Programmatic Monitoring Approach for Highway Stormwater Runoff in Support of Endangered Species Act (ESA) Section 7 Consultation

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Background

To support the preparation of biological assessments for Endangered Species Act (ESA) Section 7 consultations, the Washington State Department of Transportation (WSDOT) initiated a joint project in 2007 with the Federal Highway Administration (FHWA), the U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries) to develop a mutually acceptable approach for assessing the potential water quality effects of highway stormwater runoff on ESA-listed aquatic species.

This process ultimately culminated in the development of the Highway Runoff Dilution and Loading (HI-RUN) model for western Washington. The model predicts loadings and end-of-pipe concentrations for select water quality constituents found in highway stormwater runoff. Because these predictions are generated using a probabilistic approach (i.e., Monte Carlo simulations), potential effects on ESA-listed aquatic species can now be assessed using a "risk-based" approach. Specifically, the HI-RUN model permits the user to estimate the probabilities that the current effects thresholds identified by the Services (i.e., a 2.0 µg/L increase in dissolved copper over background receiving water conditions, and a 5.6 µg/L increase in dissolved zinc over background receiving water conditions) could be exceeded given underlying uncertainties and natural temporal and spatial variability (e.g., variation in the size of storm events, quality of runoff, BMP effectiveness, etc.). The HI-RUN model approach differs from the previous WSDOT approach used in ESA Section 7 consultations, which generally relied on a single representative value (or small set of representative values) to determine whether effects thresholds may be exceeded. This earlier approach had several shortcomings; most notably, it failed to incorporate any of the underlying data uncertainty associated with highway stormwater runoff, and the variability in riverine flows into which this run-off is diluted.

Whereas the HI-RUN model was specifically developed to address some of the shortcomings that have been identified in previous analytical approaches used in ESA Section 7 consultations evaluating stormwater quality effects, there are still model limitations that warrant consideration during consultation. The most notable limitation stems from the fact that end-of-pipe pollutant concentrations in highway stormwater runoff are influenced by numerous factors, including site-specific conditions (e.g., proximity to urban areas, traffic volume, and basin size), storm event characteristics (e.g., antecedent dry period, and amount of precipitation), and regional weather patterns. Based on the datasets that are currently available, it is impossible to accurately predict how each of these factors will interact to determine highway stormwater runoff quality at a given site; therefore, their influence could not be directly incorporated into the HI-RUN model. Another limitation is that the water quality data used as input to the HI-RUN model were derived from a relatively small number of monitoring locations and BMP types. For this particular

application, although these data are considered the most representative available, some extrapolation is required in order to estimate pollutant concentrations across the full range of conditions encountered in western Washington.

In view of these limitations, output from the HI-RUN model is intended to provide a general assessment of the risk of potential water quality impacts to ESA-listed species. The model can be used to assess whether a project may improve or degrade the quality of stormwater runoff originating from a site, and determine the likelihood that fish may be exposed to elevated pollutant concentrations. To compensate for the limitations of the model and the broader uncertainties surrounding pollutant concentrations in highway stormwater runoff, a conservative approach was established for interpreting output from the HI-RUN model. Specifically, a default risk threshold of 5 percent was to be applied when interpreting whether (and where) fish may be exposed to pollutant concentrations exceeding the established effects thresholds.

Although this conservative threshold is implicit in the HI-RUN model, some terms and conditions have been included in recent Biological Opinions that would require project-specific monitoring to meet a varied objectives; sometimes to validate or "ground-truth" model approximations of pollutant loading and end-of-pipe concentrations, sometimes to confirm stormwater discharges will not exceed thresholds for potential water quality effects on ESA-listed species, and sometimes to confirm these same thresholds will not be exceeded beyond a specified distance (i.e., limit of incidental take). However, while the reasons for requiring monitoring have varied, it can be said that in general project-specific monitoring to meet these objectives is not feasible. For example, this monitoring would require collection of a large number of samples to detect changes in receiving water concentrations that are commensurate with the established effects thresholds. In addition, not all projects may meet the conditions necessary to successfully monitor a stormwater BMP. For example, monitoring at some projects may be impossible due to logistical considerations related to access and/or safety. Furthermore, some projects may be unsuitable for monitoring because hydraulic conditions in the associated stormwater conveyance system preclude the use of the required monitoring equipment. None of these project based monitoring limitations can be determined at the time of consultation, they can only be determined after the project has been constructed.

