RAILROAD MANAGEMENT,

VEGETATION CONTROL

AND TOXICS REDUCTION:

A Report for
Standing Together for Healthy Solutions,
Montpelier, Vermont

by
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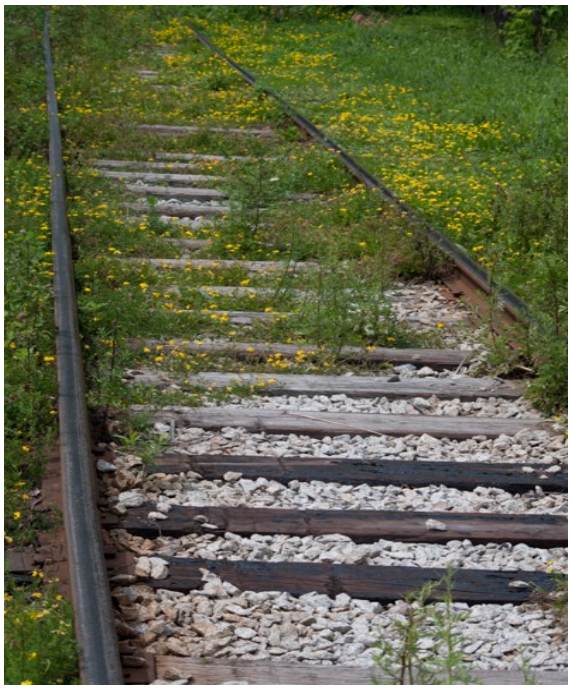

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I. INTRODUCTION

In 2014 several citizens of Montpelier, Vermont attended the May 6, 2014 meeting of VT Pesticide Advisory Council to request a no-spray area on the Washington County Railroad -- Barre-Montpelier Section (Railroad) for two and one-half miles through Montpelier (City), from the I-89 interchange to Pioneer Street. The railroad track is adjacent to a schoolyard, peace park, recreational bike path, a food co-operative, and apartment buildings where at least one chemically injured person is living. The Council agreed to stipulate a no-spray area through the City in the 2014 permit and urged the Railroad to work with the citizens and City to find alternatives for weed management in 2014. Citizens made several unsuccessful attempts to contact the Railroad in the ensuing months. In spring of 2015, the Railroad requested and was granted an herbicide permit, saying they had been unable to work with the citizens. Upon learning of the permit, citizens formed a grass-roots organization, Standing Together for Healthy Solutions (STHS), and held meetings with Mayor John Hollar, City Council, and Secretary of Agriculture Chuck Ross seeking a no-spray area. Negotiations between Mayor Hollar, the Railroad and Secretary Ross resulted in a plan in which a much smaller portion of the railroad right-of-way (ROW), that is, between Main and Granite Streets, would not be sprayed but be mechanically managed in 2015, and the City would assume the costs. Such an arrangement did not provide needed protection for STHS or for the Winooski River and set a poor precedent. On July 22 City Council agreed to hear testimony on the plan and voted to support further exploration of alternatives to chemical weed control on the ROW in Montpelier for the future. This research report is integral to the ongoing effort to find alternatives to chemical weed management.

II. ABSTRACT

Since the 1990s the International Union of Railways (UIC) and Swiss Railroads, or Schweizerische Bundesbahnen (SBB) have examined railroad practices in efforts to reduce herbicide use because of groundwater and surface water contamination from the chemicals used (SBB 1989; SBB 2000 and UIC 2003) and increased areas where herbicide use is prohibited. Banned in 1992, the soil sterilant herbicides diuron and atrazine were found to move easily through permeable track foundations and to contaminate surface water and drinking water in Europe. Glyphosate was later prohibited in water protection areas but allowed for use in some other areas, in combination with other methods (SBB 1998).

Glyphosate's health effects and State ownership of most Vermont railroad rights-of-way prompt heightened vigilance and concern for the relationship between railroad structures, vegetation management and toxics reduction.

