
16	Fill tanks with water only to inspect for leaks			
17	Operate spray system and inspect for correct spray pattern and calibration			

OPERATORS
SIGNATURE_____

REPAIR REQUEST OF MOTOR EQUIPMENT

Instructions for Vehicle Operators: If repairs are needed, fill out this report and give to supervisor or have supervisor fill out. Turn in completed form to District garage.

Clean and empty ALL trash before sending to District Shop.

DATE:	**COUNTY:**
EQUIPMENT LICENSE NO.:	**TYPE OF EQUIPMENT:**
OPERATOR’S NAME:	

X	SECTION	REMARKS
	Bed	
	Body/Cab	
	Brakes	
	Engine	
	Heater/Air Conditioner	
	Horn	
	Hydraulics	
	Instrument Panel/Gauges	
	Interior	
	Lights	
	Mirrors	
	Snow Plow & Plow Frame	
	Front/Rear Axle Assembly	
	Salt Spreader and Controls	
	Steering	
	Suspension	
	Tires & Wheels	
	Transmission	
	Windows	
	Wipers	
	Other	

REMARKS:_____

_____

_____

SUPERVISOR SIGNATURE_____ OPERATOR SIGNATURE_____

MPH Calculator

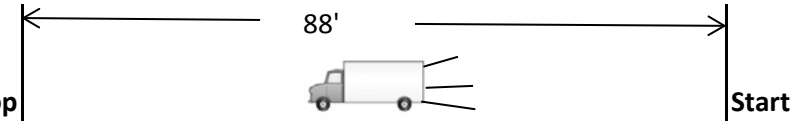
Calculate Speed

$$\frac{\cancel{88'}}{\text{seconds to run course}} \times \frac{\text{Constant Value } 60}{\cancel{88} \text{ Constant Value}} = \text{MPH}$$

Setup a course 88' long.
Time how long in seconds it
it takes the truck to
run the course in seconds.
Divide the # of seconds into 60 to obtain MPH.
The two 88's cancel eash other out.

$$\frac{60}{\text{seconds to run course}} = \text{MPH}$$

Runs course in 8.5 seconds



$$\frac{60.00}{8.50} = 7.0000 \text{ MPH}$$

Gallons Per Acre Calculator (GPA)

A)

Collect spray from Nozzle for 15 seconds. Multiple x 4 to get value for 1 minute. Pour into a container that is graduated in ounces. Then divide by 128 oz. to obtain gallons.

128 oz. = 1 gallon

$$\frac{\text{ounces collected}}{128.00} = \text{Gallons}$$

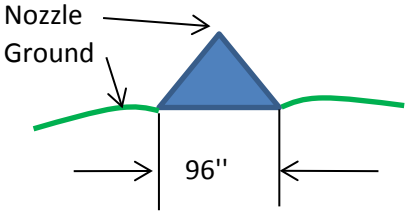
Example: If you collect 512 oz., how many gallons do you have?

$$\frac{512.00}{128.00} = 4.0000 \text{ gallons}$$

B)

$$\text{GPA} = \frac{\text{Gallons Collected} \times 5940}{\text{Speed} \times \text{Width in inches the nozzle is spraying.}}$$

Example:



$$\frac{\text{4 gallons collected} \times 5940}{\text{7 mph} \times \text{96'' wide spray}} = \text{GPA}$$

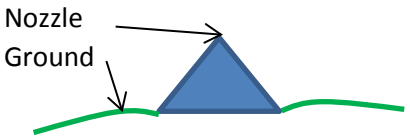
$$\frac{4.0000 \times 5940}{7.0000 \times 96} = \text{GPA } 35.3571$$

Calculating Gallons Per Minute (GPM)

$$GPM = \frac{GPA \times MPH \times W\ (inches)}{5{,}940\ (Constant)}$$

The (GPM) gives you the gallons per minute the Nozzle is spraying.

$$4.000000 = \frac{35.35714 \times 7.0000 \times 96}{5{,}940.00}$$



West of TN River

Attachment "D"

