

Emerging Best Management Practices in Stormwater: **Addressing Galvanized Roofing**



Introduction

Stormwater is the leading contributor to water quality pollution in Washington State.¹ For this reason, the Washington Department of Ecology requires businesses and municipalities to control stormwater pollutants, such as heavy metals and organics. Strict limits on zinc require a number of Washington organizations to use source control or treatment measures to reduce zinc in runoff. According to Lisa Rozmyn, the Washington Stormwater Center's Business Resource Manager, "Zinc is difficult to control because it's everywhere in industrial sites and equipment."

With support from the Russell Family Foundation, the Pacific Northwest Pollution Prevention Resource Center (PPRC) is helping businesses navigate a tangle of emerging zinc-reduction technologies and techniques to achieve acceptable stormwater quality. As an unbiased non-profit resource, PPRC seeks to promote stormwater practices that are economically and environmentally beneficial.

This report focuses on reducing zinc runoff from galvanized roofs. It is one in a series that explores emerging techniques and practices to manage zinc in stormwater. Other report topics include: *Biochar as Filtration Media*; *Mitigating Zinc in Boatyards* and *Street & Surface Sweeping to Reduce Stormwater Pollution*.

About Galvanized Roofing & Stormwater

Industrial businesses typically need cost-effective roofing that covers large surface areas. Metal roofing, including galvanized, requires less maintenance than other options and has a significantly longer service life. Low-end galvanized roofing has a service life of 30-50 years under normal conditions. High-end galvanized roofing can last as long as 100 years.

Galvanized roofing offers a number of benefits. It is resistant to wind, naturally sheds snow, and is fire-retardant. Though naturally reflective, it can also be coated with reflective paint that blocks heat transfer and helps reduce cooling costs during warm weather. Finally, galvanized roofing is recyclable at the end of its service life, making it a more sustainable option than many other roofing choices. The above benefits suggest that galvanized roofs will remain both an option for installation and in service for decades to come.

There are many steps in the process of galvanizing steel, but ultimately the steel is immersed in a bath of 98-99+ percent zinc. While galvanizing steel reduces corrosion as compared with non-galvanized metal, all metals will eventually suffer some corrosion. Corrosion converts the base metal into its oxides. In the case of galvanized metal, contact with atmospheric carbon dioxide (CO₂) starts the oxidation process into zinc carbonates or into zinc sulfates (in the presence of sulfur dioxide, a constituent of acid rain). This unbound zinc leaches off the galvanized surface and pollutes stormwater runoff.



Any galvanized product exposed to outdoor elements, particularly precipitation, will leach zinc. Such products include: chain-link fencing, roof flashing, gutters and downspouts. Marine environments, areas with acid rain, and certain acidic industrial emissions contribute to conditions that can reduce roof lifespan and increase the rate of zinc migration from galvanized surfaces.

Studies have shown that runoff from galvanized roofs frequently contains very high levels of zinc, especially if roofs are not coated or if the coating has degraded. Some studies have found readings as high as 15,000 µg/L from the point source of one galvanized roof. For an industrial site, the Washington State permit limit for zinc in stormwater is 117 µg/L. For boatyards, the limit is 90 µg/L. Roofing with high zinc leachate can readily contribute to overall levels of zinc that exceed permit limits.

Options to Reduce Zinc Runoff from Galvanized Roofing

Zinc runoff from galvanized roofing can be reduced or mitigated in several ways, ranging from low cost to high cost.

Low Cost Measures

- **Pressure wash the roof, gutter, and downspouts** to remove sediment, collect the wash water and properly dispose of it. Removing this sediment before anticipated rainy season(s) can help minimize the zinc-containing sediment that enters the stormwater system. Use water or neutral cleaners with a pH between 5 and 7. Acidic or caustic cleaners will cause a chemical reaction with the zinc that can hasten the leachate process.

- **Install high-metal-removal capacity planter boxes or other filtration systems** at downspouts from zinc roofs. There are several options in both design and filtration media. Some installations are simply filters that collect and filter out contaminants like zinc. Among filtration media, sand and biochar/compost mixtures have proven particularly effective at removing zinc. The Port of Vancouver has used easy-to-build planter boxes loaded with metal-absorbing plants. Each of these units treats about 600 square feet of galvanized roof runoff to acceptable zinc levels.²

- **Coat galvanized gutters and the interior of downspouts** (include exterior if not already coated) or consider replacing them with an alternative non-zinc material.

- **Ensure all downspouts are in good repair and discharge is directed to the proper place** - draining to some form of filtration system.

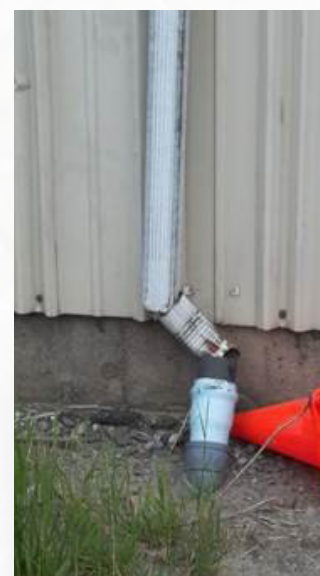


Figure 2: This roof runoff is being directed into the ground, and not to an appropriate treatment system. It's a good idea to ensure that downspouts are in good repair and connecting to a storm sewer port or Low Impact Development area.