This report gleans information from three European railroad management documents explaining the importance of multiple aspects of railroad management in vegetation control. Vermont Pesticide Advisory Council's sharepoint site includes two of those documents: the 2001 pamphlet based on the 1998 SBB report by Christian Muller (SBB 2001), and the International Union of Railways' comprehensive report on railroad weed management (UIC 2003). The Integrated Vegetation Management Plan 2006-2011 commissioned by VT Pesticide Advisory Council in 2005 offers Vermont rail expertise and support for integrated vegetation management, and is also available on the sharepoint site. New weed control technologies are described here as well.

photo 1: Washington County RR 7/18/15

Fundamentally, the European experience tells us that long-term reliance on chemical control of weeds alone treats only the symptoms, leads to contamination of water resources, and actually creates weed problems. Long-term investment in proper railroad construction and maintenance for safe and reliable operation can also prevent and reduce weed growth on the railroad. This report reviews such practices, pertinent laws and policies, and provides recommendations for the people of Montpelier and the State of Vermont.

III. RAILROAD SAFETY, MAINTENANCE, & WEED CONTROL

Safety and soundness of the railroad system depend on a ballast bed that is mostly free of weeds (SBB 1998, 2001). Some rail authorities in Europe are considering a level of weed tolerance and acceptable amount of fine material in the ballast for different categories of track (UIC 2003 @ 2, 35). Methods to control weeds can either prevent weed growth, or remove weeds after their development, depending on the plants and the situation involved, so identifying and mapping weed species are integral to weed control.

Plant species creating problems for railroads can be grouped and described in three general categories.

1) Plant species reproducing and spreading through seeds germinate close to the surface and would not grow without water or soil. Keeping the ballast bed clean of soil and free of water prevents growth of weeds.

2) Plant species like field horsetail and reed grow into the ballast from underground and develop deep and extensive root systems, and rely on these root systems during dry periods. They indicate water-logged, loamy, and silty soils which are problems for railroad construction.

3) Plants like blackberry and Virginia creeper send runners above ground onto the ballast from areas adjacent to the ballast and can be controlled by regular mowing and maintenance of areas along the railroad (SBB 1998 @1, 8)

Factors to be considered in railroad maintenance methods which also aid in

weed control include the following: 1) long-term safety and working order of the track system; 2) cost; 3) protection of human health and the environment; 4) protection of water quality.

Dependence on one method of weed control alone encourages development of a one-sided vegetative community which can include problem plants. Use of herbicides attacks only the symptoms of railroad problems and has only short-term effect (UIC 2003 @14).

Railroad construction and maintenance methods influencing weed control generally fall in five categories: 1) structural; 2) mechanical, 3) biological, 4) chemical, and 5) thermal /electrical. Preventive methods such as structural and mechanical should be prioritized (UIC 2003 @ 30). See Table 1 below.

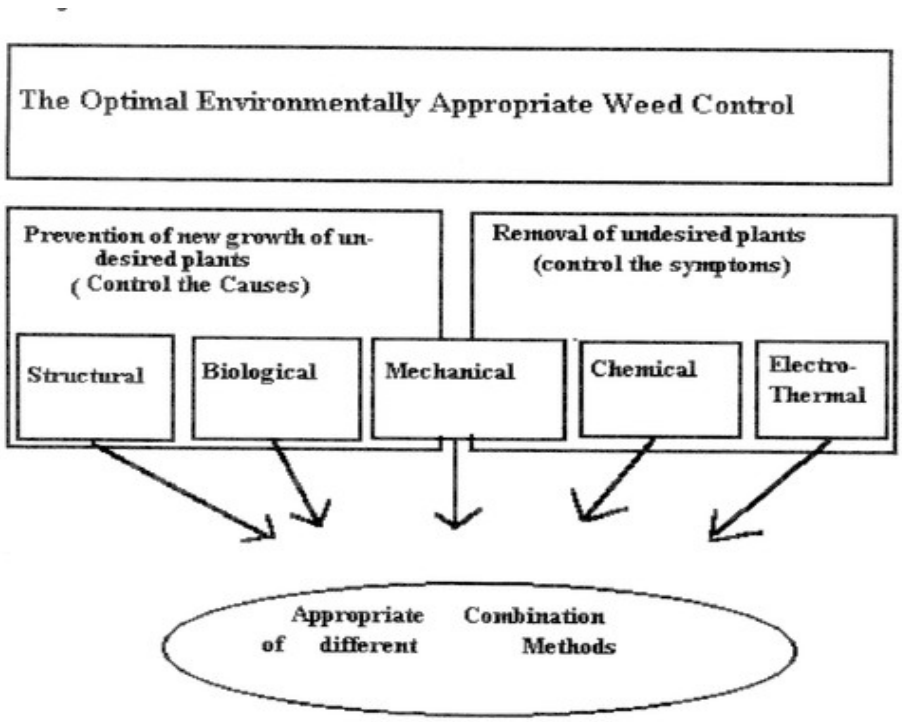

Table 1 shows relationship of railroad maintenance methods to weed control. (SBB 1998 @ S11)