25 gal/acre

Viewpoint 16oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath
1,000	640.0	40.0	66.0
750	480.0	30.0	49.5
500	320.0	20.0	33.0
400	256.0	16.0	26.4
300	192.0	12.0	19.8
250	160.0	10.0	16.5
200	128.0	8.0	13.2
150	96.0	6.0	9.9
100	64.0	4.0	6.6
50	32.0	2.0	3.3
10	6.4	0.4	0.7

25 gals/acre

Surfactant 16oz. (90 Non-ionic)

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath
1,000	1,280.0	40.0	66.0
750	960.0	30.0	49.5
500	640.0	20.0	33.0
400	512.0	16.0	26.4
300	384.0	12.0	19.8
250	320.0	10.0	16.5
200	256.0	8.0	13.2
150	192.0	6.0	9.9
100	128.0	4.0	6.6
50	64.0	2.0	3.3
10	12.8	0.4	0.7

West of TN River

25 gals/acre

Esplanade 5oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath Guardrail/Cable Rail
1,000	200.0	40.0	66.0
750	150.0	30.0	49.5
500	100.0	20.0	33.0
400	80.0	16.0	26.4
300	60.0	12.0	19.8
250	50.0	10.0	16.5
200	40.0	8.0	13.2
150	30.0	6.0	9.9
100	20.0	4.0	6.6
50	10.0	2.0	3.3
10	2.0	0.4	0.7

25 gals/acre

Glyphosate 64oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath
1,000	2,560.0	40.0	66.0
750	1,920.0	30.0	49.5
500	1,280.0	20.0	33.0
400	1,024.0	16.0	26.4
300	768.0	12.0	19.8
250	640.0	10.0	16.5
200	512.0	8.0	13.2
150	384.0	6.0	9.9
100	256.0	4.0	6.6
50	128.0	2.0	3.3
10	25.6	0.4	0.7

East of TN River

Attachment "D"

25 gals/acre

Perspective 10oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath Guardrail/ Cable Rail
1,000	400.0	40.0	66.0
750	300.0	30.0	49.5
500	200.0	20.0	33.0
400	160.0	16.0	26.4
300	120.0	12.0	19.8
250	100.0	10.0	16.5
200	80.0	8.0	13.2
150	60.0	6.0	9.9
100	40.0	4.0	6.6
50	20.0	2.0	3.3
10	4.0	0.4	0.7

25 gals/acre

Surfactant 16oz. (90 Non-ionic)

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath Guardrail/ Cable Rail
1,000	1,280.0	40.0	66.0
750	960.0	30.0	49.5
500	640.0	20.0	33.0
400	512.0	16.0	26.4
300	384.0	12.0	19.8
250	320.0	10.0	16.5
200	256.0	8.0	13.2
150	192.0	6.0	9.9
100	128.0	4.0	6.6
50	64.0	2.0	3.3
10	12.8	0.4	0.7

East of TN River

25 gals/acre

Esplanade 5oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath Guardrail/C able Rail
1,000	200.0	40.0	66.0
750	150.0	30.0	49.5
500	100.0	20.0	33.0
400	80.0	16.0	26.4
300	60.0	12.0	19.8
250	50.0	10.0	16.5
200	40.0	8.0	13.2
150	30.0	6.0	9.9
100	20.0	4.0	6.6
50	10.0	2.0	3.3
10	2.0	0.4	0.7

25 gals/acre

Glyphosate 64oz./ac.

