Implementation of Revised Freshwater Sediment Screening Values

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Introduction: a bit of history

- 2002: Ecology evaluated existing freshwater (FW) screening values
- 2003: Ecology published report using the Floating Percentile Method (FPM) to generate FW benthic screening levels
- 2007: RSET freshwater group responded to comments by gathering more data for input into the model (greater geographical coverage and more biological endpoints).
- 2011: Ecology published the final FPM report
- 2013: Ecology adopts the freshwater FPM-derived benthic SQS and CSL values in part V of the SMS rule.

Introduction: Benthic standards and the SMS rule:

Cleanup Screening Level
WAC 173-204-560(4)
SCUM II Ch 7
Highest of:

- Risk based criteria *Lowest of:*
  - Benthic Cleanup Screening Level WAC 173-204-562 or -563 SCUM II Ch 8
  - Human Health Risk HQ = 1; 10^{-5} WAC 173-204-561(3) SCUM II Ch 9
  - Ecological Risk Narrative WAC 173-204-564; SCUM II Ch 10
  - ARARs: Federal, State, Local, Tribal WAC 173-204-560(4); SCUM II Ch 17
- PQL WAC 173-204-560(4) SCUM II Ch 12
- Regional Background WAC 173-204-560(4) SCUM II Ch 11

Sediment Cleanup Level
WAC 173-204-560(2)
SCUM II Ch 7:
Adjusted upwards from SCO based on technical possibility & net adverse environmental impacts

Sediment Cleanup Objective
WAC 173-204-560(3)
SCUM II Ch 7
Highest of:

- Risk based criteria *Lowest of:*
  - Benthic Sediment Cleanup Objective WAC 173-204-562 or -563 SCUM II Ch 8
  - Human Health Risk HQ = 1; 10^{-6} WAC 173-204-561(2); SCUM II Ch 9
  - Ecological Risk Narrative WAC 173-204-564; SCUM II Ch 10
  - ARARs: Federal, State, Local, Tribal WAC 173-204-560(4); SCUM II Ch 17
- PQL WAC 173-204-560(3) SCUM II Ch 12
- Natural Background WAC 173-204-560(3) SCUM II Ch 11

Introduction

- Benthic standards and dredging- need to have similar overlays as the rule
- 2013: The RSET Freshwater Technical Working Group intended to propose a multi-tiered approach to address toxicity to other species (fish) and bioaccumulative issues.
  - Use the elutriate test trigger approach (SEF, Chapter 10) to develop water quality-based sediment screening values
  - fish and wildlife-based screening values (including bioaccumulative compounds)
  - background-based screening values (for selected metals).

Problem Statements

- The SMS benthic criteria only account for chemical toxicity to benthic invertebrate communities and may not be protective of sensitive fish species and other organisms.

- The water quality criteria-derived SLs described later in this presentation were developed using typical values for water quality parameters (hardness, pH, and TOC). Procedures for site-specific use of SLs needed to be developed.

- The Pacific Northwest region is known to have naturally elevated metals concentrations in large part due to the volcanic nature of this region. In some cases, sediment background concentrations should be taken into consideration.

APPROACH

- Multiple SLs
  - Benthic SLs
  - Background
  - WQ-based SLs
  - Fish and bioaccumulative SLs still under development
- Tiered testing procedures for exceedances
  - Based on what SL was exceeded
  - Biological testing
  - Elutriate testing
  - Modeling
  - Development of site-specific SL or background (required agency approval)

Benthic FW screening levels

- Benthic screening level development described in in Ecology's publication #11-09-05, "Development of Benthic SQVs for Freshwater Sediments in Washington, Oregon, and Idaho" (Avocet, 2011).
- The development and evaluation of these SLs have been presented in previous SMARMs and will not be covered in this presentation.

Benthic freshwater screening levels

Analyte	ECY BENTHIC SLs	
	SQS/SL1	CSL/SL2
Metals (mg/kg)		
Arsenic	14	120
Cadmium	2.1	5.4
Chromium	72	88
Copper	400	1200
Lead	360	>1300
Mercury	0.66	0.8
Nickel	26	110
Selenium	11	>20
Silver	0.57	1.7
Zinc	3200	>4200

">" values: > "Greater than" value indicates that the toxic level is unknown, but above the concentration shown. If concentrations above this level are encountered, bioassays should be run to evaluate the potential for toxicity.