Evaluation of maintenance methods should consider the following factors:

1) effects on plants: what is the effect on plants, and how long does the effect last?

2) technical / operational factors: is it possible to apply the methods within the operational demands of the RR companies?

3) economic: how much does the method cost?

4) ecological factors: in what ways does the method have effects on the environment? (UIC 2003 @ 45)

IV. STRUCTURAL METHODS

Structural methods are the most effective in the prevention of new weed growth by reducing the water supply for the weeds in the ballast; however, such measures tend to be the most costly and are usually applied to new construction or in areas where herbicide use is prohibited. Structural methods include the following:

1) layers of asphalt in the track foundation;

2) permeable concrete barriers in the shoulder area;

3) lateral obstacles between the ballast bed and the bordering embankment;

4) installation of fabric in the shoulder area.

Descriptions of these methods follow:

1) A layer of thick asphalt installed in newly installed rail lines not only prevents water build-up in the track area, but also hinders subterranean growth of weeds, and has prevented the need for chemical applications for weed control for more than ten years (SBB 1998 at S5). The feasibility of this construction method depends on factors such as amount of traffic on the affected rail section and cost, as older sections to be reconstructed in this way must not be used for several weeks (SBB 1998 @ 12).

2) Permeable concrete barriers bordering the ballast serve both as walkways and also as barriers to lateral growth of weeds effectively so that no weeds have grown across them (SBB 1998 @ S5). Used since 1980s, these structures need to fulfill the following criteria:

a) effective barrier against in-growing plant species and appropriate for walking on;

b) unimpeded drainage of the ballast;

c) no interference with mechanical maintenance;

d) simple, cost-efficient and durable construction;

e) no obstruction for future renovation.

Barriers can be built quickly and easily at reasonable cost. More discussion of these barriers is available in SBB 's 2001 report, available on VPAC's sharepoint site. (SBB 2001 @ 8).

3) Shoulder strips or green strips adjoining the concrete bars must be planted as soon as possible after construction with desired grass species to prevent invasion of weed seeds, and mowed regularly. Cable canals or concrete slabs can also be used in this way (SBB 2001 @ 9).

photo 2: concrete bars, Swiss Rail (SBB) 2001

4) In groundwater protection zones or areas where horsetail is growing (resistant to glyphosate) construction fabric or foil can be installed in the shoulder to hinder new growth. It must be non-degradable, resistant to atmospheric corrosion and to root growth of horsetail and reeds, secured well with gravel against wind, and must be opaque and sturdy to prevent weed growth (SBB 1998 @ S5; SBB 2001 @ 8).

The structural methods above are effective in reducing weed growth, and frost and rust damage to tracks, which can limit track load capacity (UIC 2003 @ 38),

and also fulfill other important functions in the track structure (SBB 2001 @ 5) including long-term rail safety.

EXAMPLE of RAIL SECTION NEEDING STRUCTURAL WORK

The portion of Washington County Railroad in photo 3 below is full of silt, hospitable to weeds, and has broken, decaying ties. In this condition the structure fails to provide safety or stability for trains travelling upon it, and is in deep need of re-construction. Herbicides willl not correct these problems. Eliminating the soil, replacing broken ties, installing an asphalt layer as a base, providing a stable rock ballast, and concrete side bars would all prevent weed growth in this area of the track as well as provide a stable basis for a safely functioning railroad.

photo 3: Washington County RR, Montpelier,VT
July 18, 2015, before herbicide treatment

