Herrera Environmental Consultants, Inc.

Memorandum

To	Megan White, John Grettenberger, Michael Grady, Sharon Love
cc	Marion Carey
From	Julie Hampden and John Lenth, Herrera Environmental Consultants
Date	April 14, 2011
Subject	Indirect Effects Stormwater Runoff Analytical Method

The analytical method outlined below is intended for analysis of water quality impacts associated with stormwater runoff associated with development identified as a indirect effect of transportation projects. The method serves as an addition to the guidance presented in the technical memorandum issued on June 17, 2009 by the multi-agency Project Management Team (PMT) (consisting of representatives from US Fish and Wildlife Service, National Marine Fisheries Service, Federal Highway Administration, and Washington State Department of Transportation (WSDOT) titled *Endangered Species Act (ESA), Transportation and Development; Assessing Indirect Effects in Biological Assessments*.

The method is intended to provide a coarse scale analysis of the changes in annual loads for three stormwater pollutants from changes in land use and or impervious surface. This method should only be used to assess development related indirect effects that can be directly associated with a transportation project per the Project Management Team technical memorandum. It should also be noted that this method does not address potential changes in stormwater quantity from development related indirect effects.

This method is a simple "wash-off" model that relies upon unit area annual pollutant loads (pounds/acre/year) for individual land uses to predict annual pollutant yields (pounds/year) from the changes in land use associated with the indirect effects of the project for the existing and projected conditions following completion of the transportation project. It is based upon Method 2: Applying Literature Values as described in the 2009 WSDOT guidance document, *Quantitative Procedures for Surface Water Impact Assessments*, but it replaces the land use type categories and annual pollutant loading rates used in Method 2 with more current data that is specific to Western Washington. As a result, this method is only applicable to projects in Western Washington.

The model utilizes unit area annual pollutant loads for three parameters (total suspended solids, total zinc, and total copper) and the following four land use types:

- **Forest:** generally refers to second growth coniferous forests with only minor commercial timber harvesting activities.

- **Agricultural:** generally refers to irrigated cropland for food production and low to medium density livestock grazing.
- **Low- to Medium Density Development:** generally refers to low and medium density single family residential development with one to six dwellings per acre.
- **High-Density Development:** generally refers to commercial, industrial, multi-family residential development and/or high density single family residential development (> six dwellings per acre).

These loads are documented in Table 1 of this document; Attachment A to this memorandum also shows the raw data that were used to calculate these loads and their source. Note that roads are not called out as a unique land use type because they represent both a unique contaminant source and a conduit for transporting contaminants from surrounding land use types. At present, there are insufficient data to quantify unit area annual pollutant loads from roads only. Therefore, the acreage for roads under the current and projected conditions should be added to the corresponding acreage for the land use category where the roads are located. Unlike roads, impacts from highways on transportation projects can be evaluated directly using the Highway Runoff and Dilution (HI-RUN) model. Detailed instructions for performing these evaluations can be found in the HI-RUN model user's guide: http://www.wsdot.wa.gov/NR/rdonlyres/85B43C71-DEBE-478C-A468-C6BF64D86B64/0/BA_HighwayRunoffUsersGuide.pdf.

Table 1. Unit area pollutant loading rates (lb/acre/year) by land use.

	Total Suspended Solids			Total Copper			Total Zinc		
	Median	25th Percentile	75th Percentile	Median	25th Percentile	75th Percentile	Median	25th Percentile	75th Percentile
Forest	41.9	36.2	58.7	0.0077	0.0065	0.0086	0.0226	0.0132	0.0386
Agricultural	42.5	23.2	45.0	0.023	0.015	0.023	0.0380	0.0252	0.0386
Low- to Medium-Density Development	43.6	31.1	104	0.010	0.0059	0.017	0.0353	0.0236	0.0587
High-Density Development	79.3	59.7	85.0	0.025	0.016	0.034	0.171	0.0353	0.388

lb/acre/year: pounds/acre/year
Source: Herrera (2007), Herrera et al. (2011)

The method is straightforward to apply. The estimated acreage of land for a given land use type is multiplied by the unit area annual pollutant load associated with that land use to determine the annual load of a given pollutant from that acreage for median, 25th percentile and 75th percentile values (see example calculations in Attachment B to this memorandum). Comparisons of pre- and post-project loads for each land use within an action area are used to illustrate the effects of the project and its indirect effects on loading. The 25th percentile and 75th percentile values provide some measure of the uncertainty in the annual load estimates.

