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State of Washington

Final Cost-Benefit and Least Burdensome Alternative Analyses

Chapter 173-204 WAC

Sediment Management Standards

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Final Cost Benefit and Least Burdensome Alternative Analysis

Chapter 173-204 WAC
Sediment Management Standards

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Abbreviations Used in this Document

AT	Averaging Time
BAF	Bioaccumulation Factor
BSAF	Biota Sediment Accumulation Factor
BW	Body Weight
CBA	Cost-Benefit Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CR	Cancer Risk
CSL	Cleanup Screening Level
CTCR	Confederated Tribes of the Colville Reservation
DDT	Dichloro-diphenyltrichloroethane
DMMP	Dredged Material Management Program
DOI	Department of the Interior
ED	Exposure Duration
EF	Exposure Frequency
EIM	Environmental Information Management
EPA	Environmental Protection Agency
FCR	Fish Consumption Rate
FDF	Fish Diet Fraction
HQ	Hazard Quotient
LBA	Least Burdensome Alternative
MTCA	Model Toxics Cleanup Act
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
PCBs	Polychlorinated biphenyls
PLP	Potentially Liable Party
PLPs	Potentially Liable Parties
ppm	parts per million
ppt	parts per thousand
PQL	Practical Quantitation Limit
RCW	Revised Code of Washington
RfDo	Reference Dose
RME	Reasonable Maximum Exposure
RSET	Regional Sediment Evaluation Team
SCO	Sediment Cleanup Objective
SFo	Oral Slope Factor
SF_{OC}	Fraction of Organic Carbon in Sediment
SIZ	Sediment Impact Zone
S_L	Shellfish Lipid Fraction
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
TEQ	Toxic Equivalent
TMDL	Total Maximum Daily Load
TPHs	Total Petroleum Hydrocarbons
UCF	Unit Conversion Factor
UTL	Upper Tolerance Limit
WAC	Washington Administrative Code

Executive Summary

This report reviews the economic analyses performed by the Washington State Department of Ecology (Ecology) to estimate the expected benefits and costs of the adopted amendments to the Sediment Management Standards (SMS rule; Chapter 173-204 WAC). The amendments establish standards and procedures that incorporate risks to human health, background, and freshwater benthic standards in sediment cleanup that were narrative under the baseline and used the Model Toxics Control Act (MTCA) rule for compliance requirements.

The Washington Administrative Procedure Act (RCW 34.05.328) requires Ecology to evaluate significant legislative rules to "[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the law being implemented."

How is the rule beneficial overall?

- Cleanup timing and background concentrations (3.2): The adopted rule will establish achievable short-term cleanup goals, and over time eliminate hot spots in excess of the sediment cleanup objective, which is likely at or below background concentrations. Then (likely beyond the typical 20-year scope of Ecology analyses) future sediment quality will reach the sediment cleanup objective, and closer to more protectively stringent human health-based cleanup levels. **Overall, the adopted rule results in more protective concentrations of contaminants being achieved sooner.**
- Property value and exchange benefits (3.3): By bringing cleanup properties to less contaminated levels sooner, Ecology expects the adopted rule to **increase property values sooner**, and **reduce transaction costs of property buying and selling**, including time cost and lost productivity in industry, as well as prospective redevelopment of property for residential and commercial use.

What happens to the number of sites?

- Number of sites under only SMS benthic criteria (3.4.1): While it is not the baseline, Ecology acknowledges public concern regarding the difference between sites identified under the historic benthic criteria-only interpretation of the SMS rule, and the adopted rule amendments. Ecology modeled sites in Puget Sound identified under benthic criteria only, as 3 dioxin sites and 26 mercury sites. These chemicals were used because they are likely driving chemicals for cleanup. Data for statewide modeling was not available, but Ecology assumed all 70 existing sites in the middle of the cleanup process could encounter the altered costs and cost-savings below.
- Number of sites under the actual baseline that includes the SMS benthic criteria and human health risk (3.4.2): To illustrate and estimate the number of sites under the actual baseline which uses both the benthic criteria and the narrative human health risk (interpreted using the MTCA rule provisions on human health, natural background, and practical quantitation limits) as factors in setting the cleanup standard, Ecology modeled sites in Puget Sound identified under these combined standards. Ecology identified 23

dioxin and 60 mercury sites in this modeling. Data for statewide modeling was not available.

- Change in number of sites (3.4.3): Ecology modeled sites in Puget Sound identified under the adopted rule amendments, as 16 dioxin and 41 mercury sites. Data for statewide modeling was not available. Compared to the number of sites identified under the baseline (bullet above), this modeling indicates a **reduction of 30 – 32 percent in the number of sites**. If scaled to statewide sediment cleanup sites, this would be a reduction of 45 – 48 sites statewide. (Model results also indicated an **86 – 90 percent reduction in total site acreage.**)

<u>What is the cost impact to a site?</u>

- Site characterization (3.5.1):
  - Ecology estimated a prospective **cost-savings of $148 thousand to $840 thousand per site**.
  - Ecology also identified a **possible cost to Potentially Liable Parties (PLPs) or Ecology of $200 thousand to $250 thousand to be the first to establish regional background concentrations** for an embayment or equivalent region. This cost would not be incurred by most PLPs, and could be avoided entirely by defaulting to natural background at Puget Sound sites.
- Cleanup: Ecology modeled, to the extent possible, the impact of the adopted rule amendments on the costs of cleanup at different sites. Overall, Ecology expects a **cost-savings of $0 to $2.4 million at a typical sediment cleanup** of wide variety.
  - Sediment cleanup at a representative embayment site (3.5.2): Ecology identified a potential cost savings of $0 to $2.4 million in cleanup.
  - Sediment cleanup at a freshwater sediment site for benthic community protection (3.5.3): Ecology identified a potential cost savings of $2 thousand to $60 thousand in analytic costs.
  - Soil and ground water cleanup on an upland site (3.5.4): Ecology does not expect the costs of upland cleanup to be impacted by the adopted rule amendments.
  - Cleanup at a freshwater site (3.5.5): While sufficient data and sampling was not available for Ecology to perform a separate modeling for cleanup at a freshwater site, Ecology expects the marine example above (with an estimated cost-savings of up to $2.4 million) to be illustrative of the impacts of the adopted rule amendments on a freshwater site. Ecology does not expect numeric freshwater criteria to significantly affect the process or outcomes of freshwater site identification.
- Analytical costs for compliance (3.5.6): Ecology estimated the total cost for all cleanup sites in Puget Sound over a 20-year period monitoring for compliance as $1.2 million to $2.3 million higher under the adopted rule. If this modeling is scalable to statewide cleanup monitoring, this translates to **$1.6 million to $3 million total increased statewide over 20 years**.