V. MECHANICAL METHODS

Ballast Cleaning

Swiss Rail describes ballast cleaning as a mechanical method and helps us see the importance of this maintenance activity for rail stability and weed control. As the ballast ages, fine dust rubs off the ballast stones and begins to build up in the ballast, creating a medium to hold water and germinate seeds. Ballast cleaning during dry weather is one of the most important measures of weed control, because it removes the medium in which plant seeds can grow, except for horsetail and reeds (SBB 2001 @ 26). This process is described as follows:

> "The ballast cleaning machines used on the SBB network pick up the dirty ballast with a conveyor scoop or an excavator belt. The material thus extracted is passed through a mechanical cleaning system in which the fine particles are sifted out. The cleaned ballast is then spread back beneath the track." A good ballast cleaning can remain effective for 20 to 40 years depending on circumstances, if adjacent green strips have been installed and well maintained." (SBB 2001 @ 10).

photo 4: ballast cleaning machine (SBB 2001 @ 16)

Ballast Cleaning

Using ballast bed cleaning machines, the ballast can be cleaned without dismantling the track. The central features are powerful scraper chains that excavate the fouled ballast and at the same time prepare the foundation for the new ballast. The ballast is cleaned in large oscillating screens with several screening levels which ensures optimum quality. The clean ballast is returned to the track directly behind the excavating chain. The residue from the cleaning is passed into a spoil conveyor and transport system.

Ballast Vacuuming

A soil vacuuming procedure developed in Germany cleans the embankment of the ballast to a depth of 10-20 cm (4-8 inches). The upper layer is loosened by large rakes, cleaned of polluting soil materials, replaced clean and compressed again. With low amounts of seeds and dust, 1.2km can be cleaned easily, but with extreme weed growth 2-3 rounds are needed at reduced speeds (SBB1998 @ 18).

Mowing

Mowing green strips and the embankment along the railroad is important to keep brambles and vines from reaching onto the ballast. While the runners on the tracks may be treated by herbicide applications, the mother plant must be cut mechanically on the embankment to stop production of runners. Regular mowing will promote thick growth of grass which can help crowd out the vining plants. Timing of mowing is important in cutting weed plants before they create seeds which can blow onto the tracks. Early cutting also helps keep costs down and avoids use of large machinery on tracks (UIC 2003 @ 37).

Hand weeding

This method is flexible, has low CO2 foot-print, is not weather-dependent, and can be useful in areas adjacent to water where herbicides are inappropriate for use. The disadvantages include its high cost per treatment unit, and short-lived effect. This method can also leave depressions in the soil where new weeds can grow. The effectiveness of weeding techniques depends on the weed species, season, growing conditions, weather, and seed supply in the soil. (SBB 1998 @ 20)

Mowing equipment and methods with estimated fuel consumption rates are discussed in Swiss Rail's earlier report (SBB 1998 @64-5). While the measurements are in metric units, one can get a sense of the energy needs of various mowing techniques.

VI. BIOLOGICAL METHODS

Biological methods can be used in combination with structural and mechanical means to control vegetation. They include the following:

1) maintaining a green strip adjacent to the railroad;

2) mapping the ROW to determine plant species, soil types and areas needing soil changes indicated by problem plants;

3) removing trees in the green strip which shade the rail line and drop organic matter on the ballast;

4) growing preferred plant types along the rail line. (SBB 1998; SBB 2001; UIC 2003);

5) using a biological product, Chontrol Paste (under development in Canada) to control cut-stump resprouting (Lallemand, 2013).

Understanding the types of weeds and their means of propagation helps to determine methods used to control weeds. Some weeds have small seeds with low energy reserves; others have large seeds with energy reserves for long germination times. Still other weeds produce runners above or root systems with tubers deep below the soil surface.

Plants such as horsetail or reeds indicate the presence of wet, compacted clay soil, or water in the soil, and help point out areas that need management such as draining, removal to sufficient depth of wet soil and replacement with gravel or well-draining soil. The reworked area should be replanted immediately with preferred low-growing grass species suitable to the area in order to out-compete any seeds and weed particles in the replacement fill. Horsetail prefers poorly drained soil, reproducing both by spores and by extending tuberous roots underground more than six feet deep and growing sideways as well. Their tuberous roots provide food storage for the plant for long periods, making the plant very difficult to eradicate. Horsetail is also allelopathic to grasses (Burrill & Parker 1994), making establishment of desired controllable vegetation more difficult.