If the accuracy and reliability of HI-RUN model outputs can be assessed programmatically, project-specific terms and conditions for stormwater quality monitoring should be unnecessary. Furthermore, project-specific terms and conditions for monitoring deviate from the intended purpose of the HI-RUN model's development, wherein output from the model was to be used to evaluate the potential for incidental take based on the exceedance of water quality thresholds within the receiving waters, and zones of incidental take would be authorized by the Services based on project-specific constraints.

In order to tie required monitoring back to the process developed for assessing potential effects of highway stormwater runoff (i.e., use of the HI-RUN model), a programmatic rather than project-specific monitoring approach is needed. This document outlines a programmatic approach for consideration by the agencies listed above, and is intended to satisfy the stormwater

quality monitoring needs of future ESA consultations. The specific goals of this monitoring are as follows:

- Obtain additional data for improving the HI-RUN model's predictions for untreated runoff.

- Obtain additional data for improving the HI-RUN model's predictions for treated runoff.

To the extent possible, this monitoring will be coordinated with monitoring obligations specified in WSDOT's recently issued Municipal Stormwater Permit from the Washington State Department of Ecology (Ecology). The following sections provide an overview of the monitoring procedures that would be used to meet each of the goals identified above.

Monitoring of Untreated Runoff

Monitoring of untreated runoff will be performed in connection with monitoring requirements that are specified in Section S7.B of WSDOT's Municipal Stormwater Permit. This monitoring will involve the collection of flow-weighted composite samples at edge of pavement for the analysis of representative pollutants in highway runoff. The data obtained from this monitoring will be used to improve the accuracy of future versions of the model by providing a larger pool of data for characterizing pollutant concentrations in untreated runoff.

Pursuant to requirements of the Municipal Stormwater Permit, a Quality Assurance Project Plan (QAPP) will be developed to provide a detailed description of the sampling procedures that will be used in connection with this monitoring. The following subsections provide a general overview for the following elements of the monitoring design: site selection, sampling procedures, sample timing and frequency, and monitoring parameters.

Site Selection

Sampling will be performed at a total of four sites in Western Washington to characterize pollutant concentrations at edge of pavement. These sites will be selected to meet the following criteria that are specified in Section S7.B.3 of the Municipal Stormwater Permit:

- Two highly urbanized sites (≥100,000 annual average daily traffic [AADT])

- One urbanized site (≤100,000 and ≥30,000 AADT)

- One rural site (≤30,000 AADT)

Specific monitoring locations at each site will be established to facilitate the collection of samples from the edge of the pavement or from a location within a pipe conveyance system where stormwater has not passed through a treatment BMP, a vegetated area, or the soil column.

In addition to the criteria specified, additional considerations during site selection will include:

- Traffic safety and site access considerations for field crews.
- Suitability of site hydraulics for required flow monitoring instrumentation.
- Susceptibility of site to vandalism and/or theft.
- Schedule of road improvements/maintenance projects that might interrupt or interfere with monitoring.

Sampling Procedures

Automated monitoring equipment will be employed for this monitoring to facilitate the collection of flow-weighted composite samples during discrete storm events. Each flow-weighted composite sample will generally consist of at least 10 aliquots; however, samples with 7 to 9 aliquots may be considered acceptable if other sampling criteria are met. For storm events lasting less than 24-hours, flow-weighted composite samples will be collected over at least 75 percent of the storm event hydrograph. For storm events lasting longer than 24-hours, flow-weighted composite samples will be collected for at least 75 percent of the hydrograph of the first 24-hours of the storm. Grab samples will also be also be collected for selected parameters during each event (see discussion below).

Sample Timing and Frequency

Sampling will initiate by the fall of 2011 and may continue up to the expiration date of the permit (March 4, 2014). Sampling will be conducted during up to 14 qualifying storm events per water year. These storm samples will be distributed throughout the year to reflect the distribution of rainfall between the wet and dry seasons. The goal will be to collect 60-80 percent of the samples during the wet season and 20-40 percent during the dry season. The following criteria will be used to define qualifying storm events for this sampling in the wet and dry seasons, respectively:

A qualifying storm event during the wet season (October 1 through April 30) will meet the following conditions:

- Rainfall depth: 0.20-inch minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: less than 0.02-inch rain or no surface runoff in the previous 24-hours

A qualifying storm event during the dry season in (May 1 through September 30) will meet the following conditions:

- Rainfall depth: 0.20-inch minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: less than 0.02-inch rain in previous 72 hours

Monitoring Parameters
Flow -weighted composite samples will be analyzed for the following parameters that can be evaluated using the HI-RUN model:

- Total Suspended Solids
- Total and Dissolved Copper
- Total and Dissolved Zinc

(Note: Section S7.B of WSDOT's Municipal Stormwater Permit will require characterization of additional parameters in connection with this monitoring. This full list of parameters is identified in Attachment A to this document.)

