DEPARTMENT OF
ECOLOGY
State of Washington

Addendum to Quality Assurance Project Plan

Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff

November 2013

Publication No. 13-03-122

Publication Information

Addendum

This study has been funded in part by the United States Environmental Protection Agency (EPA) through their National Estuary Program (NEP), via an interagency agreement (PC-00J20101) with the Department of Ecology serving as lead organization for "Toxics and Nutrients Prevention, Reduction, and Control" projects. The Asphalt Roofing Manufacturers Association (ARMA) has also provided funding for this study.

This addendum is on the Department of Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/1303122.html

This addendum is an addition to an original Quality Assurance Project Plan. It is not a correction (errata) to the original plan.

Activity Tracker Code

Ecology's Activity Tracker code for this addendum is 13-003.

Original Publication

Quality Assurance Project Plan: Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff

Publication No. 13-03-105
https://fortress.wa.gov/ecy/publications/SummaryPages/1303105.html

Author and Contact Information

Nancy Winters
P.O. Box 47600
Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

For more information contact: Communications Consultant, phone 360-407-6834.

Addendum to Quality Assurance Project Plan

Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff

November 2013

Approved by:

Signature: Date: October 2013
Ron Mc Bride, Client, Water Quality Program, WQP

Signature: Date: October 2013
Carol Kraege, Section Manager, Reducing Toxic Threats, W2R

Signature: Date: October 2013
Megan Warfield, Reducing Toxic Threats, W2R

Signature: Date: October 2013
Nancy Winters, Author / Project Manager / Principal Investigator, EAP

Signature: Date: October 2013
Allison Kingfisher, BMS/Facilitator, W2R

Signature: Date: October 2013
Dale Norton, Author's Unit Supervisor, EAP

Signature: Date: October 2013
Will Kendra, Author's Section Manager, EAP

Signature: Date: October 2013
Joel Bird, Director, Manchester Environmental Laboratory

Signature: Date: November 2013
Bill Kammin, Ecology Quality Assurance Officer

Signatures are not available on the Internet version.

WQP: Water Quality Program
W2R: Waste 2 Resources Program
BMS: Building Materials Specialist
EAP: Environmental Assessment Program

Table of Contents

List of Tables

Introduction

From February to April, 2013, the Washington State Department of Ecology (Ecology) evaluated contaminant concentrations in runoff from eighteen constructed roofing panels during 10 storm events. Analysis included total and dissolved metals: arsenic, cadmium, copper, lead and zinc. Analysis also included organic compounds: polycyclic aromatic hydrocarbons (PAHs), phthalates, and polybrominated diphenyl ethers (PBDEs).

This work was conducted because previous Puget Sound pollutant loading studies had indicated that roofing systems may be significant sources of arsenic, cadmium, copper, zinc, and possibly polycyclic aromatic hydrocarbons and phthalates in the Puget Sound Basin (Ecology, 2001a and b). The roofing assessment was designed to provide regional data on contaminant levels in runoff from new roofing materials commonly used in the Puget Sound area. The roofing materials studied are listed in Table 1.

Roofing systems include not only roofing material but also many other components such as heating, ventilation, and air conditioning (HVAC) systems, gutters, downspouts, and flashing materials. Evaluation of each of these components was beyond the scope and budget of the original project; consequently, only one component, roofing materials, was evaluated.

Notable findings for metals from the first ten sampling event included elevated concentrations of arsenic, copper, and zinc in the following roofing types:

- Treated cedar shake and PVC roofs released statistically significantly higher concentrations of arsenic than the glass controls. These ranged as high as 4,690 ug/L and 117 ug/L for the treated cedar shake and PVC roofs, respectively.
- Runoff from the treated wood shake, copper, asphalt shingle, and asphalt shingle treated with algae- resistance roofs released statistically significantly higher copper concentrations than the glass controls. The treated wood shake and copper roofs released concentrations of up to two orders of magnitude higher than the other roofing types that released copper.
- Several roof types released statistically significantly higher concentrations of zinc than the glass controls including the Zincalume®, EPDM, wood shingle, painted galvanized metal, and PVC roof panels. Runoff from the Zincalume® roof ranged from 38 to a high of 578 ug/L, and runoff from the ethylene propylene diene monomer (EDPM) roof ranged from 44 to 313 ug/L. These two roof types released the highest zinc concentrations.

The results from the first round of sampling indicate that with the exception of a few roofing materials, which are releasing arsenic, copper, and zinc, the contribution of new roofing materials as sources of contaminants to Puget Sound may be lower than originally estimated in the Puget Sound Assessment. Overall, organics levels were generally low in most runoff samples with the exception of phthalates in the runoff from the treated cedar shake roof, which were sampled only during the first three of 10 events.