Tank Size	ounces of Herbicide	40 acres coverage	5' Swath Guardrail/C able Rail
1,000	2,560.0	40.0	66.0
750	1,920.0	30.0	49.5
500	1,280.0	20.0	33.0
400	1,024.0	16.0	26.4
300	768.0	12.0	19.8
250	640.0	10.0	16.5
200	512.0	8.0	13.2
150	384.0	6.0	9.9
100	256.0	4.0	6.6
50	128.0	2.0	3.3
10	25.6	0.4	0.7

"

Attachment "E"

TABLE A. CLEAR ZONE DISTANCE (Lc) (FEET)

DESIGN SPEED	DESIGN ADT	FORESLOPES (H:V)			BACKSLOPES (H:V)		
		6:1 OR FLATTER	5:1 TO 4:1	3:1	6:1 OR FLATTER	5:1 TO 4:1	3:1
40 MPH OR LESS	UNDER 750 (7)	7 - 10	7 - 10	(4)	7 - 10	7 - 10	7 - 10
	750 - 1500	10 - 12	12 - 14	(4)	12 - 14	12 - 14	12 - 14
	1500 - 6000	12 - 14	14 - 16	(4)	14 - 16	14 - 16	14 - 16
	OVER 6000	14 - 16	16 - 18	(4)	16 - 18	16 - 18	16 - 18
45-50 MPH	UNDER 750 (7)	10 - 12	12 - 14	(4)	10 - 12	8 - 10	8 - 10
	750 - 1500	14 - 16	16 - 20	(4)	14 - 16	12 - 14	10 - 12
	1500 - 6000	16 - 18	20 - 26	(4)	16 - 18	14 - 16	12 - 14
	OVER 6000	20 - 22	24 - 28	(4)	20 - 22	18 - 20	14 - 16
55 MPH	UNDER 750 (7)	12 - 14	14 - 18	(4)	10 - 12	10 - 12	8 - 10
	750 - 1500	16 - 18	20 - 24	(4)	16 - 18	14 - 16	10 - 12
	1500 - 6000	20 - 22	24 - 30	(4)	20 - 22	16 - 18	14 - 16
	OVER 6000	22 - 24	26 - 32 (3)	(4)	22 - 24	20 - 22	16 - 18
60 MPH	UNDER 750 (7)	16 - 18	(9)	(9)	14 - 16	12 - 14	10 - 12
	750 - 1500	20 - 24	(9)	(9)	20 - 22	16 - 18	12 - 14
	1500 - 6000	26 - 30	(9)	(9)	24 - 26	18 - 22	14 - 18
	OVER 6000	30 - 32 (3)	(9)	(9)	26 - 28	24 - 26	20 - 22
65-70 MPH	UNDER 750 (7)	18 - 20	(9)	(9)	14 - 16	14 - 16	10 - 12
	750 - 1500	24 - 26	(9)	(9)	20 - 22	18 - 20	12 - 16
	1500 - 6000	28 - 32 (3)	(9)	(9)	26 - 28	22 - 24	16 - 20
	OVER 6000	30 - 34 (3)	(9)	(9)	28 - 30	26 - 30	22 - 24

ADAPTED FROM TABLE 3J OF THE "ROADSIDE DESIGN GUIDE," AASHTO, 2011.

CZc = (Lc)(Kcz)
WHERE CZc = CLEAR ZONE ON OUTSIDE OF CURVATURE, (FEET)
Lc = CLEAR ZONE DISTANCE, (FEET) (FROM TABLE-A)
Kcz = CURVE CORRECTION FACTOR

NOTE: THE CLEAR ZONE CORRECTION FACTOR IS APPLIED TO THE OUTSIDE OF CURVES ONLY. CURVES FLATTER THAN 2950 FEET DO NOT REQUIRE AN ADJUSTED CLEAR ZONE.

TABLE B. HORIZONTAL CURVE CORRECTION FACTORS (Kcz) (5)

RADIUS (FT)	DESIGN SPEEDS (MPH)						
	40	45	50	55	60	65	70
2950	1.1	1.1	1.1	1.2	1.2	1.2	1.2
2300	1.1	1.1	1.2	1.2	1.2	1.2	1.3
1970	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1640	1.1	1.2	1.2	1.3	1.3	1.4	1.4
1475	1.2	1.2	1.3	1.3	1.4	1.4	1.5
1315	1.2	1.2	1.3	1.3	1.4	1.4	-
1150	1.2	1.2	1.3	1.4	1.5	1.5	-
985	1.2	1.3	1.4	1.5	1.5	1.5	-
820	1.3	1.3	1.4	1.5	-	-	-
660	1.3	1.4	1.5	-	-	-	-
495	1.4	1.5	-	-	-	-	-
330	1.5	-	-	-	-	-	-

ADAPTED FROM TABLE 3.2 OF THE "ROADSIDE DESIGN GUIDE", AASHTO, 2011.