Benthic freshwater screening levels

Analyte	ECY BENTHIC SLs	
	SQS/SL1	CSL/SL2
Organic contaminants (ug/kg)		
4-Methylphenol	260	2000
Benzoic acid	2900	3800
beta-Hexachlorocyclohexane	7.2	11
bis(2)-Ethylhexyl)phthalate	500	22000
Carbazole	900	1100
Dibenzofuran	200	680
Dibutyltin	910	130000
Dieldrin	4.9	9.3
Di-n-butyl-phthalate	380	1000
Di-n-octyl-phthalate	39	>1100
Endrin ketone	8.5	**
Monobutyltin	540	>4800
Pentachlorophenol	1200	>1200
Phenol	120	210
Tetrabutyltin	97	>97
DDDs	310	860
DDEs	21	33
DDTs*	100	8100
PAHs	17000	30000
PCB Aroclors	110	2500
Tributyltin	47	320
Bulk Petroleum Hydrocarbons (mg/kg) (NW-TPH method)		
TPH-Diesel	340	510
TPH-Residual	3600	4400

Benthic freshwater screening levels

Ammonia and Sulfides, listed below, are used only to inform bioassay testing.

Conventionals (mg/kg)		
Ammonia	230	300
Total sulfides	39	61

- Ammonia and sulfides will not be used to determine suitability of the material for open water disposal or in-water placement.
- Sulfide and ammonia SLs will be used to inform bioassay testing (e.g. special handling to remove ammonia/sulfides prior to bioassays) and water quality monitoring requirements at the dredging site.

Water- Quality Criteria-based SLs

- It was recognized that SLs were needed to protect other species
- In the absence of other SLs, it was proposed to use the "Elutriate Trigger" approach in Chapter 10 of the SEF.
- WQ-based SLs are based on equilibrium partitioning, EPA water quality criteria, and reasonably protective assumptions of WQ parameters
  - pH 7
  - Hardness 18.9 mg/L
  - TOC 1%
  - Total suspended solids 100 mg/L

Water- Quality Criteria-based SLs

Analyte	ECY BENTHIC SLs		WQC-BASED SLs (EPA)	
	SQS/SL1	CSL/SL2	chronic	acute
Metals (mg/kg)				
Arsenic	14	120	1900	3400
Cadmium	2.1	5.4	3.9	20
Chromium	72	88	2380	18330
Copper	400	1200	110	140
Lead	360	>1300	160	4030
Mercury	0.66	0.8	150	280
Nickel	26	110	510	4550
Selenium	11	>20		
Silver	0.57	1.7		15
Zinc	3200	>4200	3630	3600

Water- Quality Criteria-based SLs

Analyte	ECY BENTHIC SLs		WQC-BASED SLs (EPA)	
	SQS/SL1	CSL/SL2	chronic	acute
Organic contaminants (ug/kg)				
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Benzoic acid	2900	3800		
beta-Hexachlorocyclohexane	7.2	11		
bis(2)-Ethylhexyl)phthalate	500	22000		
Carbazole	900	1100		
Dibenzofuran	200	680		
Dibutyltin	910	130000		
Dieldrin	4.9	9.3	90	380
Di-n-butyl-phthalate	380	1000		
Di-n-octyl-phthalate	39	>1100		
Endrin ketone	8.5	**		
Monobutyltin	540	>4800		
Pentachlorophenol	1200	>1200	39	50
Phenol	120	210		
Tetrabutyltin	97	>97		
DDDs	310	860		
DDEs	21	33		
DDTs*	100	8100	7	
PAHs	17000	30000		
PCB Aroclors	110	2500	33	4720
Tributyltin	47	320	18	110

Background Based SLs

- RSET proposed Willamette upstream data for background (LDWG 2012). However, background varies over geographic areas.
- Data from Ecology's publication #09-03-032 ("Baseline characterization of nine proposed freshwater sediment reference sites, 2008") was used to evaluate Washington sediment metals background

Background Based SLs

Metal (lowest risk-based SL in parentheses)	Willamette sed bkg (95th %ile)	WA sed (90/90UTL)
Arsenic (14)	3.8	**17**
Cadmium (2.1)	0.2	0.7
Chromium (72)	32.7	60
Copper (110)	38.0	**146**
Lead (360)	14.3	53
Mercury (0.66)	0.1	0.22
Nickel (26)	26.1	**57**
Selenium (11)	0.4	2
Silver (0.6)	**0.7**	0.19
Zinc (459)	105.0	110

Metals background appears to be higher in Washington compared to that of Willamette.