Landscaped areas need regular attention by mowing to keep any vine-type vegetation from reaching the ballast. Properly built and maintained verges (green strips) along railroads can repress unwanted vegetation for at least 30 years. (SBB 2001 at 8)

Removing trees in the green strip along the railroad deprives it of shade, falling plant materials, raises the temperature of the ROW, and allows the ballast to stay dryer so that water does not accumulate in the ballast and encourage weed growth (UIC 2003 @ 4). When a deciduous tree is cut, it puts forth several sprouts the following year, unless the cut stump is treated to discourage sprouting. A biological product under development in Canada, Chontrol Paste, is similar to a product, Mycotech, used in a successful trial on the CVPS utility ROW in 2005 (Kelley R & Dickinson D 2007) under an Experimental Use Permit.

photo 5: applying Mycotech, Norbert Major and CVPS crew, September 2005

Digital technology enables photography of the railroad to record images of track defects or nuisance plants (Weart 2012). Mercier, Inc. is developing an ultra high-speed, high-definition camera connected to a computer (Weart 2012). Computer-aided design software available in Vermont could then create a GIS map of weed communities in the ROW to help determine management strategies (VGIS 2015).

VII. CHEMICAL METHODS

In the European Union and in Switzerland, glyphosate is now the only herbicide used on railroads, and 80-90% of it is used by backpack sprayers only where weeds occur (SBB 1998 @ 2). There is considerable risk of the spray mist being

blown off-site by the wind (SBB 2001 @ 11), resulting in loss of product and risk of inhalation by neighbors. Glyphosate has moved offsite to surface waters in several studies (Botta F 2009; Kolpin D 2006).

The advantages of back-pack sprayed glyphosate are the following: it is cost effective; the rail-line remains available; the CO2 footprint is low. Disadvantages include the following: it requires good knowledge and proper use; it has no preventive effect, it can promote plant resistance in field horsetail (SBB 1998 @42; SBB 2001 @ 13), and it exposes others to toxic substances in the air through respiration, a very direct mode of exposure and in water. The spray must be directed toward the ballast at all times (SBB 2001 @ 11).

Swiss Rail compared energy output in the backpack herbicide sprayer method versus the motor sprayer method and found that the backpack sprayer method was significantly lower in its energy use. They also compared the motor sprayer method with the hot steam method and found them generally equal in energy consumption.

The Integrated Vegetation Management Plan 2006-2011 for VT Rail Systems stated that

> "All appropriate non-chemical techniques and methods which remove or control pest vegetation will be identifed and integrated into the overall vegetation management program. No sector or area of the ROW will receive herbicide treatment if a routine or operational activity will remove the vegetation during the process. This operational procedure is intended to further *reduce the reliance on chemical control a*nd the *amount of herbicide applied each year*." (emphasis added)

While this plan is no longer in effect, the principle articulated above supports VPAC's statutory mandate of pesticide reduction and increasing areas managed without toxic chemicals.

VIII. THERMAL METHODS

Swiss Rail found that "sensitive one-year- or several year-old species without distinct storage organs may be appropriately addressed by flame, infra-red, steam or hot water methods. Species that are several years old with underground regenerative organs like dandelion, for instance, as well as field horsetail are encouraged by this measure for lack of competition." (SBB 1998 @ 50) Overall, SBB did not find thermal methods (steam, burning) to be cost effective in a vegetation control program.

IX. ALTERNATIVE METHODS

photo 6: Frostbite at work

Frostbite

"Frostbite" is a system using condensed carbon dioxide recaptured from industrial sources. The Frostbite 2.0 sprayer converts the liquid CO2 to dry ice frost upon release to atmospheric pressure, and allows the user to deposit the dry ice directly to individual weed plants. The CO2 is carried by backpack in a canister with a siphon. This method has been successfully used on weeds in lawns and golf courses (FrostBite 2015). Plant type, size and life stage matter in the method's effectiveness. For example, if the crown of a single crab-grass plant will fit under the ~3” diameter insulated cone of the Frostbite sprayer, it will take approximately 0.04 pounds of CO2. If the plants are chickweed or henbit

at 100% coverage, approximately 1-2 pounds CO_2 may be used; if crabgrass, probably 2-3 pounds. A 20-pound capacity cylinder can treat approximately 600 weeds. Weeds that don't have a crowded root system require about 20% more CO_2 to control compared to the same type, size, or life stage plant that has a crowded, weak, or shallow root system. The density and depth of root systems in the railroad ballast would determine the amount of CO_2 used in this method.