- Dredged material for marine sediment (3.5.7): Ecology estimated the total cost as **$373 thousand higher for all projects over 20 years** under the adopted rule.
- Source control (3.5.8): Ecology estimated the total cost for all cleanup sites in Puget Sound over 20 years as $482 thousand to $2.9 million higher for National Pollutant Discharge Elimination System (NPDES) dischargers that are PLPs under the adopted rule amendments. If this is scalable statewide, this represents an **increased cost of $629 thousand to $3.8 million statewide over 20 years**. Ecology does not anticipate significant new permitting requirements for NPDES dischargers that are not identified as PLPs.

CHAPTER 1: Background and Introduction

1.1 Introduction

This report reviews the economic analyses performed by the Washington State Department of Ecology (Ecology) to estimate the incremental expected benefits and costs of the adopted amendments to the Sediment Management Standards (SMS rule; Chapter 173-204 WAC).

The Washington Administrative Procedure Act (RCW 34.05.328) requires Ecology to evaluate significant legislative rules to "[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the law being implemented."

Ecology's analysis is based on the best available information at the time of this analysis.

1.2 Summary of the adopted rule amendments

The adopted rule amendments:

- The adopted rule amendments apply to Part V "Sediment Cleanup Standards" as cleanup standards under the authority of RCW 70.105D and are not considered water quality standards.
- Allow for establishment of cleanup standards for sediment sites that are protective of human health and the environment. This includes:
    - Establishing a two tier framework incorporating human health, background, and benthic criteria, a cleanup screening level and sediment cleanup objective.
    - Establishing the sediment cleanup level at the sediment cleanup objective, which then may be adjusted upward based on certain criteria but may not exceed the cleanup screening level;
    - Determining the sediment cleanup objective based on the highest of: risk-based levels; natural background; or practical quantitation limit.
    - Determining the cleanup screening level based on the highest of risk-based levels; regional background; or practical quantitation limit.
- Incorporate background concentrations of contaminants – both "regional" and Model Toxics Control Act (MTCA) natural background. Allows for Ecology to establish regional background level(s) for contaminants.
- Clarify how Ecology can establish a sediment cleanup unit – a subdivision of a sediment site for the purpose of expediting cleanup.
- Clarify information to be included in the remedial investigation/feasibility study for a sediment site.

- Use the cleanup screening level and the sediment cleanup objective to identify and assess the hazard of sites.
- Establish how risk-based levels will be set: based on protection of human health; based on protection of benthic toxicity; based on protection of higher tropic level species; or based on other applicable state or federal laws.
    - Describe how setting a risk-based level based on protection of human health will include an exposure parameter using a site specific fish consumption rate.
    - Detail how to set a risk-based level based on protection of the benthic community in freshwater sediments.
    - Detail how to set a risk-based level based on protection of higher tropic level species.
- Clarify requirements for selection of cleanup actions for sediment sites.
- Clarify requirements governing establishment and monitoring of sediment recovery zones.

1.3 Reasons for the adopted rule amendments

The adopted rule amendments are necessary to:

- Allow for greater coordination of the sediment and upland portion of sites by harmonizing the SMS rule and the MTCA rule provisions where appropriate.
- Reduce the risk to human health and the environment by incentivizing cleaning up of high-risk contaminated areas (sediment cleanup units).
- Establish cleanup level(s) for sites which will be achievable and protective of human health and the environment. This includes taking into account anthropogenic background contaminant concentrations (both natural and regional).
- Establish a clear path for making cleanup decisions using risk-based levels based on protection of human health, protection of benthic toxicity, and protection of higher trophic level species.
- Deal with inconsistent decision making and costly site characterization and investigation at freshwater sediment sites by providing for use of chemical and biological standards in setting a risk-based level based on protection of the benthic community.

By establishing a clear path for management of sediment cleanup sites, from identification to the cleanup action decision, the adopted rule amendments will encourage quicker and more effective cleanup actions, reducing human and environmental exposure to contaminants.

1.4 Document organization

Ecology organized this document into the following chapters:

- **Baseline and adopted rule amendments** (Chapter 2): In-depth description and comparison of the baseline requirements in state rules to the adopted rule amendments.
- **Likely costs and benefits of adopted rule amendments** (Chapter 3): Analysis of the types and size of costs and benefits Ecology expects impacted entities to incur. Costs include site-characterization costs and background contaminant exposure. Benefits include reduced cleanup costs and monitoring, and expedited cleanup leading to long-term reductions in regional and natural background contaminant levels.
- **Cost-benefit comparison and conclusions** (Chapter 4): Discussion of the complete implications of the Cost-Benefit Analysis. Comments on the results.
- **Least burdensome alternative analysis** (Chapter 5): Analysis of considered alternatives to the final rule.

CHAPTER 2: Baseline and Adopted Rule Amendments

2.1 Introduction

In this chapter, Ecology describes the baseline to which the adopted rule amendments are compared. The baseline is the regulatory context in the absence of the amendments being adopted.

In this chapter, Ecology also describes the adopted rule amendments, addresses complexities in the scope of analysis, and indicates which cost and benefit analyses are discussed in Chapter 3 of this document.

2.2 Baseline

In most cases, the regulatory baseline is the existing rule. If there is no existing rule, the federal or local rule is the baseline. Sometimes there is no baseline because there is no regulation at any level of government, and yet other times, the baseline is for changes to other regulations (e.g., federal regulation is expected to be enacted before or just after the adopted rule; or a regulatory program would otherwise change or expire in the absence of the adopted rule).

The baseline is complex for the adopted SMS rule because there are multiple factors involved. Those factors are:

- Existing SMS rule (Chapter 173-204 WAC).
- The state law authorizing the SMS rule (Chapter 70.105D RCW, the Model Toxics Control Act). The state law requires the minimum cleanup standards for remedial actions to be at least as stringent as the cleanup standards under section 121 of the federal cleanup law, 42 U.S.C. Sec. 9621, and at least as stringent as all applicable state and federal laws.
- Existing Model Toxics Control Act (MTCA) rule (Chapter 173-340 WAC).

2.3 Analytic scope

Ecology typically analyzes the impact of adopted rules over a 20-year timeframe, using a 1.58 discount rate where appropriate and possible.[1] This means, where possible, Ecology typically presents quantifiable costs and benefits in present values. For this adopted rule, Ecology could not confidently determine the number of future sediment cleanup sites (most identified sites are due to historic contamination and are likely already identified), and so chose instead to compare costs and benefits on a per-site and regional basis. If benefits likely

[1] 1.58 is the historical average of real (inflation-adjusted), risk-free rates of return on US Treasury I Bonds at the time of analysis.

exceed costs at each of the representative sites or regions, then the same holds regardless of how many sites there are in future.