Table 1. Roofing materials studied.

No.	Roof Type	Description/Comment
Steep Slope Roofs		
1	Asphalt shingle - composite 6 types of shingles without algal resistant (AR) copper-containing granules	A composite of 6 different asphalt manufacturers' shingles commonly used in Washington without chemicals used for algae control
2	Asphalt shingle - composite 6 types of shingles with AR copper-containing granules	A composite of 6 different asphalt manufacturers' shingles commonly used in Washington with chemicals used for algae control
3	Copper	Copper paneling roof
4	Manufacturer-painted galvanized steel	Galvanized steel coated with paint applied by the manufacturer
4	Concrete tile	Concrete tile is generally 20-30% concrete; 50-60% sand and aggregate; 0-5 % limestone and may include an acrylic coating
6	Wood shingle	Cedar most prevalently used in Washington, with no preservative and no fire retardants
7	Manufacturer-treated wood shake	Treated with chromate copper arsenate (CCA) to preserve wood
8	Frosted glass (control)	Glass control panel constructed at steep slope to subtract wet and dry air deposition
Low Slope Roofs		
9	Thermoplastic polyolefin (TPO)	A single ply thermoplastic roofing material
10	Polyvinyl chloride (PVC)	A single ply roofing material
11	Ethylene propylene diene monomer (EPDM)	A rubberized single ply roofing material
12	Built-up roof (BUR) with oxidized asphalt granulated cap sheet	Commercial roofing includes asphalt felt and hot applied asphalt and an oxidized asphalt granulated cap
13	Modified BUR with styrene butadiene styrene (SBS) granulated cap sheet	BUR modified with an SBS-amended cap sheet
14	Modified BUR with Atactic polypropylene (APP) granulated cap sheet	BUR modified with an APP amended cap sheet
15	Zincalume®	An aluminum zinc alloy product sheet metal roofing
16	Frosted glass (control)	Glass control panel constructed at low slope to subtract wet and dry air deposition

However, the results collected to date do not provide Ecology with a long enough period of record to have confidence in making decisions regarding future actions related to assessing roofing system or whether source control actions are needed for the materials tested.

Contaminant concentrations in runoff may increase or decrease over time as roofing materials age. At the October 24, 2012 meeting of the Roofing Task Force (RTF), participants identified evaluation of the leaching of contaminants over time as a high priority for consideration. It is unclear how concentrations of contaminants will change over time, especially for roofing materials that had elevated metals concentration in runoff. New roofs may behave differently than roofs that have been subjected to weathering. The roofing materials tested had aged for less than three months during the initial sampling. The panels have now been exposed to aging of heat and a summer of more intense ultra violet radiation (summer of 2013). These agents could affect the release of contaminants. Additional fall/winter sampling will provide data to begin to evaluate changes in concentrations over time since the initial sampling was conducted.

A robust baseline from a single location over a one-year period will better serve the ongoing studies of these panels when they are moved to the Washington Stormwater Center for continued research. A robust baseline from a single location over a one year period will also better serve in making comparisons with runoff from other roofing components that will likely be the focus of additional Ecology research. Also, a more robust baseline would be beneficial for comparisons with runoff from aged roofing materials found in the literature.

Due to the limited number of samples collected (ten events) of the original study and to the variability typical of stormwater, we can only resolve differences between very high concentrations and controls with confidence. The additional data collection this fall and winter will provide greater statistical power in discerning differences between materials and changes over time. This is especially true for materials which have low to moderately elevated concentrations.

Collection of additional storm event data will allow Ecology to gain confidence in the results, prioritize further actions related to assessing roofing systems, and determine the need to evaluate other sources of contaminants in the Puget Sound basin.

Objectives

This second round of this study is designed as a focused pilot study to gain a better understanding about the range of the concentrations of selected chemicals that leach from roofing materials exposed to precipitation events that are typical in intensity and duration of those in the Puget Sound region. The primary objectives of this follow-on study are to:

- Build on previous sampling to increase confidence in determining the range of concentrations of specific chemicals leached from various roofing materials used in the Puget Sound basin.
- Determine changes in concentrations in runoff following a 7-month to 1-year period of aging.
- Provide a robust baseline for comparison with the future study of these panels at the Washington Stormwater Center as the panels age.

Organization and Schedule

The organization differs slightly from the original Quality Assurance (QA) Project Plan (Ecology, 2013). Table 2 lists the people involved in this project. Table 3 presents the schedule for the amended QA Project Plan.