Costs for the Frostbite system are $599 for the sprayer, and optionally $250 for a harness to carry the CO_2 cylinder, for a total close to $850. A 20-pound capacity CO_2 cylinder costs $160, full, and refills in Vermont cost $50-60. The full tank may weigh up to 50 lbs, so a harness would be useful to carry it. AirGas Inc. North Division in Barre, Vermont provides cylinders with the appropriate siphons and CO_2 refills (conversation by phone with representative 10/7/15).

Vinegar

This common household product has been used to kill and control weeds in domestic situations for a long time. Vinegar is a dessicant: it dries the leaves of plants, and is non-selective. Most vinegar is 5% acetic acid. One gallon vinegar mixed with 1 ounce dish detergent as an agent to hold the vinegar on the leaf have proven effective on young weeds, especially if used on a hot, dry day. Weeds with deep taproots may not be controlled with one application at the 5% solution. Vinegar at 20% acetic acid is available but must be handled and used carefully, as it is an acid and will burn tissue and eyes. If used to drench soil in railroads, it will kill the deep-rooted weeds (Garden Counselor 2015). Use of vinegar for weed control was corroborated by another source, Kevin Lee Jacobs, who uses it straight with a pump spray directly from the gallon bottle (Jacobs KL nd) to kill young weeds.

However, let us be clear that, similar to use of Frostbite, this method is a short-term fix, treating the symptom, the weed, which is an indicator that railroad ballast cleaning is needed for long-term structural integrity.

X. POLICY & LAW

Most of Vermont's railroads--the right-of-way, ballast, rails and ties--are owned by the State of Vermont, putting them into the category of public assets. This concept has important implications for Vermonters, the Legislature and governmental bodies: we need policies to assure that railroads are managed professionally for public health and safety and for long-term environmental sustainability.

The Vermont Rail Advisory Council was created to represent rail interests, government agencies, commerce, and environmental NGOs. Currently the last category appears not to be represented. The sub-committee on infrastructure may need to be alerted to the condition of the railroad under consideration in this report.

Vermont Agency of Transportation (VTrans) Rail Program is the steward of the State's rail network, responsible for ensuring the safe, efficient movement of freight and passengers, and the management of associated assets throughout the state. How might they assist Montpelier City Council, Secretary of Agriculture, and STHS in implementing integrated railroad maintenance on the line through Montpelier?

According to Vermont Statutes Annotated, Title 6, VT Pesticide Advisory Council (VPAC) was established in 1970 to create policies leading to a reduction in the use of pesticides. In the 1980s the statute was strengthened to include establishment of benchmarks by which pesticide reduction can be measured. Unfortunately, such benchmarks have not been established. To a large degree, VPAC's tradition has been to consider permits for use of herbicides in a total reliance upon chemicals for pest control without examination of railroad condition, relationship to watersheds or alternative methods.

In 2005 VPAC formed the Railroad Vegetation Management Workgroup, led by

Lene Gary, to develop an integrated management plan for the Vermont Rail System, which manages five major rail segments in Vermont. This important effort resulted in the Integrated Vegetation Management Plan (IVMP), which was voluntarily adopted in April 2006 by Vermont Railway, Green Mountain Railroad, Clarendon & Pittsford Railroad, Washington County RR (Barre-Montpelier) and Washington County Railroad (Connecticut River Division). Its value consisted in the thorough examination of all the management methods within the experience of Vermont railroad masters in relation to vegetation control, a general outline of federal requirements, and its description of how the IVMP could meet Federal Railroad Administration requirements as well as reduce herbicide use. A weakness is that rail management in other countries was not examined. This IVMP was in effect from April 2006 to December 2011 (VPAC 2006). Because the IVMP was voluntary, there was no follow-up on results, outcome or compliance before it expired.