2.4 Analyzed changes

Under the adopted rule amendments, Part V includes a cleanup decision framework to address bioaccumulative chemicals which present risks to human health and the environment. The adopted framework includes methods and policies for establishing risk-based cleanup standards, procedures for incorporating background concentrations, and requirements for sediment cleanup actions. Depending on site-specific characteristics, these adopted rule amendments may result in changes to site identification, characterization, cleanup levels, cleanup actions, and monitoring activities. Those impacts at a site, in turn, may result in the costs and benefits presented in Chapter 3. As part of the cost benefit analysis, Ecology qualitatively or quantitatively analyzed the impacts of the following changes to the SMS rule:

2.4.1 Site characterization

The adopted rule revisions include updated requirements for site characterization, investigations, and evaluations. Under both the baseline and adopted rule amendments, the site is defined by the area where a hazardous substance came to be located. The sediment cleanup level, combined with the point of compliance, typically defines the area or volume of sediment at a site or sediment cleanup unit that must be addressed by the cleanup action. The area of the site, or sediment cleanup unit, which requires remedial action because it is above the cleanup level, may be impacted by the adopted rule amendments.

2.4.2 Background concentrations

Under the adopted rule amendments, Ecology will establish a natural background and regional background for a geographic area that applies to sites within that area. These values are used within the context of the two tier framework to set the sediment cleanup level for the site.

2.4.3 Site identification

The adopted rule revisions include revised criteria for identifying cleanup sites where three sample stations that are spatially and chemically similar exceed the upper tier value, the cleanup screening level (CSL).[2]

[2] WAC 173-204-560(4) and WAC 173-204-510(2) and WAC 173-204-520(3)

2.4.4 Cleanup level and cleanup actions

Under both the baseline and adopted rule amendments, sediment cleanup actions conducted must comply with sediment cleanup standards which take into account human health protection. Under the adopted rule amendments, a sediment cleanup level is the concentration or level of biological effects for a contaminant in sediment that is determined by Ecology to be protective of human health and the environment.

The sediment cleanup level is established in accordance with the requirements in WAC 173-204-560(2). The sediment cleanup level is initially set at the sediment cleanup objective (SCO) and is only adjusted upward (less conservative) as required, based on what is technically possible and whether meeting the cleanup level will have a net adverse impact on the aquatic environment. A sediment cleanup level may not be adjusted upward above the cleanup screening level (CSL).

2.4.5 Risk-based levels protective of human health

The adopted rule amendments clarify that risk-based levels protective of human health must be based on a reasonable maximum exposure (RME) scenario, specifically taking into account tribal exposure. In addition, both the baseline and adopted rule amendments require that calculation of risk-based levels protective of human health take into account a site-specific fish consumption rate.

2.4.6 Monitoring for cleanup sites

It may be assumed that under the adopted rule amendments, the added clarity and requirements for assessing risk to human health and the environment will require PLPs to use more sensitive analytical techniques to more accurately detect contaminants at very low levels, or detect specific types of chemicals.

2.4.7 Dredged material management

Ecology describes the impact the additional requirements of the adopted rule amendments may have on dredged material management, using dioxin as a case study.

2.4.8 Freshwater benthic standards

The adopted rule amendments establish numeric benthic criteria to support cleanup decisions at freshwater sediment sites. Under the adopted rule amendments, the narrative standard in Part V of the rule for freshwater sediments is replaced with numeric chemical and biological benthic criteria for freshwater sediment cleanup to protect the benthic community. Ecology analyzed the impacts of the following adopted sediment cleanup requirements:

- Sediment cleanup sites are identified if three or more contiguous stations have chemical concentrations or biological effects that exceed the CSL.

- Remedial investigations must characterize the nature and extent of releases including areas that exceed the chemical concentrations and biological effect levels corresponding to the SCO and CSL.
- Sediment cleanup levels must initially be established at the SCO, and may be adjusted upward provided certain criteria are met, but cannot be adjusted higher than CSL levels.
- Sediment cleanup actions conducted at freshwater sediment sites must comply with sediment cleanup standards for protection of human health and the environment (including the benthic community and higher trophic levels).

2.4.9 Source control

Part IV of the current SMS rule establishes sediment source control requirements. WAC 173-204-410(1)(c) states that "…[t]he department shall implement the standards of WAC 173-204-420 so as to prevent the creation of new contaminated sediment cleanup sites identified under WAC 173-204-520." The adopted rule amendments make no changes to Part IV of the SMS. However, the adopted rule amendments do make a policy statement regarding source control in Part V.

However, Ecology expects that as site cleanups progress under the adopted rule amendments, source control will become a priority and focus for the agency. Because the adopted rule amendments are likely to lead to the agency placing an emphasis on source control activities, a review of potential impacts was completed.

2.4.10 Upland cleanup sites

Under the Model Toxics Control Act (MTCA) Cleanup Regulation, cleanup levels for soil and ground water at upland sites must be established at concentrations that prevent violations of cleanup levels for other media, such as surface water and sediments. For example:

- WAC 173-340-720(c) states that "…[g]round water cleanup levels shall be established at concentrations that do not directly or indirectly cause violations of surface water, sediments, soil or air cleanup standards established under this chapter or applicable state and federal laws…"
- WAC 173-340-740(d) states that "…[s]oil cleanup levels shall be established at concentrations that do not directly or indirectly cause violations of ground water, surface water, sediment, or air cleanup standards established under this chapter or applicable state and federal laws…"

Ecology analyzed the impacts of sediment cleanup requirements on soil and ground water cleanup standards that are established to prevent exceedances of sediment cleanup standards based on human health protection.

2.4.11 Summary figures

Figure 1, below, illustrates the structure of the adopted rule amendments for establishing sediment cleanup standards. The adopted rule amendments include elements of both parts of the baseline – the existing SMS rule and MTCA rule.

Figure 2, below, illustrates the likely impacts of the adopted rule amendments. Under the baseline, sediment chemical concentrations are likely to decrease slowly over a long timeframe. Under the adopted rule, sediment concentrations are likely to decrease more quickly, under clearer and more achievable broad cleanup objectives, and then further fall gradually over the long run. The site-specific cleanup standard may be located anywhere in between (and inclusive of) the sediment cleanup objective and cleanup screening level.