Table 2. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Ron McBride WQP Phone: 360-407-7543	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Nancy Winters SCS, EAP Phone: 360-407-7392	Project Manager, Technical Lead, Primary Investigator	Conducts field sampling and ensures transportation of samples to the laboratory, with assistance of field crew. Conducts QA review of data, analyzes and interprets data. Writes the QAPP, draft report, and final report addendum.
Melissa Mc Call Field Staff –SCS, EAP Phone: 360-407-7392	Field collection Coordinator	Assists in conducting field sampling, recording field data in field log book, and arranging and ensuring appropriate transportation of samples to the laboratory.
Lisa Rozmyn Washington Stormwater Center, Puyallup, WA Phone: 253-445-4552	Field collection assistance	Assists, as available, in conducting field sampling, recording field data in field log book, and arranging and ensuring appropriate transportation of samples to the laboratory.
Allison Kingfisher W2R, Eastern Regional Office Phone: 509-329-3448	Building Materials Specialist	Facilitates RTF meetings, collaboratively develops agendas, communicates with RTF members, maintains list of members with phone numbers and email addresses.
Dale Norton SCS, EAP Phone: 360-407-6765	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Will Kendra SCS, EAP Phone: 360-407-6698	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Carol Kraege RTT, W2R Phone: 360-407-6906	Section Manager Reducing Toxic Threats	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Joel Bird MEL, EAP Phone: 360-871-8801	Director, MEL	Approves the final QAPP.
Tom Gries SCS, EAP Phone: 360-407-6327	NEP Quality Coordinator	Reviews draft QAPP and reports; recommends QAPP approval. May conduct field audit of project.
William R. Kammin EAP Phone: 360-407-6964	Ecology Quality Assurance Officer	Approves the draft QAPP and the final QAPP.

See next page for definitions of acronyms.

Acronyms in Table 2:

WQP: Water Quality Program
EAP: Environmental Assessment Program
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section
W2R: Waste 2 Resources Program
RTF: Roofing Task Force
RTT: Reducing Toxic Threats Section
MEL: Manchester Environmental Laboratory
NEP: National Estuary Program

Table 3. Proposed schedule for completing field and laboratory work and report addendum.

Field and laboratory work	**Due date**	**Lead staff**
Field work	Oct. 2013 – Feb. 2014	Nancy Winters
Laboratory analyses completed	35 calendar days after receipt of each set of samples, with EDD results of final analyses no later than March 22, 2014	Manchester Environmental Laboratory (MEL)
Final report		
Author lead / Support staff	Nancy Winters	
Schedule		
Draft report addendum due to supervisor	June 1, 2014	
Draft report addendum due to client, NEP Quality Coordinator, and peer reviewers	June 15, 2014	
Draft due to external reviewer(s)	July 1, 2014	
Final (all reviews completed) due to publications coordinator	August 30, 2014	
Final report due on web	September 30, 2014	

EDD: Electronic data deliverable

Changes from 2013 QA Project Plan

The procedures for field sampling and analyses will follow the original QA Project Plan's (Ecology, 2013) procedures for sampling and analysis of runoff from the pilot-scale roofing panels assessment with exceptions described in this section.

Runoff from the pilot scale roof panels will be collected and analyzed between the end of October 2013 and the beginning of February 2014. An attempt will be made to collect 10 storm events during this period. Due to the need to relocate the panels from the Ecology facility and the timeline for completing the project, sampling will need to end no later than February 7, 2014, regardless of whether 10 events have been completed

Runoff collected from roof panels will be sampled and analyzed for five metals (arsenic, cadmium, copper, lead, and zinc) during each of the 10 storm events. Only total metals will be analyzed. In addition, during three storm events that provide adequate volume, PAHs, phthalates, and PBDEs will be sampled and analyzed. An attempt will be made to distribute these three events across the sampling period. Lower-volume storms may be sampled when total metals analysis is the only parameter to be analyzed.

Tables 4 and 5 list the analyses to be performed and the number of samples anticipated for each rain event. The project manager will notify the Manchester Environmental Laboratory (MEL) staff when sampling is anticipated and will confirm delivery schedule with MEL just before samples are processed.

Table 4. Numbers of samples by analysis per rain event for three rain events.

Sample	Total Metals EPA 200.8	PAHs & Phthalates SW 8270 SIM	PBDEs SW 8270D
Panels	18	18	18
Field splits	3	3	3
MS/MSD	4	4	4
Distilled deionized water blank	1	1	1
Equipment rinse blank	1	1	1
Total Samples/Event (three rain events)	27	27	27

Table 5. Numbers of samples for total metals for the remaining seven rain events.