Monitoring of Treated Runoff

Monitoring of treated runoff will be performed in connection with monitoring requirements that are specified in Section S7.E of WSDOT's Municipal Stormwater Permit. This monitoring will involve the collection of flow-weighted composite samples at the inlet and outlet of treatment best management practices (BMPs) for highway runoff. The data obtained from the outlet monitoring would be used to improve the accuracy of future versions of the model by providing a larger pool of data for characterizing pollutant concentrations in treated runoff.

Pursuant to requirements of the Municipal Stormwater Permit, a QAPP will be developed to provide a detailed description of the sampling procedures that will be used in connection with this monitoring. The following subsections provide general overview for the following elements of the monitoring design: site selection, sampling procedures, sample timing and frequency, and monitoring parameters.

Site Selection

Monitoring will be conducted at representative BMPs from WSDOT's Highway Runoff Manual (HRM). Monitoring will be performed on at least two different types of treatment BMPs, at no less than two sites per BMP (i.e., at approximately four sites in total). BMPs will be selected from the following treatment categories:

- Basic treatment (suspended solids)
- Enhanced treatment (metals)
- Metals/Phosphorus treatment
- Oil control

To ensure successful implementation of the monitoring program, additional considerations will include:

- Traffic safety and site access considerations for field crews.
- Suitability of site hydraulics for required flow monitoring instrumentation.
- Susceptibility of site to vandalism and/or theft.
- Schedule of road improvements/maintenance projects that might interrupt or interfere with monitoring.

Sampling Procedures

Sampling procedures used for this monitoring will follow guidelines specified in the Technology Evaluation Protocol – Ecology (TAPE) for preparing, implementing and reporting the results of BMP performance monitoring studies. In accordance with these guidelines, automated monitoring equipment will be employed to facilitate the collection of flow-weighted composite samples from the inlet and outlet of each BMP during discrete storm events. As a guideline, each flow-weighted composite sample will consist of at least 10 aliquots and be collected over at least 75 percent of the storm event hydrograph. Grab samples will also be also be collected for selected parameters during each event (see discussion below).

Sample Timing and Frequency

Sampling will initiate by the fall of 2011 and may continue up to the expiration date of the permit (March 4, 2014). Sampling will be conducted during between 12 and 35 qualifying events over this period, depending on the treatment goal that is being assessed for the BMP. The ultimate goal will be to collect a sufficient number of samples to verify the treatment performance of each BMP with 95 percent confidence and 80 percent power. A qualify storm event will meet the following conditions:

- Rainfall depth: 0.15-inch minimum, no fixed maximum
- Rainfall duration: 1-hour
- Antecedent dry period: less than 0.04-inch rain in the previous 6-hours

Monitoring Parameters [See related, previous comments (p. 5).]

Flow -weighted composite samples will be analyzed for the following parameters that can be evaluated using the HI-RUN model:

- Total Suspended Solids
- Total and Dissolved Copper
- Total and Dissolved Zinc

(Note: Section S7.E of WSDOT's Municipal Stormwater Permit will require characterization of additional parameters in connection with this monitoring. This full list of parameters is identified in Attachment A to this document.)

Attachment A

Pursuant to Section S7.B of WSDOT's Municipal Stormwater Permit, samples collected at representative end-of-pavement monitoring sites must be analyzed at for the following suite of parameters.

Flow-weighted composite samples:

- Metals: Total and dissolved copper, zinc, cadmium and lead
- Polycyclic Aromatic Hydrocarbons
- Total suspended solids
- Chlorides
- Phthalates
- Herbicides: Triclopyr (Ester formula only), 2,4-D, Clopyralid, Diuron, Dichlobenil, Picloram , and Glyphosate
- Nutrients: Total phosphorus, ortho-phosphate
- Whole Effluent Toxicity (*Hyalella azteca* 24-hour test)

Grab samples:

- Total Petroleum Hydrocarbons: NWTPH-Dx and NWTPH-Gx
- Fecal coliform
- Temperature (collected from runoff in-situ or as a grab sample)
- Visible sheen observation

Pursuant to Section S7.E of WSDOT's Municipal Stormwater Permit, samples collected at representative BMP performance monitoring sites must be analyzed at for the following suite of parameters.

Flow-weighted composite samples:

- Total suspended solids
- Particle size distribution
- pH
- Total phosphorus
- Ortho-phosphate
- Hardness
- Total and dissolved copper
- Total and dissolved zinc

Grab samples:

- Total Petroleum Hydrocarbons: NWTPH-Dx and NWTPH-Gx
- Visible sheen observation