Figure 1: Adopted two tiered rule framework for establishing sediment cleanup standards that incorporates human health risks and background concentrations of contaminants

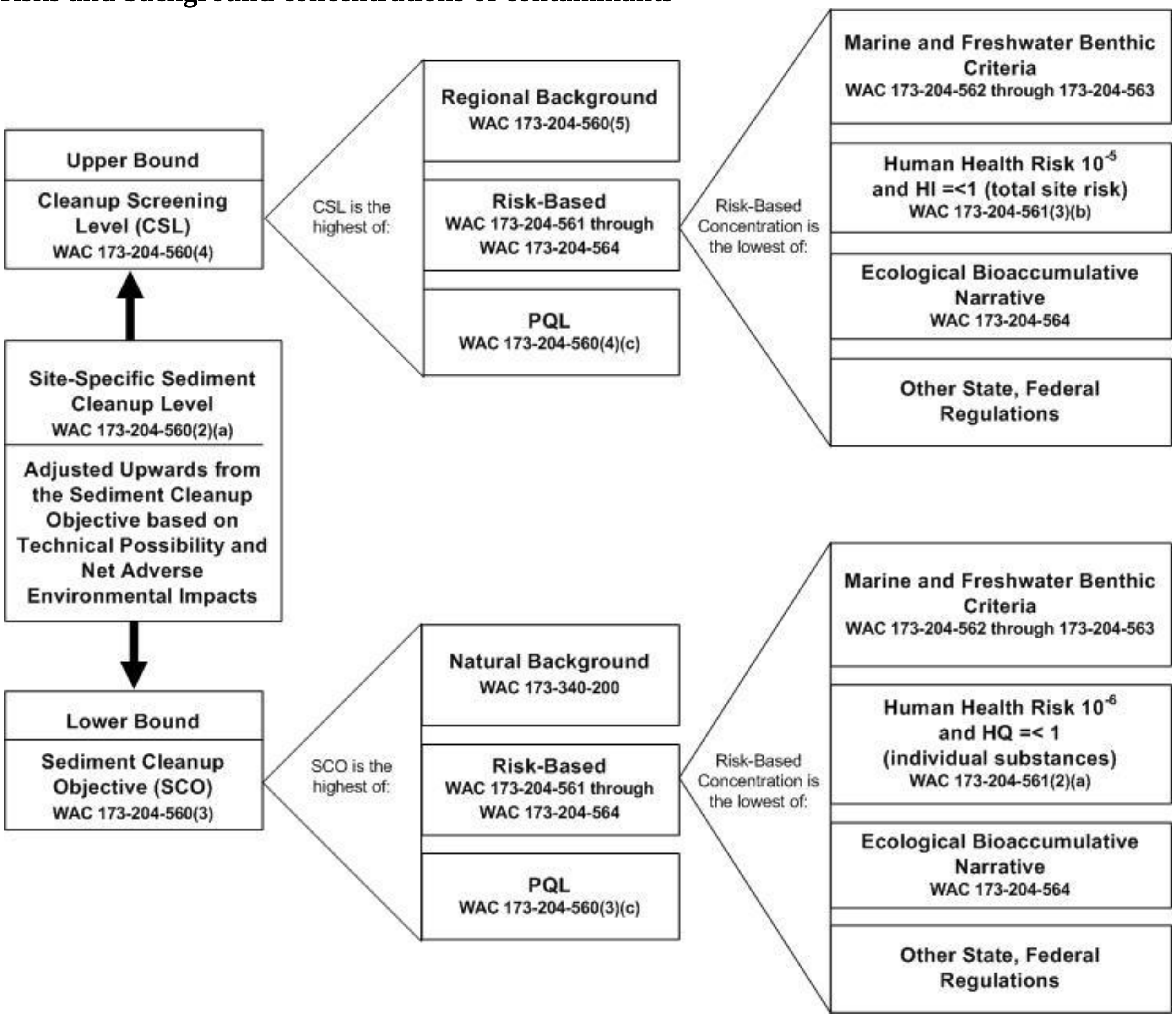
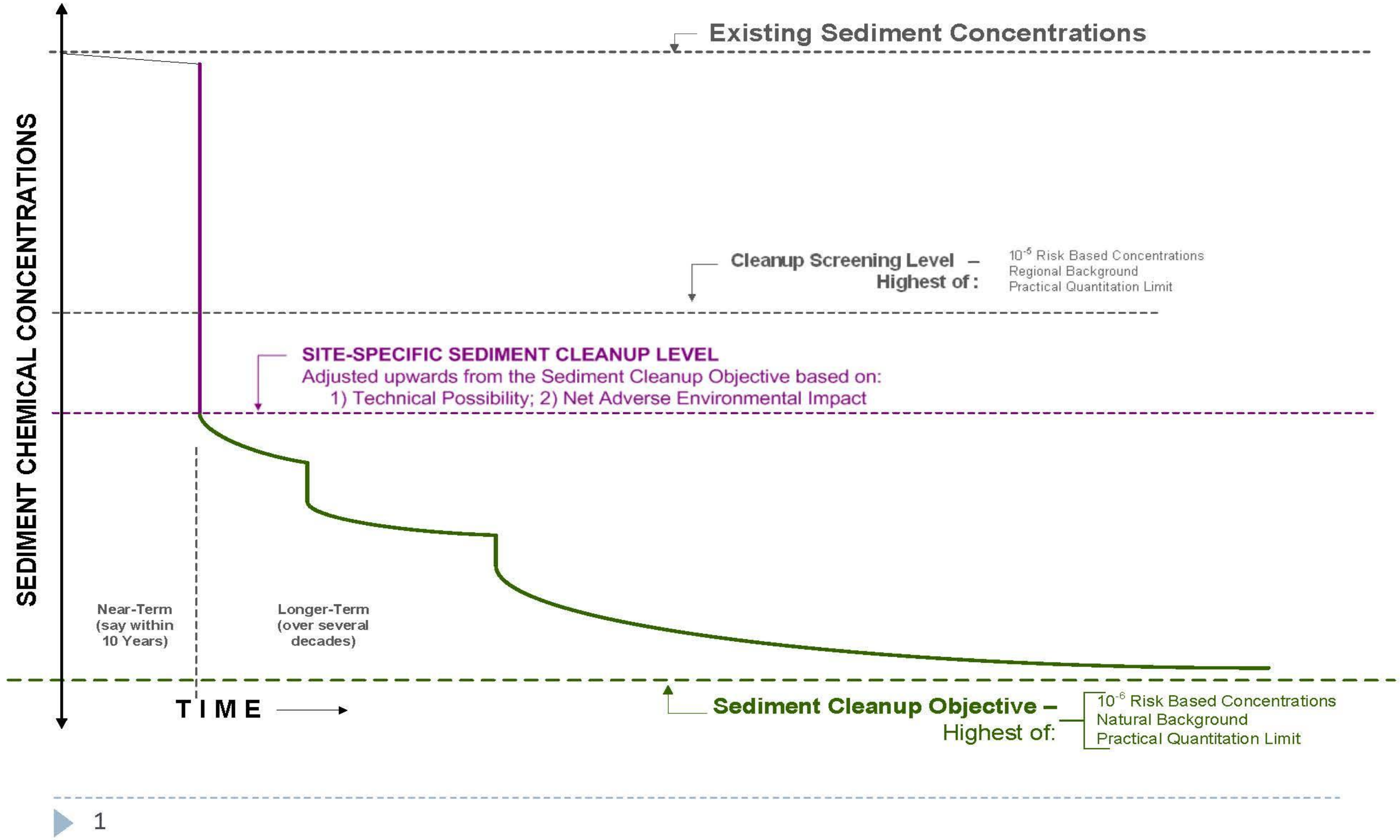