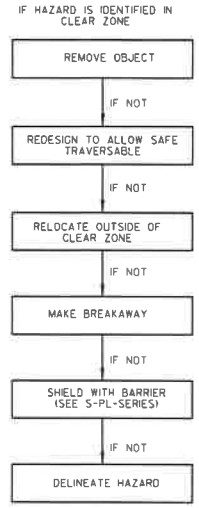


FIGURE A.
DESIGN OPTIONS FOR
HAZARDS IN CLEAR ZONE

GENERAL NOTES

(1) CLEAR ZONE IS DEFINED IN THE "ROADSIDE DESIGN GUIDE," AASHTO, 2011, AS THE TOTAL ROADSIDE BORDER AREA, STARTING AT THE EDGE OF THE TRAVELED WAY, AVAILABLE FOR SAFE USE BY ERRANT VEHICLES. THIS AREA MAY CONSIST OF A SHOULDER, A RECOVERABLE SLOPE, A NON-RECOVERABLE SLOPE, AND/OR A CLEAR RUN-OUT AREA. THE DESIRED WIDTH IS DEPENDENT ON THE TRAFFIC VOLUMES, SPEEDS, AND THE ROADSIDE GEOMETRY. SEE THE "ROADSIDE DESIGN GUIDE," AASHTO, 2011 FOR MORE DETAILED INFORMATION.

(2) CLEAR ZONE DISTANCES ARE RELATED TO DESIGN SPEED, TRAFFIC VOLUME AND SLOPE CONDITIONS AS SHOWN IN TABLE A.

(3) WHERE A SITE SPECIFIC INVESTIGATION INDICATES A HIGH PROBABILITY OF CONTINUING CRASHES, OR SUCH OCCURRENCES ARE INDICATED BY CRASH HISTORY, THE DESIGNER MAY PROVIDE CLEAR-ZONE DISTANCES GREATER THAN THE CLEAR ZONE SHOWN IN THE TABLE A.

(4) BECAUSE RECOVERY IS LESS LIKELY ON THE UNSHIELDED, TRAVERSABLE (3:1), FILL SLOPES, FIXED OBJECTS SHOULD NOT BE PRESENT IN THE VICINITY OF THE TOES OF THESE SLOPES. RECOVERY OF HIGH-SPEED VEHICLES THAT ENCROACH BEYOND THE EDGE OF THE SHOULDER MAY BE EXPECTED TO OCCUR BEYOND THE TOE OF SLOPE. DETERMINATION OF THE WIDTH OF THE RECOVERY AREA AT THE TOE OF THE SLOPE SHOULD TAKE INTO CONSIDERATION RIGHT-OF-WAY AVAILABILITY, ENVIRONMENTAL CONCERNS, ECONOMIC FACTORS, SAFETY NEEDS, AND CRASH HISTORIES. ALSO, THE DISTANCE BETWEEN THE EDGE OF THE THROUGH TRAVELED LANE AND THE BEGINNING OF THE 3:1 SLOPE SHOULD INFLUENCE THE RECOVERY AREA PROVIDED AT THE TOE OF THE SLOPE. SEE THE ROADSIDE DESIGN GUIDE, AASHTO 2011 FOR MORE INFORMATION.

(5) THESE MODIFICATIONS ARE NORMALLY CONSIDERED ONLY WHEN CRASH HISTORIES INDICATE A NEED OR A SPECIFIC SITE INVESTIGATION SHOWS A DEFINITE CRASH POTENTIAL THAT COULD BE SIGNIFICANTLY LESSENED BY INCREASING THE CLEAR-ZONE WIDTH, AND WHEN SUCH INCREASES ARE COST EFFECTIVE.

