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Desktop Hazard Assessment of Stormwater Runoff from the

Nordic Heritage Museum, Seattle, WA

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Executive Summary

The International Zinc Association was asked to apply state of the science methods to estimate whether stormwater runoff from a proposed development would require treatment technologies to achieve regulatory compliance. As a result, an annual stormwater runoff scenario for zinc was assessed for the planned Nordic Heritage Museum in Seattle, Washington. Details specific to the project, site, and state regulations were combined to determine whether runoff would present stormwater compliance concerns. Results suggest that, on an average annual basis, **runoff from the façade covering the Nordic Heritage Museum would not exceed the Washington stormwater benchmark for zinc of 117 µg/L**. This result is due to a combination of factors, including the pre-weathered nature of the material, vertical installation, annual rainfall, air quality (very low SO_2 levels), and total land area of the site.

Methods

Data Collection

Site-specific information included the overall footprint of the site, average annual rainfall, average annual atmospheric sulfur dioxide (SO_2) concentration, and a soil attenuation factor (Table 1). Air quality, represented by SO_2, has been correlated with the corrosion potential for several metallic surfaces including zinc [1, 2, 3]. Air quality data for the Seattle area was obtained from a comprehensive report from 2012 and corroborated with a live web-link for a site near the proposed development (see footnote 'b' in Table 1). A soil attenuation factor was applied due to the fact that runoff from the vertical façade application would be delivered directly to the ground surrounding the building. Although soil application could potentially result in 98% attenuation of zinc within the first 5 cm [4], the land cover around the Nordic Heritage Museum could vary (e.g., grass, mulch, soil, gravel, etc.). As a result, a conservative value of 80% attenuation (20% of zinc load allowed to enter stormwater conveyance system) was used.

Material-specific information was obtained from the rolled zinc manufacturer (VMZinc) and architect (Mithun/Pier 56), including surface treatment, proposed surface area, and average inclination (Table 1). The inclination is an important variable related to contact time between runoff and the zinc surface [1, 2, 3]. That is, a steeper inclination has less contact time and results in less surface corrosion. In addition, a correction factor was applied based on the surface treatment applied to the rolled zinc. The Nordic Heritage Museum will use a pre-weathered rolled zinc (Quartz grey and Anthra black) which have documented corrosion rates that are only 60% of that observed from un-weathered rolled zinc surfaces [5].

Analysis

Quantitative information for the site, climate, air quality, and building materials were combined in order to calculate several variables (Table 2). First, an inclination factor was calculated to account for the vertical orientation of the rolled zinc panels. It was estimated that zinc corrosion from the panels would be approximately 48% of that expected from a flat (horizontal) application. Second, the total zinc load was calculated to be 2.9 kg/yr based on the inclination, air quality (SO_2), and surface area. Third, the annual average zinc runoff concentration (0.051 mg/L) was calculated by dividing the zinc load by the total rainfall volume at the site. Finally, the zinc runoff concentration was compared to the WA Department of Ecology stormwater benchmark for zinc (0.117 mg/L). The conclusion drawn from this assessment illustrates that on an average annual basis, runoff from the façade covering the Nordic Heritage Museum would not exceed the WA stormwater benchmark for zinc (Runoff Hazard Quotient = 0.44). This result is due to a combination of factors, including the pre-weathered nature of the material, vertical installation, annual rainfall, air quality (very low SO_2 levels), and total land area of the site.

Table 1. Details related to the site, climate, air quality, and building materials.

Project Name:	Nordic Heritage Museum	Material:	Pre-weathered rolled zinc
Location:	Seattle, WA	Application:	Vertical façade
Land Area (ha):	0.74	Surface Area (m^2):	4,000
Annual Rainfall (mm/yr):	920 [a]	Inclination (°):	90
Atmospheric SO_2 ($\mu g/m^3$):	1 [b]	Correction Factor (CF):	0.6 [d]
Attenuation Factor (AF):	<0.2 [c]		

[a] Source: http://www.usclimatedata.com/climate/seattle/washington/united-states/uswa0395
[b] Source: http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2273569.pdf and corroborated by http://aqicn.org/city/usa/washington/seattle/olive-st/
[c] Soil attenuation potential [4].
[d] Corrosion rate correction for pre-weathered rolled zinc, relative to un-treated rolled zinc [5].

Table 2: Calculations for estimating zinc runoff concentrations and comparison to WA stormwater benchmark for zinc.

Variable	Calculation	Result	
Inclination Factor (F)	-0.0116 * Inclination + 1.5203	= 0.4763	
Zinc Load [1,2,3]	(1.36 + 0.16 * SO_2) * F	= 0.724 g Zn/m^2/yr = 2.896 kg Zn/yr	
Site Precipitation	Land Area * Rainfall	= 6,808,000 liters/yr	
Zinc Runoff [a]	$\frac{\text{Zinc Load * CF * AF}}{\text{Site Precipitation}}$	= 0.051 mg Zn/L	**Runoff Hazard Quotient = 0.44**
WA DOE Benchmark [b]	-	= 0.117 mg Zn/L	

[a] CF = Correction Factor; AF = Attenuation Factor (Table 1)
[b] Source: http://www.ecy.wa.gov/programs/wq/stormwater/industrial/index.html

References

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