Figure 2: Sediment Contaminant Concentrations over Time under the Baseline and Adopted Rule

Baseline: Sediment chemical concentrations likely to decrease very gradually over time, but not to the sediment cleanup objective of the low risk-based concentration. Adopted rule amendments: Sediment chemical concentrations are reduced much sooner in the near term, to below achievable regional backgrounds by active cleanup. This will result in reduction of risk and natural resource restoration occurring sooner. Then sediment chemical concentrations gradually decrease closer to low risk-based concentrations over the long term by continued cleanup and large scale source reduction and source control strategies.



CHAPTER 3: Likely Costs and Benefits of Adopted Rule Amendments

3.1 Introduction

Ecology estimated the expected costs associated with the adopted amendments to the SMS rule, as described in section 2.2 of this document. The baseline is the regulatory circumstances and most likely application in the absence of the adopted rule amendments. The costs and benefits analyzed here are associated with the broad impacts of the adopted amendments, as they impact cleanup standards, site identification, site characterization, cleanup actions, and monitoring requirements.

Due to the levels of sediment contamination statewide, and the uncertainty in estimating discovery of new sediment cleanup sites (most identified sites are due to historic contamination and are likely already identified), Ecology could not confidently quantify the number of future sites to be regulated by either the previous or adopted SMS rule. Instead of estimating costs and benefits state wide, Ecology estimated the costs and benefits of the adopted rule amendments to different representative sites and geographies, including:

<u>How is the rule beneficial overall?</u>

- Cleanup timing and background concentrations (3.2)
- Property value and exchange benefits (3.3)

<u>What happens to the number of sites?</u>

- Number of sites under only benthic criteria (3.4.1)
- Number of sites under benthic criteria and human health criteria (3.4.2)
- Change in number of sites (3.4.3)

<u>What is the cost impact to a site?</u>

- Site characterization (3.5.1)
- Sediment cleanup at a representative embayment site (3.5.2)
- Sediment cleanup at a freshwater sediment site for benthic community protection (3.5.3)
- Soil and ground water cleanup on an upland site (3.5.4)
- Cleanup at a freshwater site (3.5.5)
- Analytical costs for compliance (3.5.6)
- Dredged material for marine sediment (3.5.7)
- Source control (3.5.8)

For representative calculations, Ecology chose appropriate chemicals of concern that commonly drive human-health based sediment cleanups: mercury, dioxin, and polycyclic aromatic hydrocarbons (cPAHs).

To the extent possible, Ecology quantified these impacts, and has otherwise described them qualitatively to include in overall assessment of the costs and benefit of the adopted rule amendments.

3.2 Cleanup timing and background concentrations

Ecology expects the adopted rule to result in more efficient determination of cleanup standards, though in the short term the cleanup level is likely to be based on background concentrations (CSL = regional background and SCO = natural background) because risk based levels are typically more conservative than background (background levels are higher than risk-based levels; i.e., more cleanup would be required to get to risk-based levels). Under the baseline, site identification and cleanup processes are likely insufficient to reduce the broad level of contamination in all sediments in Washington State. This is due to the high potential of recontamination from ubiquitous bioaccumulative contaminants (dioxin and mercury for example) and continuing inputs from upland sources such as stormwater (controllable and uncontrollable) and atmospheric deposition, potential infeasibility of meeting a lower cleanup level, greater cost of actively remediating large areas contaminated above the lower cleanup level, and the increased negotiation time before conducting the cleanup.

However, under the adopted rule amendments, Ecology expects to achieve more protective levels by first expediting the process to clean up sediments contaminated above the sediment cleanup objective (likely these will be based on background), and then allowing source control and natural recovery (under long-term monitoring) to reduce sediment concentrations to the sediment cleanup objective and more protective risk-based concentrations (under a very long term timeframe).

The medium-term and long-term expectations for the effects of the adopted rule amendments extend beyond the 20-year timeframe Ecology uses to analyze adopted rules. Therefore, for this analysis, Ecology only considered the short-term impacts of reducing sediment contamination to background levels.

Under the adopted rule amendments, some cleanup actions for sediment sites may not require active remedial actions to reduce contaminants to the level that would be required under the baseline (because the baseline results in a cleanup level of natural background, while the adopted rule amendments result in a cleanup level potentially as high as regional background). This could result in potentially higher risks for human health and the environment under the adopted rule amendments as compared to the baseline. However, there are a number of mitigating factors to any potential additional risk posed:

- Cleanup actions: As illustrated in the Puget Sound-wide and embayment-specific analysis, a change in the cleanup level does not necessarily result in a change to all active remedial actions as the remedy is also based on cost and technical feasibility.

- Sediment movement: Contaminated sediments are continuously covered by new sediments due to natural sediment deposition, resulting in reduced risk of humans or animals being exposed to them.
- Contamination distribution: Higher levels of contamination tend to be near shore, where the risk is greater to both human health and the environment, subtidal areas that pose less exposure and risk are closer to regional or natural background levels. A change in cleanup levels may affect the remedy away from the near shore in terms of longer term monitoring, but will not adversely affect how human health and the environment are protected in high exposure areas because those areas (in the form of sediment cleanup units) will still require an active remedial action. Under the adopted rule, this active remediation may occur sooner.
- The sooner active remediation of the nearshore environment is conducted, the sooner natural resource restoration can occur. This includes reducing contaminant loading to the productive nearshore environment and restoration of shellfish and eelgrass beds, and other critical aquatic life habitat.

Ecology could not confidently quantify any health or environmental risk resulting from the shift between the baseline and adopted rule amendments. For human health, this is because of uncertainty and site-specificity in all of the inputs to risk calculations. Ecology used highly conservative assumptions in the embayment-specific analyses to calculate risk-based concentrations (to prospectively estimate an upper bound to costs if human-health drove the cleanups under either baseline or the adopted rule amendments). Used in reverse, however, the human health risk calculations would not accurately estimate health risk, and would not have a systematic bias allowing predictability in over- or under-estimation.