(6) SEE THE "ROADSIDE DESIGN GUIDE," AASHTO, 2011, FOR COMPOSITE ROADSIDE SECTIONS AND DISCUSSION ON OUTSIDE DITCHES AND CHANNELS.

(7) FOR ROADWAYS WITH LOW VOLUMES, IT MAY NOT BE PRACTICAL TO PROVIDE FULL CLEAR ZONE DISTANCE IN SUCH CASES PROVIDE MAXIMUM AMOUNT OF CLEAR ZONE THAT IS PRACTICAL.

(8) CLEAR ZONE DISTANCES DO NOT APPLY TO LOW SPEED URBAN ROADS. IN SUCH CASES PROVIDE A MINIMUM LATERAL OFFSET FROM EDGE OF TRAVELED WAY TO CURB. (SEE FIGURE B)

(9) USE 6:1 SLOPES ONLY ON ROADWAYS WITH DESIGN SPEEDS 60 MPH AND ABOVE. IF 6:1 IS IMPRACTICAL, CONSIDER SHIELDING AREA WITH BARRIER SYSTEM.

(10) STOPPING SIGHT DISTANCE THROUGHOUT THE HORIZONTAL CURVE SHALL BE MAINTAINED. IN SOME CASES ADDITIONAL RIGHT OF WAY MAY BE REQUIRED TO INSURE THIS AREA IS KEPT CLEAR OF SIGHT OBSTRUCTIONS.

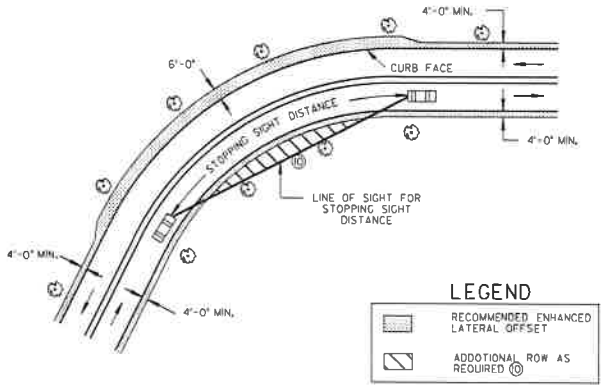


FIGURE B.
MINIMUM LATERAL OFFSET FOR
LOW SPEED URBAN ROADS (8)

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

CLEAR ZONE CRITERIA

7-11-13 | S-CZ-1

Attachment "F"

REGION

TENNESSEE DEPARTMENT OF TRANSPORTATION
DAILY HERBICIDE REPORT

ACTIVITY NO: 437 District_____

DRIVER: _____ DATE: _____ COUNTY: _____

WEATHER CONDITIONS: _____ TEMPERATURE: _____ WIND: _____

ROUTE: _____ START (Log Mile): _____ STOP (Log Mile): _____ HERBICIDE (Gal/Oz):_____

ROUTE: _____ START (Log Mile): _____ STOP (Log Mile): _____ HERBICIDE (Gal/Oz):_____

ROUTE: _____ START (Log Mile):_____ STOP (Log Mile):_____ HERBICIDE (Gal/Oz):_____

ROUTE: _____ START (Log Mile):_____ STOP (Log Mile):_____ HERBICIDE (Gal/Oz):_____

ROUTE: _____ START (Log Mile):_____ STOP (Log Mile):_____ HERBICIDE (Gal/Oz):_____

ROUTE: _____ START (Log Mile):_____ STOP (Log Mile):_____ HERBICIDE (Gal/Oz):_____

EQUIPMENT:
TRUCK TAG #_____ TRACTOR TAG # _____ Backpack----------

TYPE OF SPRAYING:
R.O.W. ☐ **GUARDRAIL** ☐ **SHOULDERS** ☐ **MEDIAN** ☐
COMPLEX ☐ **MISC** ☐

TARGET SPECIES:
BRUSH ☐ **GRASS** ☐ **BROADLEAF** ☐ **WOODY** ☐ **KUDZU** ☐
THISTLES ☐ **JOHNSON GRASS** ☐ **OTHER** _____