Federal Railroad Administration (FRA) Regulations for railroads are found in 49 CFR Part 213. In regard to vegetation control (213.37), several criteria are listed; no language expressly requires complete sterilization with herbicides. In regard toVermont Agency of Transportation Rail Program railroad ballast in general, Section 213.103 requires that

"all track shall be supported by material which will (a) Transmit and distribute the load of the track and railroad rolling equipment to the subgrade; (b) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails;
(c) Provide adequate drainage for the track;..."

49 CFR 213.109 contains requirements for condition of the crossties:

"Crossties, other than concrete, counted to satisfy the requirements set forth in paragraph (b)(4)Vermont Agency of Transportation Rail Program of this section shall not be

(1) Broken through;

(2) Split or otherwise impaired to the extent the crosstie will allow the ballast to work through, or will not hold spikes or rail fasteners;

(3) So deteriorated that the crosstie plate or base of rail can move laterally 1⁄2 inch

relative to the crosstie; or

(4) Cut by the crosstie plate through more than 40 percent of a crosstie's thickness."

49 CFR 213.9 pertains to classes of track and travelling speeds. 49 CFR 213.241 regulates inspections and maintenance of inspection records by track owners.

photo 7: Washington Cty RR. Do these cross ties comply with CFR 49 Sec 213.109 above?

Vermont Statutes Annotated Title 6 Section 1102 provides a mandate to VPAC to establish policies leading to a reduction in the amount, the area affected and the risk to the public inherent in the use of pesticides. Section 1102 (d) (6) A-E call for establishing benchmarks for the reduction of pesticides, including increasing the acreage managed by means of integrated pest management techniques.

Written in 1991, Vermont Regulations for Control of Pesticides have not been revised in a rule-making process, despite two attempts to do so (2001 and 2013). Section IV of the regulations pertain to ROW permits. Studies within the State and elsewhere indicate that pesticides are contaminating surface water. New scientific knowledge about their effects on human and wildlife health and endocrine disruption indicate that revision of these regulations is an urgent matter for public health and safety.

XI. RECOMMENDATIONS

1. VTrans Rail Program should assist VT Rail Systems in obtaining a grant to

a) create a GIS map of week communities in the Barre-Montpelier section of Washington County RR;

b) organize a demonstration of the Frostbite system and to use it on a portion of the railroad in Montpelier not treated with herbicides in 2015.

c) purchase Frostbite system for future use in areas off-limits to herbicides.

2. Select railroad section on which to do a trial of vinegar as an alternative weed-killer.

3. VT Rail Program and/or Legislature should require a significant structural upgrade of the 2/12 miles of track in Montpelier to rid the track of dirt and provide a properly supporting ballast for trains carrying heavy loads of stone. This will contribute greatly to weed reduction and to rail safety.

4. Initiate legislation or city ordinance to forbid use of glyphosate and other herbicides on the 2 1/2 miles of railroad track through Montpelier, from I-89 interchange to Pioneer Street.

5. Montpelier City Council and STHS should request inspection records from VT Rail Division for the Washington County Railroad (Barre-Montpelier) for the last 10 years and compare to FRA requirements.

6. Find an environmental representative for the VT Rail Advisory Council. (see http://rail.vermont.gov/rail_council)

7. Urge monitoring of water quality for glyphosate in Winooski River at least one point in river after treatment of railroad outside of Montpelier. Seek analysis from USGS labs for newer technology.

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PHOTO CREDITS

cover photo, photos 1, 3, 7: John Snell, Jr, Montpelier, VT, July 18, 2015
photos 2, 4: Swiss Rail, SBB (2001) (10/1/15)
photo 5: Sylvia Knight, Stockbridge VT, September 2005
photo 6: Frostkills.com

About the Author

A 25-year resident of Charlotte, VT, Sylvia Knight's interest in health effects, environmental contamination, state-sanctioned uses, policy and science related to pesticides began in 1995. Continuing study of these issues, she brings research and a view of the whole to discussions about pesticide issues such as lampricides, diuron on railways, transmission / utility rights-of-way, pesticide regulations, and phosphate content of glyphosate in the Lake Champlain TMDL debate. Active from 2000 to 2008 on the Charlotte Conservation Commission, she contributed comments on the Northwest Reliability Project. For more on her work see www.earthcommunityadvocate.info.