Higher Cost Measures

- **Paint or coat with a zinc-free coating system.** Several different types of coatings are effective in reducing zinc leachate to the point of compliance with stormwater runoff limits. They can also be reflective to reduce heat absorption. Typical coating options include urethanes, epoxies, and acrylics. Acrylic performance is on a par with the other coatings, but is more environmentally friendly in both manufacture and application. Silicone, which is self-sealing and has a longer anticipated lifespan than other options, tends to cost more and may require additional or slightly different prep methods.

- **Painting existing galvanized roofing requires more preparation than a typical paint job.** Necessary steps to minimize future corrosion and zinc releases include, but may not be limited to:
 - > Thoroughly cleaning to remove dirt, debris, and loose paint from any previous coating; collecting and properly disposing of that wash water;
 - > Removing rust by mechanical means or neutralization by chemical means;
 - > Sealing and/or priming holes, gaps, and joints and fasteners (“hot spots”); and
 - > Priming, if recommended for the type of coating applied.
- **Apply an overlay-type roofing system.** This typically begins with insulating the corrugated ribs of the galvanized roofing. Next, a cover board, which may provide additional insulation properties, is mechanically attached to the roof. Finally, a membrane is attached to provide a waterproof barrier and UV protection. An overlay system of this type typically requires less maintenance and superior longevity to a coating system, but at greater initial expense.
- **Replace aging galvanized roofing.** Roofing materials such as modified bitumen come in peel and stick form and are more cost-effective than the glue-down variety. Avoid installing uncoated galvanized sheet roofing on new or replacement construction. If conditions are such that galvanized roofing is preferred, look for pre-coated, or install with the intent of coating the roof.
- **Install centralized stormwater treatment technology** wherein all runoff is collected, diverted to the system, and treated before discharge. This is particularly useful for a site with multiple sources of zinc and has been employed successfully by Vigor Shipyard in Seattle, two Darigold plants, and many other industrial sites. These treatment systems must be designed with high enough capacity to remove the zinc to acceptable levels at typical rain flow volume for the region. Most treatment systems will require quarterly replacement of the filtration media, depending on contaminant loads, amount of precipitation, and efficacy of the filtration media. See a list of treatment technologies that have been certified through Washington State Department of Ecology’s Technology Assessment Protocol (TAPE).³

Additional Notes

If you choose to paint the roof as a means of eliminating zinc runoff, select a painting contractor with experience in applying coatings for this purpose. Ensure their bid contains the necessary preparation steps and the exact type of primer and paint or coating to be used. Review the primer and paint or coating specifications (e.g., Safety Data Sheet) to determine the constituents of the coatings. Primers for galvanized roofing often contain zinc themselves because zinc provides superior adhesion to a galvanized surface. Using a zinc-containing primer can improve coating longevity.

Many available top coatings also contain zinc. While the zinc in these coatings is encapsulated, the availability of zinc-free coatings makes zinc-free the preferred product for the top coat. When soliciting contractor bids, specify a zinc-free top coat. Painting or coating a roof is season-dependent in the Puget Sound area, and contractors’ workloads tend to increase in August and September. Plan well in advance if roof coating is one of your zinc reduction options to meet permit levels by a certain date. One downside of coating is that it requires more frequent maintenance than unpainted galvanized roofing.



(Image courtesy Great Western Coatings.)

- **Construct green infrastructure or low impact development (LID) areas** that can capture runoff and naturally filter out pollutants including zinc. Examples include constructed wetlands, raingardens, and bioswales. For more in-depth information on these strategies, check out the LID Technical Guidance Manual for Puget Sound, produced by the Washington State University (WSU) Puyallup Research & Extension Center and the Puget Sound Partnership.



(Image courtesy Aaron Clark, 12,000 Raingardens.)

Does Coating a Galvanized Roof Reduce Zinc Discharge?

Significant reductions of zinc in stormwater have been achieved using roof coatings in laboratory tests. However, field performance data for overlay systems and silicone coating is not well-studied. Research suggests that - when applied properly - urethane, epoxy and acrylic paint systems contain zinc well.



The table below provides data on four roofs coated using zinc-free, water-based acrylic coating. In each instance the sample readings prior to painting the roof were much higher than the stormwater discharge limits for zinc (117 µg/L). All facilities achieved the desired results, reducing zinc levels well below stormwater discharge limits.

<i>Great Western Coatings Four Roof Coating Projects: Zinc Reduction - Results</i>				
Facility Location	Seattle	Seattle	Everett	Everett
Surface Type	Galvanized Roof	Painted Roof	Galvanized Roof	Painted Roof
Surface Area (ft²)	10,000	10,000	150,000	2,000
Initial Zinc (µg/L)	14,000	14,000	1100	800
Final Zinc (µg/L)	22	39	73	11

Disclaimer: PPRC does not endorse or guarantee any paint or coating products, or contractor services.

** Data courtesy of Great Western Coatings.⁴*

If you are interested in finding out more information or details for a specific BMP, or need referrals or assistance with metal removal in stormwater, please contact PPRC : (206) 352-2050.

Conclusion

Because of their utility, galvanized roofs are common. But these surfaces are also significant sources of zinc in stormwater. Whether methods of source control or treatment, the use of BMPs can effectively reduce zinc pollution. Coating galvanized surfaces with zinc-free paint can dramatically reduce zinc runoff. For best results coating roofs, businesses should be fastidious in their paint preparation and roof maintenance. Most major coating companies offer a line of zinc-free coatings for galvanized roofs and some also offer contractor services. Contractor services will provide you with Safety Data Sheets that contain information about the constituents in the coating. They can also provide you with references, including applicable test data.

References

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