Steps for Analyzing Annual Pollutant Loadings Associated with Development Related Indirect Effects

1. First identify the areas within the action area that will be changed as an indirect effect of the proposed project (see PMT technical memorandum cited above).

2. For the existing condition, estimate the area (in acres) of land, within the portion of the action area that will be changed that is currently represented by each land use type in Table 1.

3. Multiply the area for each land use type by the appropriate unit area loading rate in Table 1 for that land use to obtain median annual load estimates for each land use type under the existing condition. An example of how these calculations are performed is provided in Attachment B.

4. Add the annual load estimates for all land use types to produce an estimate of the total load from changed portion of the action area under the existing condition.

5. For the projected condition following completion of the transportation project (or each proposed alternative for the project), estimate the number of acres of land, within the portion of the action area that will be changed, that will be represented by each land use type in Table 1. An example of how these calculations are performed is provided in Attachment B.

6. Multiply the area for each land use type by the appropriate unit area loading rate in Table 1 for that land use to obtain annual load estimates for each land use type under the projected condition.

7. Add the annual load estimates for all land use types to produce an estimate of the total load from the changed portion of the action area under the projected condition.

Note, if there are multiple basins or receiving waters within the action area that will be affected by development-related indirect effects from the proposed transportation project or project alternatives, it may be necessary to provide additional tables depicting how many acres will be affected in each of these individual basins and to quantify the annual loading effects of each alternative on each basin, in addition to the overall action area. To do this, the biologist would need to complete the following additional steps.

8. In order to calculate areas for each land use type by basin, the biologist would need to determine the extent of the drainage basin /receiving water basin. The total basin area, for each basin, can be delineated using the on-line GIS-based tool StreamStats, developed by USGS: http://water.usgs.gov/osw/streamstats/index.html.

9. Once the extent of the basin(s) has been established, the biologist would then determine the extent of each land use type within each basin.

10. As described in steps one through six above, calculations would be completed, by basin (rather than action area) for existing and projected conditions to discern the changes between existing and projected land use and loading conditions by basin.

Once the project-specific loading rates have been established for the existing and projected conditions within the action area, the biologist can analyze changes in land use and loading by comparing the differences between the areal extent of land uses and associated loading within the action area between the existing and projected conditions. The biologist should summarize these results within the indirect effects section of the biological assessment and provide a qualitative discussion regarding chemical, biological and ecological effects of stormwater runoff pollutant loadings.

In general, changes in loading affect baseline conditions in the receiving water body, which in turn may affect the suitability of habitat for listed species. Increased pollutant loads contribute to the continued or increased degradation of baseline water quality conditions. Conversely, decreased loads contribute to improvement of baseline conditions. Though changes in loading may contribute to sublethal effects to listed aquatic species via ingestion or food chain interactions, it may be difficult to link these changes to adverse effects to listed aquatic species. As a result, the indirect effects analysis above will allow the biologist to generally characterize potential changes to baseline conditions but does not describe potential direct effects to fish.

In the indirect effects section, the biologist should qualitatively describe trends in baseline conditions and how projected developments may affect these trends. The biologist should also refer the reader back to the stormwater effects section of the BA to describe or address the overall effects of sediments, metals and other stormwater constituents on fish. WSDOT's Biological Assessment Preparation of Transportation Projects Advanced Training Manual provides general information on potential effects of stormwater constituents on fish in the Stormwater Impact Assessment Chapter (17). This information is available on WSDOT's website: http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm.