EQUIPMENT CALIBRATED: DATE _____

HERBICIDE USED:	**EPA #**	**Amount used:** (gal./oz./lb.)	**RATE per AC:** (gal./oz./lb.)
HERBICIDE_____	_____	_____	_____
HERBICIDE_____	_____	_____	_____
HERBICIDE_____	_____	_____	_____
LOAD DRIFT: _____	_____	_____	_____
DEFOAMER: _____	_____	_____	_____
SURFACTANT: _____	_____	_____	_____

TOTAL WATER USED: _____ TOTAL ACRES TREATED: _____

COMMENTS (adverse incidents, spills, accidents): Report Filled By: _____

Certification Number_____

Calibrating Boom Sprayers for Forestry Herbicide Application Checklist

Herbicide application rates are generally prescribed in pounds or quarts per acre of ground on which the herbicide is actually applied. A recommendation might, for example, be 3 lbs/A or $^1/_2$ qt/A. Since herbicides are usually combined with water and applied in dilute form, it is necessary to accurately determine the number of gallons of liquid being applied per acre. This enables the sprayer operator to determine the application rate of the sprayer, in gallons per acre, and the ratio at which herbicides and water must be combined to give the desired rate of application, whether the area to be sprayed is 20 acres or $^1/_2$ acre.

This fact sheet describes the steps and considerations for calibrating tractor-drawn boom sprayers. Calibration of hand sprayers is discussed in Natural Resources Fact Sheet F-20; determining the amount of herbicide required to spray a specific tree planting is discussed in Natural Resources Fact Sheet F-23; and calibrating boom sprayers for agricultural crops is discussed in Extension Bulletin AEX-520.

To assure accuracy in calibration, take all measurements carefully and carry all calculations to at least three decimal places where appropriate. Final measurement of herbicide volume or weight should be done as accurately as equipment will allow.

Determine Application Rate of Sprayer

Follow these steps to determine the sprayer application rate:

1. Determine the volume of spray delivered by nozzles.

Single Nozzle Per Band- With the tractor stationary, and the sprayer operating at the same pressure that will be used in the field, place a jar with a capacity of at least one quart under each nozzle and measure the number of seconds needed to spray one quart from each nozzle (Figure 2a). The flow rate in gallons per minute (GPM) for each nozzle is then determined as follows:

$$GPM = \frac{15}{\text{number seconds needed to spray 1 quart}}$$

Example: With the sprayer stationary and operating at the pressure to be used in the field, it takes 60 seconds for a nozzle to spray 1 quart. The delivery rate of the nozzle is:

GPM = $^{15}/_{60}$ = 0.25 gallons per minute

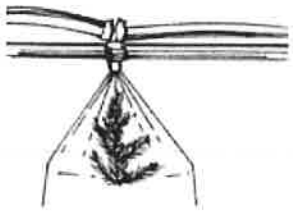


Figure 2a. Boom with single nozzle spraying each row of trees.

Multiple Nozzles Per Band (Overlapping Spray Pattern)- If multiple nozzles are used to spray a single row (Figure 2b), determine the delivery rate of each nozzle for the row and add the amounts together to obtain the total amount of spray being delivered to the row.

Example: The spray boom to be used is configured so that two nozzles with overlapping patterns are used to spray a single row. The flow rate of one nozzle is 0.25 GPM, and the other is 0.29 GPM. The total volume of spray delivered to the band is 0.54 GPM.

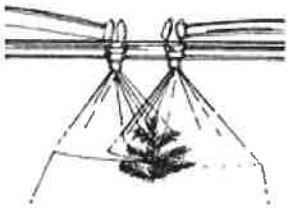


Figure 2b. Boom with overlapping nozzles spraying each row of trees.

2. Replace bad nozzles.

Calculate the average flow rate in gallons per minute for the nozzles on the boom. If the flow rate of any nozzle is more than 10 percent higher or lower than the average flow rate, clean the nozzle and remeasure flow rate. Replace any clean nozzle that differs from the average flow rate by more than 10 percent. Repeat this process until the variation in flow rate for all nozzles is within 10 percent of the average.