To determine which metals may need background based SLs, soil and sediment background data was compared to the benthic and WQ-based SLs.

Background Based SLs: Washington Sediment data

- Sediment data for the metals were looked at more closely to determine if they could be used as background.
- Non-normal distribution
- Apparent outliers were present in all but nickel datasets
- In absence of other data, outliers removed and the 90/90 UTL calculated
- Only nickel had background higher than SLs.
- Statistical evaluation indicated that more data is needed for all metals to establish reliable background sediment values.

Background Based SLs

Metal (lowest risk-based SL in parentheses)	Willamette sed bkg (95th %ile)	WA sed (all data) (90/90UTL)	WA sed (outliers removed) (90/90UTL)
Arsenic (14)	3.8	17	6.5
Cadmium (2.1)	0.2	0.7	0.5
Chromium (72)	32.7	60	no outliers
Copper (110)	38.0	146	49
Lead (360)	14.3	53	12
Mercury (0.66)	0.1	0.22	0.14
Nickel (26)	**26.1**	**57**	**no outliers**
Selenium (11)	0.4	2	0.6
Silver (0.6)	0.7	0.19	0.13
Zinc (459)	105.0	110	no outliers

Background Based SLs: Washington Soil data

- Ecology's publication #94-115 (Natural Background Soil Metals Concentrations in Washington State) was evaluated to determine if it could provide an interim SL
- 90th percentile = 38 ppm
- Soil data will be adopted until sufficient sediment data is available to develop statistically supported sediment background.

Background Based SLs

Metal (lowest risk-based SL in parentheses)	Willamette sed bkg (95th %ile)	WA sed (all data) (90/90UTL)	WA sed (outliers removed) (90/90UTL)	WA soil (90th %ile)
Arsenic (14)	3.8	17	6.5	7
Cadmium (2.1)	0.2	0.7	0.5	1
Chromium (72)	32.7	60	no outliers	42
Copper (110)	38.0	146	49	36
Lead (360)	14.3	53	12	17
Mercury (0.66)	0.1	0.22	0.14	0.04
Nickel (26)	**26.1**	**57**	**no outliers**	**38**
Selenium (11)	0.4	2	0.6	na
Silver (0.6)	0.7	0.19	0.13	na
Zinc (459)	105.0	110	no outliers	85

The FW Screening Level Table

Analyte	ECY BENTHIC SLs		WQC-BASED SLs (EPA)		WA-specific metal background
	SQS/SL1	CSL/SL2	chronic	acute	
Metals (mg/kg)					
Arsenic	14	120	1900	3400	
Cadmium	2.1	5.4	3.9	20	
Chromium	72	88	2380	18330	
Copper	400	1200	110	140	
Lead	360	>1300	160	4030	
Mercury	0.66	0.8	150	280	
Nickel	26	110	510	4550	38 (*interim*)
Selenium	11	>20			
Silver	0.57	1.7		15	
Zinc	3200	>4200	3630	3600	

SL is the lowest risk-based value (benthic or WQ-based SL) unless background is higher than risk (nickel)

SL2 or acute WQ-based SL: used primarily for antidegradation evaluations

Using the FW Screening Level Table

- If project sediment data are below all SLs, then the material is suitable for open water disposal or in-water placement and passes antidegradation evaluation.
- If project sediment data exceed one or more screening levels, then the material is considered unsuitable unless further evaluation is conducted.

Using the FW Screening Level Table

- Tiered testing options based on which SL was exceeded
- Benthic SL: Bioassays
  - Details covered in next talk!