3.3 Property value benefits

By reducing the time to remediation of sediment sites – reducing concentrations in sediments sooner – the adopted rule amendments will likely make remediated properties (and adjacent or nearby real estate) able to be bought and sold both sooner and at better prices. This likely impact of the adopted rule amendments potentially benefits PLPs, nearby property owners, neighborhood development or redevelopment, and ultimately jobs and the tax base.

Remediated properties (as well as those suffering from contagion of nearby low property values caused by contamination) are likely to sell for higher prices, and allow for redevelopment, or replacement with other industry compliant with modern environmental and health regulations. In the interim, they are also likely to burden current owners and operators for a shorter time. For just those acreages identified in Puget Sound as complying with cleanup under the adopted rule amendments (nearly 2,000 acres along valuable coastlines), this could mean selling for millions of dollars sooner.

3.4 What happens to the number of sites?

For an overall view of the impact of the adopted rule amendments on the number of sediment cleanup-related sites, Ecology estimated the impact to the total identified sites. In this estimation, Ecology considered both the historic interpretation of the SMS rule (using only benthic criteria to define sites) and the more recent (approximately five-year) interpretation (using both the benthic criteria and the MTCA rule to meet human health protectiveness as factors in setting the cleanup standard as required by the SMS rule).

3.4.1 Number of sites under only benthic criteria

There are currently 172 sediment cleanup sites identified statewide, of which 115 are in Puget Sound. Approximately 160 of these were identified under historic interpretation of the SMS rule, using only benthic criteria, while sites identified in approximately the last five years used both benthic criteria and MTCA human health protectiveness requirements as factors in setting the cleanup standard.

Ecology does not expect all of these sites to be impacted. This is because the adopted rule allows cleanup sites that have a final cleanup action plan to continue cleanup under their established requirements. Of these 172 sites, approximately 140 are in the cleanup process. For example, they have not been issued a No Further Action letter or are not in the monitoring stage. Of these 140 sites, approximately 50% percent of these sites (or approximately 70 sites) have their cleanup requirements change under the adopted rule amendments. The degree to which this will occur depends on site-specific criteria and progress, but Ecology, for the purposes of this analysis, has assumed all 70 sites would encounter altered requirements under the adopted rule.

While it was not possible (given data and sampling limitations) to estimate the number of sites that would exist statewide just under the benthic criteria, Ecology was able to model a subset of sites, located in Puget Sound. Using likely contaminants dioxin and mercury, Ecology identified 3 and 26 sites, respectively for these contaminants, that exceeded the SMS benthic screening levels. Table 1 shows the site numbers and associated acreages.[3] Ecology expects site identification under just benthic criteria to function similarly on a statewide basis.

Ecology notes, however, that based on current legal interpretation (and recent application) of the SMS rule, this does not represent the baseline for this analysis. While the number of sites that would exist under just the benthic criteria of the SMS is lower than under other criteria (see below), it is not representative of how sites would be identified in the future (and in the last five years) under the existing SMS rule.

[3] The sites were identified by chemical concentrations at or above the SMS cleanup screening level and the boundaries of the site were defined by chemical concentrations above the SMS sediment quality standard. Appendix B further details this modeling.

Ecology acknowledges public concern during the public comment process, that proposed cleanup standards were more stringent than the benthic criteria. Ecology agrees that this is the case, but notes that the benthic criteria alone are not the baseline for this analysis. Rather, the baseline for comparison is the cleanup standard (including the cleanup screening level and sediment quality standard) set using existing interpretation and practice of the MTCA rule provisions on human health to achieve the narrative human health protectiveness required by the SMS rule. Section 3.4.2 further illustrates this baseline.

3.4.2 Number of sites under benthic criteria and human health risk

There are currently approximately 7 sediment cleanup and related sites identified under the modern interpretation of the SMS rule – setting the cleanup standard (including the cleanup screening level and sediment quality standard) using the MTCA rule provisions on human health to achieve the human health protectiveness required by the narrative SMS rule. Ecology expects that, under the baseline, future sediment sites would be identified using this interpretation of the SMS rule.

While it was not possible (given data and sampling limitations) to estimate the exact number of sites that would exist statewide under the recent (at least five-year) interpretation of the SMS rule, Ecology was able to model a subset of sites, located in Puget Sound. Using likely contaminants dioxin and mercury, Ecology identified 23 and 60 sites, respectively for these contaminants, that exceeded the applicable CSL (which is equivalent to the SCO when incorporating human health risk, PQL, and natural background). Table 1 shows the site numbers and associated acreages.[4] These sites were identified as having dioxin and mercury contamination in excess of natural background, which was used as the cleanup level because it was higher than human health risk and PQL. Ecology expects site identification under just benthic criteria to function similarly on a statewide basis. This is the baseline for this analysis.

3.4.3 Change in number of sites

Ecology was not able to model site identification under the adopted rule on a statewide basis, because of data and sampling limitations. Ecology was, however, able to model a subset of sites, located in Puget Sound. Using likely contaminants dioxin and mercury, Ecology identified 16 and 41 sites, respectively for these contaminants, that exceeded the applicable concentrations in the adopted rule. Table 1 shows the site numbers and associated acreages.[5] Because the adopted rule allows

[4] The sites were identified and bounded by chemical concentrations at or above MTCA natural background cleanup standard. For this analysis, the practical quantitation limit was not used as this determination is site specific. Appendix B further details this modeling.
[5] The sites were identified by clusters at or above SMS regional background cleanup standard. For this analysis, the practical quantitation limit was not used as this determination is site specific. The boundaries of the clusters

Ecology to set cleanup levels for a site up to the cleanup screening level (e.g., regional background) (if certain criteria are met), these sites were identified as having dioxin and mercury contamination in excess of regional background. Ecology expects site identification to function similarly on a statewide basis.

Compared to the number of sites identified under the (risk-based) baseline (see section 3.4.2), Ecology's modeling indicates a reduction of 30 – 32 percent in the number of sites (and an associated reduction of 86 – 90 percent in site acreage). Assuming this result is scalable from Puget Sound to statewide, this would conservatively mean a reduction of 45 to 48 sediment cleanup sites statewide.

Ecology believes it has, at the time of publication, identified all sites with historic sediment contamination. New sites in future are likely to be identified based on new chemicals identified as hazardous to health, as well as bioaccumulative contaminants. These sites are expected to be similar in their locations to historic contamination, due to locations of human populations, industry, and zoning. These sites are not, however, likely to experience different standards or requirements than under the baseline.