Example: The nozzles on a 4-nozzle boom deliver 0.26, 0.27, 0.28, and 0.30 GPM. Average delivery rate is 0.2775 GPM. The difference between the average flow rate and individual flow rates for all nozzles is within 10% of the average delivery rate. However, if the delivery rates were 0.26, 0.27, and 0.28, and 0.32 GPM, average delivery rate would be 0.2825 GPM, and the nozzle with the 0.32 GPM delivery rate would have to be replaced.

3. Determine tractor speed in the field to be sprayed.

Measure a known distance, in feet, and time the tractor over that distance. Operate the tractor at the same miles per hour (MPH) and revolutions per minute (RPM) to be used in the actual spraying. Begin the test run from a standing start far enough ahead of the measured course so that the tractor is traveling at the desired speed before coming to the start of the course. The speed of the tractor is calculated as follows:

$$\text{MPH} = \frac{(\text{distance traveled in feet}) \times (0.68)}{\text{number of seconds needed to travel pre-measured distance}}$$

Example: If it takes 29 seconds to travel 150 feet, the travel speed is:

$$\text{MPH} = \frac{(150 \text{ feet}) \times (0.68)}{29 \text{ seconds}} = 3.5 \text{ MPH}$$

4. Determine the application rate.

The acreage application rate, gallons per acre (GPA), of the spray boom is determined as follows:

$$\text{GPA} = \frac{(\text{gallons per minute}) \times (5940)}{(\text{MPH}) \times (\text{band width in inches})}$$

"Gallons per minute" is the boom average for either single or overlapping nozzles. Note that band width is expressed in inches.

Example: Using a boom with an average nozzle spray rate of 0.25 GPM, a speed of 3.5 MPH, and spraying a 24-inch wide band, the gallons per acre application rate is as follows:

$$\text{GPA} = \frac{(0.25 \text{ GPM}) \times (5940)}{(3.5 \text{ MPH}) \times (24 \text{ inches})} = 17.68 \text{ GPA}$$

5. Evaluate suitability of application rate.

Compare the calculated application rate with that recommended for the specific herbicide to be used (refer to label on herbicide container). If the calculated rate is more than 5 percent higher or lower than the recommended rate, small adjustments in the sprayer speed and/or pressure can be made. Do not exceed the pressure recommended for the nozzles. If reasonable speed and/or pressure changes will not achieve the desired application rate, a different set of nozzles may be needed.

Determine Correct Amount of Herbicide to Use

The amount of herbicide and water needed to spray a planting depends on the sprayer calibration,the recommended herbicide rate, and the number of acres to be treated. Follow these steps to determine the amount of herbicide and water required for a specific planting:

1. Determine acres sprayed with one sprayer tankfull.

$$\text{acres sprayed} = \frac{\text{tank capacity in gallons}}{\text{GPA}}$$

Keep in mind that "acres sprayed" is the actual amount of ground that is sprayed. When spraying bands, this is not the same as the number of acres driven over.

Example: Using the example above, if the spray tank held 100 gallons of water, the calculation would be as follows:

$$\text{acres sprayed} = \frac{\text{100 gallons}}{\text{17.68 GPA}} = \text{5.66 acres of actual ground sprayed with one tankful}$$

2. Determine the amount of herbicide to add to full tank.

$$\text{amount of herbicide add to full sprayer} = \text{recommended rate of application on herbicide} \times \text{number of acres sprayed with a full tank}$$

Example: If the recommended herbicide application rate is 4 lbs/A, you need to add 22.64 pounds of herbicide to a full 100 gallon spray tank.

amount of herbicide to add to full sprayer = (4 lbs/A) x (5.66 A/tankfull) = 22.64 lbs per tank