ATTACHMENT A

Data Sources for Unit Area Pollutant Loading Rates used in Indirect Effects Analysis

Study	Site	Land-Use Category	Total Suspended Solids (lb/acre/year)	Total Copper (lb/acre/year)	Total Zinc (lb/acre/year)
Herrera (2007)	S322	Forest	133	0.0080	0.0120
Herrera (2007)	F321	Forest	62.5	0.0062	0.0123
Herrera et al. (2011)	FB200	Forest	34.5	0.0045	0.0294
Herrera et al. (2011)	FB203	Forest	36.3	0.0094	0.0558
Herrera et al. (2011)	FB130	Forest	47.4	0.0074	0.0416
Herrera et al. (2011)	FB372	Forest	36.1	0.0088	0.0158
Herrera (2007)	D322	Agricultural	45.0	0.015	0.0252
Herrera et al. (2011)	AG174	Agricultural	42.5	0.023	0.122
Herrera et al. (2011)	AGG	Agricultural	17.9	0.0093	0.0380
Herrera et al. (2011)	AG143	Agricultural	65.5	0.039	0.0132
Herrera et al. (2011)	AG62	Agricultural	23.2	0.023	0.0386
Herrera (2007)	Y320	Low- to Medium-Density Development	36.0	0.010	0.0341
Herrera (2007)	A326	Low- to Medium-Density Development	46.1	0.011	0.0353
Herrera (2007)	A307	Low- to Medium-Density Development	340	0.029	0.114
Herrera et al. (2011)	RB111	Low- to Medium-Density Development	43.6	0.0076	0.0358
Herrera et al. (2011)	RB202	Low- to Medium-Density Development	161	0.022	0.0815
Herrera et al. (2011)	RB53	Low- to Medium-Density Development	20.6	0.0042	0.00453
Herrera et al. (2011)	RB209	Low- to Medium-Density Development	26.1	0.0028	0.0130
Herrera (2007)	I322B	High-Density	53.4	0.015	0.0726
Herrera (2007)	B317	High-Density	253	0.068	0.516
Herrera et al. (2011)	CB335	High-Density	79.9	0.030	0.428
Herrera et al. (2011)	CBX	High-Density	86.7	0.035	0.269
Herrera et al. (2011)	CBA	High-Density	78.7	0.020	0.0228
Herrera et al. (2011)	CBB	High-Density	25.3	0.012	0.0104

lb: pounds

Herrera. 2007. Water Quality Statistical and Pollutant Loading Analysis: Green-Duwamish Water Quality Assessment. Prepared for King County Department of Natural Resources and Parks by Herrera Environmental Consultants, Inc., Seattle, Washington. January 2007.

Herrera, Ecology and Environment, Practical Stats, and Ecology. 2011. Toxics in Surface Runoff to Puget Sound: Phase 3 Data and Load Estimates. DRAFT. Herrera Environmental Consultants, Inc., Ecology and Environment, Inc., Practical Stats, and Washington State Department of Ecology, Olympia, Washington. February 2011.

ATTACHMENT B

Attachment B: Example Calculations

Annual TSS Load Estimate for Existing Condition

Land Use Category	Existing Area (acres)		Median TSS Unit Area Loading Rate (lbs/acre/year)		Existing Annual TSS Load Estimate (lbs/year)
Forest	20	×	41.9	=	838
Agricultural	10	×	42.5	=	425
Low- to Medium-Density Development	5	×	43.6	=	218
High-Density Development	1	×	79.3	=	79
Total for All Land Uses	36				1560

Annual TSS Load Estimate for Projected Condition

Land Use Category	Projected Area (acres)		Median TSS Unit Area Loading Rate (lbs/acre/year)		Projected Annual TSS Load (lbs/year)
Forest	15	×	41.9	=	629
Agricultural	5	×	42.5	=	213
Low- to Medium-Density Development	10	×	43.6	=	436
High-Density Development	6	×	79.3	=	476
Total for All Land Uses	36				1754

Net change in annual TSS loads = projected annual TSS load – existing annual TSS load = 1754 – 1560 = 194 lbs/year