Table 1: Modeling the number of sites

Scenario	Dioxin		Mercury	
	Number of Sites	Site Acreage	Number of Sites	Site Acreage
Using Only Benthic Criteria CSLs (Historic Practice)	3	74	26	3,637
Using Benthic CSL and Human Health Risk (Baseline)	23	16,167	60	20,592
Adopted Rule	16	1,749	41	2,874

3.5 What is the cost impact to a site?

Ecology analyzed the costs of the adopted rule amendments to various types of site and circumstances. These include:

- Site characterization (3.5.1)
- Sediment cleanup at a representative embayment site (3.5.2)
- Sediment cleanup at a freshwater sediment site for benthic community protection (3.5.3)
- Soil and ground water cleanup on an upland site (3.5.4)
- cleanup at a freshwater site (3.5.5)
- Analytical costs for compliance (3.5.6)
- Dredged material for marine sediment (3.5.7)

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were defined by chemical concentrations above SMS regional background or concentrations above MTCA natural background. Appendix B further details this modeling.

- Source control (3.5.8)

3.5.1 Site characterization

Ecology estimated the costs associated with characterizing a sediment cleanup site, using the typical example site from the embayment-specific analyses. This analysis was conducted based on real data from a Puget Sound embayment.

3.5.1.1 Site characterization under the baseline

Under the baseline, the level of effort and costs for an initial investigation would be similar to the adopted rule because the initial identification of the “site” is defined by the SCO. Under the baseline, the SCO is also the standard which is used to identify the site as requiring further investigation and cleanup. A potentially liable persons (PLPs) obligation at a site would not be completed until the SCO was met. Hence, the SCO would influence the level of effort and cost for further site characterization. To estimate further site characterization costs, Ecology estimated that an approximately 4,200 acre site (bounded by the SCO) would have similar site characterization costs to a one or two time monitoring event required during long-term monitoring of a remediated site.

Costs were determined based on sampling costs, and did not necessarily include the additional costs of report writing and negotiations with PLPs. Ecology conservatively assumed 125 total samples would be necessary for the first sampling event to characterize a site. Of those 125 samples, approximately 115 would be shallow “surface grabs”, and the remaining ten would be deeper cores. The deeper cores would be necessary because of a lower baseline cleanup standard. Next, approximately 30 samples would need to be taken to fill gaps in the initial sampling data. Ecology estimated the total cost of baseline characterization based on $1,600 for surface samples, and $4,200 for deeper core samples. Based on public comment for samples that require additional equipment and personnel deployment, Ecology also used a high-end cost per sample of $12 thousand.

The total baseline cost would be approximately $274 thousand to $1.5 million to characterize a representative site. Ecology does not consider the high end of this range to be likely, as PLPs could perform all sampling in one deployment and save considerable expenditure.

3.5.1.2 Site characterization under the adopted rule amendments

Under the adopted rule, the initial identification of the “site” is defined by the SCO, similar to the baseline rule. However, under the adopted rule, the CSL is the upper bound of when a site requires further investigation and cleanup. For this analysis, the cleanup level was assumed to be at the CSL and would be used to bound the size of a site that requires remediation, rather than the SCO as required in the baseline rule. Therefore sites boundaries may be smaller under the adopted rule (For example, from 4,200 acres to 1,200 acres if the cleanup level was established at the CSL under the adopted rule).

After the initial investigation, which is assumed to have similar level of effort and costs as the baseline, further site characterization would be conducted. To achieve this, Ecology estimated an approximately 1,200 acre site would have similar site characterization costs to a one or two time monitoring event required for long term compliance monitoring. Ecology conservatively assumed 55 total samples would be necessary for the first sampling event. Of those 55 samples, approximately 45 would be shallow "surface grabs", and the remaining ten would be deeper core samples. Because the cleanup level under the adopted rule amendments would not be as stringent as under the baseline, however, these cores would not need to be as deep as those under the baseline. Next, approximately 14 samples would need to be taken to fill gaps in the initial sampling data.

Ecology estimated the total cost of this site characterization under the adopted rule amendments, based on $1,600 for surface samples, and $3,200 for deeper (but more shallow than under the baseline) core samples. Based on public comment for samples that require additional equipment and personnel deployment, Ecology also used a high-end cost per sample of $12 thousand. The total adopted rule amendment cost would be approximately $126 – 660 thousand. Ecology does not consider the high end of this range to be likely, as PLPs could perform all sampling in one deployment and save considerable expenditure.

<u>Identifying Regional Background</u>
Additionally, Ecology or some PLPs might incur the costs of establishing regional background concentrations in some areas. Ecology estimated this could cost $200 – 250 thousand per region. This cost would only be incurred by the first PLP(s) in a region to establish regional background concentrations, and could then be used in other area cleanups within the region.

3.5.1.3 Site characterization difference in cost

Based on total costs for site characterization of a representative site with contaminated sediments and posing a risk to human health, Ecology calculated reduced site characterization costs of approximately $148 – 840 thousand under the adopted rule, for a typical site. Specific sites will likely have higher or lower cost savings than the typical site. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings.

<u>Identifying Regional Background</u>
Additionally, Ecology or some PLPs might incur the costs of establishing regional background concentrations in some areas. Ecology estimated this could cost $200 – 250 thousand per region. This cost would only be incurred by the first PLP(s) in

a region to establish regional background concentrations, and could then be used in other area cleanups within the region (saving other PLPs the costs of identifying regional background). Additionally, the adopted rule allows for default to natural background concentrations if regional background cannot be established, which would save this characterization cost for the Puget Sound (where natural background is established), but not for the rest of the state.

3.5.2 Sediment cleanup at a representative embayment site

Ecology analyzed the impact of the adopted rule amendments on costs associated with cleanup in an example embayment, using data from a real embayment containing multiple points of contamination. This analysis illustrates likely cost impacts on a collection of PLPs cleaning up an embayment.

Ecology also analyzed the impacts on cleanup levels at other types of representative embayments. These examples, while without associated dollar-value impacts, further illustrate possible variations on the scenario underlying the initial embayment cost example.

3.5.2.1 Embayment cost analysis

As a case study to determine impacts of different cleanup levels under the baseline and adopted rules, Ecology chose a real area for site-specific analysis, a marine urban embayment.

Under the baseline, the cleanup level is set as close as practicable to the SQS, based on technical feasibility, cost and net environmental protection. However, because a PLPs obligation at a site is not completed until the SQS is met, for purposes of this analysis the baseline cleanup is established at the SQS. The SQS is the highest of: the risk/effects-based criteria, PQL, or natural background. Using the highest of those factors, for purposes of this analysis the SQS/cleanup level is set at natural background.