Using the FW Screening Level Table

- Tiered testing options based on which SL was exceeded
- Water Quality-based SL
  - Elutriate tests: details of testing may differ depending on informational needs (whether WQ criteria are based on whole water or dissolved phase).
  - Development of site-specific water quality criteria and SLs based on site specific pH, hardness, and/or TOC
    - Spreadsheet available
    - Subject to approval by the agencies
  - Site specific modeling to determine if water quality criteria will be met at the point of compliance

Using the FW Screening Level Table

- Tiered Testing Options

comparison	CoCs	If the SL is exceeded, material is unsuitable for open water disposal/placement* unless the appropriate tiered testing listed below passes	Pass SL
Benthic SL	all compounds	Bioassay testing- must use both species (*Hyalella* and *Chironomus*), at least one chronic exposure, and at least one sub-lethal (growth) endpoint.	If a sample is at or below all SLs, then the material is suitable for dredging/disposal/in-water placement and meets the antidegradation standard. However, when ESA-listed species are present, the Federal action agency may need to contact NMFS and/or USFWS (as appropriate) to discern whether additional analyses are needed, and whether those analyses should be done as part of an ESA consultation.
WQC-based SL	metals, dieldrin, PCP, sum DDT, PCB Aroclors, TBT	WQC-based testing options- elutriate tests show WQC will be met; develop and pass site- specific WQC SL; or model to show standards will be met at the point of compliance.	

Using the FW Screening Level Table

- Antidegradation
  - DMMP 2008 clarification paper
  - Both benthic and WQ-based SLs would be considered

Impact Analysis

- 12 projects between 2009 and 2013
- 43 DMMUs evaluated
- Columbia River, Lake Washington and Lake Union

	All COCs are less than or equal to proposed SLs	One or more detected exceedance of proposed SLs	One or more non-detects exceed proposed SLs
All COCs are less than or equal to 2006 SLs	6	2 (Ni)	12 (5 Ag, 5 PCP, 2 PCB)
One or more detected exceedance of 2006 SLs	0	16	3 (PCP)
One or more non-detects exceeded 2006 SLs	0	1 (2006 Hg, proposed Ni)	3

- Unless there is a reason to believe that PCP may be present at the dredge location, standard analytical method should be used.
- Data must be reported to MDL.
- Only detected exceedances will trigger tiered testing.

Analyte	ECY BENTHIC SLs		WQC-BASED SLs (EPA)		WA-specific metal background
	SQS/SL1	CSL/SL2	chronic	acute	
Organic contaminants (ug/kg)					
4-Methylphenol	260	2000			
Benzoic acid	2900	3800			
eta-Hexachlorocyclohexane	7.2	11			
bis(2)-Ethylhexyl)phthalate	500	22000			
Carbazole	900	1100			
Dibenzofuran	200	680			
Dibutyltin	910	130000			
Dieldrin	4.9	9.3	90	380	
Di-n-butyl-phthalate	380	1000			
Di-n-octyl-phthalate	39	>1100			
Endrin ketone	8.5	**			
Monobutyltin	540	>4800			
Pentachlorophenol	1200	>1200	39	50	
Phenol	120	210			
Tetrabutyltin	97	>97			
DDDs	310	860			
DDEs	21	33			
DDTs*	100	8100	7		
PAHs	17000	30000			
PCB Aroclors	110	2500	33	4720	
Tributyltin	47	320	18	110	
Bulk Petroleum Hydrocarbons (mg/kg) (NW-TPH method)					
TPH-Diesel	340	510			
TPH-Residual	3600	4400			

* Elutriate-based DDT value is based on the sum of sum of o,p'- and p,p'-DDXs

** no SL2 available

QUESTIONS?

Auxiliary slides

Antidegradation

DMMP CLARIFICATION PAPER

QUALITY OF POST-DREDGE SEDIMENT SURFACES (UPDATED)

Prepared by David Fox (U.S. Army Corps of Engineers), Erika Hoffman (U.S. Environmental Protection Agency) and Tom Gries (Washington Department of Ecology) for the Dredged Material Management Program (DMMP) agencies.

Bioaccumulation

- The RSET agencies understand that addressing bioaccumulation for dredging projects will be both a science and a policy issue.

- The RSET agencies will be seeking input regarding the technical approach and basis for guideline development; we understand that there will questions/concerns for implementation, but that for now we want to make sure the science is sound.

- The RSET agencies plan to have a session with technical experts this summer that will peer review work that Jeremy Buck (USFWS) and Jim Meador (NMFSC) have done to assure that we have the best science-based bioaccumulation SLs. It will NOT be a discussion on how values would be implemented, which will follow the technical discussion.