Sample	Total Metals EPA 200.8
Panels	18
Field splits	3
MS/MSD	4
Distilled deionized water blank	1
Equipment rinse blank	1
Total Samples/Event three rain events	27

As per the original QA Project Plan (Ecology, 2013), MEL will report the measured values for results which are between the Reporting Limit (RL) and the Method Detection Limit (MDL) and will "J" flag them.

MEL has agreed to provide an electronic data deliverable in Excel format and a pdf format of results with narrative for each storm event within 35 calendar days of receipt of the samples. MEL has also agreed to provide the first set of matrix spike/matrix spike duplicates (MS/MSDs) for each sampling event and each analysis without charge. Estimated costs for analyses are provided in Table 6 below.

Table 6. Estimated analytical costs for round 2 of Roofing Assessment.

Sample	Total Metals	PAHs & Phthalates	PBDEs
Total Samples/Event for each of three rain events	27*	27*	27*
Total Samples/Event for each of seven rain events	27*	0	0
Total samples for all events	270	81	81
Cost per sample	$ 116	$ 370	$ 177
Cost by analysis type	$ 31,320	$ 29,970	$ 14,337
Total			$ 75,627

*Assumes laboratory will provide first set of MD/MSDs at no cost.

Report Addendum

The project manager will prepare a draft and final report which will serve as an addendum to the original report. The addendum will be prepared in accordance with the schedule in Table 2 and will include the following:

- Deviations from this QA Project Plan Addendum.
- Sample event information such as precipitation intensity, duration and depth, dates, times, and results of chemical analyses for storms sampled under this QA Project Plan Addendum.
- Analytical results and summary statistics for samples collected between October 2013 and February 2014.
- Presentation of roof runoff quality from the roofing materials tested on a concentration (ug/L), mass basis per unit area (ug/m^2), and mass per area rain depth (ug/m^2 /mm).
- Statistical comparisons between runoff results from roofing materials and glass controls.
- Statistical comparisons of results with initial study results and literature values.
- Conclusions that can be drawn from the study and recommendations for future studies.
- Raw data provided in digital form in appendices.

Ecology reviewers, including the National Estuary Program Quality Coordinator, will comment on a draft of the report. The comments received from the internal reviewers by the deadline will be addressed in a revised draft. The RTF members will receive a copy of the draft report for their review and comment. The comment review period for the RTF will be two weeks. The project manager will address comments and prepare the final report addendum by August 30, 2014. Ecology will provide public access to electronic versions of the report generated from this project via Ecology's internet homepage (www.ecy.wa.gov). The data generated will be stored in EXCEL files and be available upon request at the end of the project.

References

Ecology. 2011a. Control of Toxic Chemicals in Puget Sound Phase 3: Primary Sources of Selected Toxic Chemicals and Quantities Released in the Puget Sound Basin. Washington State Department of Ecology, Olympia, WA. Publication No. 11-03-024. https://fortress.wa.gov/ecy/publications/summarypages/1103024.html

Ecology. 2011b. Control of Toxic Chemicals in Puget Sound: Assessment of Toxic Chemical Loads in the Puget Sound Basin, 2007-2011. Washington State Department of Ecology, Olympia, WA. Publication No. 11-03-055. https://fortress.wa.gov/ecy/publications/summarypages/1103055.html

Ecology. 2013. Quality Assurance Project Plan: Roofing Assessment - Investigation of Toxic Chemicals in Roof Runoff. Washington State Department of Ecology, Environmental Assessment Program. Olympia, WA. January 2013. Publication No. 13-03-105. https://fortress.wa.gov/ecy/publications/SummaryPages/1303105.html

Appendix. Acronyms and Abbreviations

APP	Atactic polypropylene roofing
AR	Algae-resistant
ARMA	Asphalt Roofing Manufacturers Association
BUR	Built-up roof
CCA	Chromated-copper-arsenate
DEHP	Bis (2-ethylhexyl) phthalate
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
e.g.	For example
EPA	U.S. Environmental Protection Agency
EPDM	Ethylene propylene diene monomer
HVAC	Heating, ventilation, and air conditioning
i.e.	In other words
MEL	Manchester Environmental Laboratory
MS	Matrix spike
MSD	Matrix spike duplicate
PAH	Polycyclic aromatic hydrocarbon
PVC	Polyvinyl chloride
QA	Quality assurance
RL	Reporting limit
RPD	Relative percent difference
RTF	Roofing Task Force
SBS	Styrene butadiene styrene
SOP	Standard Operating Procedure
TPO	Thermoplastic polyolefin roofing

Units of Measurement

ft	feet
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
m	meter
mg/L	milligrams per liter (parts per million)
mL	milliliters
mm	millimeter
mm/hr	millimeters per hour
ug/L	micrograms per liter (parts per billion)