3. Determine size of field a full spray tank will band.

When spraying herbicide in bands, only a fraction of each acre (the band) is actually being treated. To determine the overall field size that can be band sprayed with a full tank, perform the following calculation:

$$\text{overall field size} = \text{actual acres sprayed with full tank} \times \frac{\text{distance between center of bands in inches}}{\text{width of bands in inches}}$$

Example: You plan to spray 24-inch bands whose centers are 84 inches (7 feet) apart (Figure 3). Having previously determined that you can spray 5.66 acres of actual ground with a full 100 gallon tank, the overall field size that can be band sprayed is:

$$\text{overall field size} = 5.66 \text{ acres} \times \frac{84 \text{ inches}}{24 \text{ inches}} = 19.8 \text{ acres}$$

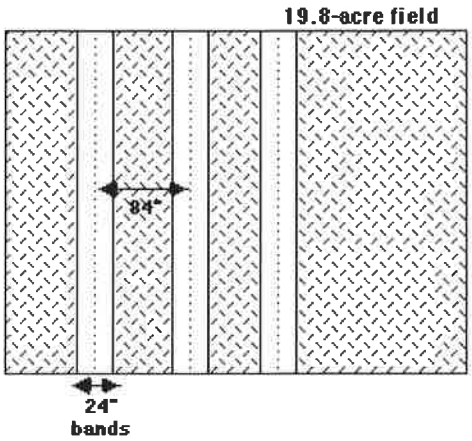


Figure 3. In this example, 5.66 acres of actual ground have been sprayed.

4. Calculate mixture when a full tank is not needed.

A two-step calculation is required to determine the amount of water and herbicide needed to spray smaller fields that do not require a full tank.

Step A: Determine what proportion the size of the actual field to be sprayed is of the field that can be sprayed with a full tank.

Example: If we wished to band spray a 15-acre field using the 100-gallon sprayer described above which will spray 19.8 acres when full, the proportion is calculated as follows:

$$\frac{15 \text{ acres}}{19.8 \text{ acres}} = 0.757 \text{ or } 75.7\%$$

Step B: Reduce both the amount of water and the amount of herbicide to the proportion calculated in Step A above.

Example: The amounts of water and herbicide needed to band spray the 15 acre field are:

amount of water needed =(100 gal) x (0.757) = 75.7 gal

amount of herbicide needed = (22.64 lbs) x (0.757) = 17.1 lbs

Tips on Measuring and Mixing Herbicides

When adding herbicides to a sprayer, it is convenient to use either a container that holds exactly the desired amount of herbicide, determine the number of teaspoons or tablespoons equal to the desired amount, or mark on a larger container exactly how full it should be to contain the desired amount of herbicide. When measuring herbicides initially, be sure to use liquid measurements for liquid materials (e.g., liquid ounces in a measuring cup) and dry measurements for powders

and other dry formulations (e.g., weight in ounces). Use Table 1 to determine equivalent measures and conversions.

Factors That Affect Spray Rate and Performance

Spraying Pressure--Spraying should be done at the same tank pressure as when calibrating. Spraying at a higher or lower pressure will result in more or less herbicide being applied as the sprayer passes over the ground.

Nozzle Type And Size--Generally, even flat fan spray nozzles are most desirable for band or spot spraying. They provide the most even distribution of spray material over the area treated. Sprayers must be calibrated for each nozzle type and size. The larger the nozzle, the more spray is put out as the sprayer passes over the ground. Thus, to maintain a particular rate of application when larger nozzles are used, smaller amounts of herbicide will be added to the water.

Speed Of Travel--Spraying should be done at a uniform speed and at the speed used when the sprayer was calibrated. Slower or faster speeds will result in higher or lower rates of herbicide application.

Nozzle Alignment--Make sure nozzles are properly aligned to applyspray uniformly where desired. If nozzles require overlapping, check the nozzle catalog or instructions to determine the overlap required for specific nozzles.

Inspect And Clean Nozzles Periodically--A common cause of non-uniform coverage is clogged nozzles. Watch the nozzles periodically while spraying to detect clogging. Always carry tools for cleaning nozzles and extra nozzles. Replace defective nozzles immediately.