Under the adopted rule amendments, the cleanup level is initially set at the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the cleanup level is set at the CSL to determine the maximum potential difference between the baseline and adopted rule amendments. The CSL is the highest of: the risk/effects based criteria, PQL, or regional background. Using the highest of those factors, for purposes of this analysis, the CSL/cleanup level is set at regional background.

Described below are how, for purposes of this analysis, Ecology determined background, PQL and risk/effects based criteria as those factors are used in setting the cleanup level for the baseline and adopted rule amendments.

Background concentrations

Baseline: Under the baseline,

- Natural background: Ecology used data from the EIM database, for Ecology-approved reference areas, BOLD sampling stations, and other stations that were determined to be similarly influenced by anthropogenic sources as the reference areas. Ecology calculated the 95^{th} upper confidence limit on the mean of the data for each chemical, as the MTCA natural background value:
    - 0.10 ppm for mercury.
    - 2.0 ppt TEQ for dioxin.

Adopted rule amendments: Ecology determined that it would be inappropriate to calculate a regional background for mercury using sampling data from the embayment because, at this specific embayment, mercury comes from specific, identified sources. In this case, regional background defaulted to natural background using the above approach. Ecology determined that it was feasible to calculate a regional background for dioxin due to the influence of numerous nonpoint sources to the bay that were distinguishable from specific releases using best professional judgment. Ecology calculated regional background for dioxin based on a statistical analysis of existing data in the EIM database, and spatial contouring to determine dioxin regional background:

- Ecology delineated the area believed to be regional background, and then excluded samples from areas near known point sources and areas suspected to be of a different population (e.g., cleanup sites). After removing trends from the data, Ecology then determined the extent of auto-correlation in samples from the background area.
- Ecology then generated upper-bound estimates (i.e., 90/90 UTL) from the regional background area determined earlier. Ecology achieved this by rendering the existing data set independent by selecting a subset of samples that are further than the auto-correlated distance apart from one another. The data set did not show evidence of significant auto-correlation among samples, so the complete data set was used to calculate the 90/90 UTL.

    Ecology determined the following values for regional background to conduct the following embayment specific analysis:

    - 0.10 ppm for mercury.
    - 14.6 ppt TEQ for dioxin.

PQL concentrations

Baseline: Ecology used the PQL for mercury and dioxin based on a review of recently surveyed laboratory reported values. Ecology removed outliers and calculated median values:

- 2.0×10^{-2} ppm for mercury.
- 5 ppt TEQ for dioxin.

Adopted rule amendments: Ecology determined the PQLs for mercury and dioxin by reviewing a recent survey of laboratory-reported values. Ecology removed the highest and lowest values, and calculated the medians:

- 2.0×10^{-2} ppm for mercury.
- 5 ppt TEQ for dioxin.

Risk based concentrations

Under both the baseline and adopted rule amendments, Ecology determined the risk based criteria for both human health and benthic risk:

Baseline:

- The human health SCO criteria at a risk level of 10^{-6}/HQ =1 is:
  - 0.016 ppm for mercury
  - 9.21 E -03 for dioxin
- The benthic CSL criteria is:
  - 0.59 ppm for mercury
  - 200 ppt for dioxin

Adopted rule amendments:

- The human health CSL criteria at a risk level is 10^{-5}/HQ = 1 is:
  - 0.016 ppm for mercury
  - 9.21 E -02 for dioxin

- The human health SCO criteria at a risk level of 10^{-6}/HQ =1 is:
  - 0.016 ppm for mercury
  - 9.21 E -03 for dioxin
- The benthic CSL criteria is:
  - 0.59 ppm for mercury
  - 200 ppt for dioxin

Table 2: Dioxin and mercury cleanup standards for a representative urban marine embayment site

	Dioxin (ppt TEQ)	Dioxin Cleanup Standard Baseline Rule	Dioxin Cleanup Standard Adopted Rule	Mercury (ppm)[6]	Mercury Cleanup Standard Baseline Rule	Mercury Cleanup Standard Adopted Rule
Baseline Rule 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Adopted Rule Amendments 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Adopted Rule Amendments 10-5 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-02			0.016		
Baseline Rule Natural Background / PQL	2.0 / 5.0	2.0 / 5.0		0.104 / 2.0 E -02	0.104	
Adopted Rule Amendments SCO Natural Background / PQL	2.0 / 5.0			0.104 / 2.0 E -02		
Adopted Rule Amendments CSL Regional Background / PQL	14.6		14.6	0.104 / 2.0 E -02		0.104

As seen in Table 2, under the baseline rule the cleanup standard would be based on natural background. The PQL for dioxin is higher than natural background. However, since PQLs can be lower than this average value, the default was made to natural background. While under the adopted rule amendments the cleanup standard would be based on regional background. In effect, the cleanup standard for mercury would be the same under the baseline rule and under the adopted rule amendments, while the cleanup standard for dioxin increases (becomes less stringent) under the adopted rule amendments. If dioxin was the chemical driving cleanup at this site, remediation activity would stay the same or decrease, while if mercury was the driving chemical, remedial action would not change.

<u>Remedy determination</u>

Ecology used baseline and adopted rule amendment cleanup acreages from the embayment specific analyses to determine remedial actions required for cleanup, estimate the total costs of these remedies, and calculate the difference

[6] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment.

due to the adopted rule amendments. Remedies selected include a mix of technologies

- Dredging
- Capping
- Long-term monitoring

The baseline allows an analysis to be conducted to select a remedy based on cost, technical feasibility, and environmental protection. The adopted rule amendments differ on some specifics in determining the remedial action, however, the basic approach is similar. Ecology determined that the area for active cleanup (involving dredging) would not significantly change between the baseline and adopted rule amendments cleanup acreages. However, monitoring behavior and capping were likely to change due to the size of the sites. Table 3 summarizes the likely remediation behavior under the baseline and adopted rule amendments, and the associated costs.

Costs for dredging included nearshore and offshore excavation, dewatering, re-handling, upland staging for disposal transport, environmental controls, transport, and disposal at an upland landfill. Costs for thin-layer capping included cap material purchase, transport, material placement, and environmental controls. Costs for monitoring included operation and mobilization of monitoring vessels, sampling, analysis, quality assurance and control, and report writing.

Table 3: Embayment-specific remediation costs under baseline and adopted rule amendments

	Baseline (Based on Natural Background as SCO	**Adopted Rule (Based on Regional Background as CSL)**
Acreage of site	4,200	1,200
Volume dredged ($yard^3$)	48,399	48,399
Dredge cost ($\$/yard^3$)	120.2	120.2
Area Capped (acres)	25	20
Cap cost /($yard^3$)	41	41
Monitoring Years	50	30
# Samples per Monitoring Event	90	40
Monitoring Events	15	7
Total Cost (millions of $)	**$11.3**	**$8.9 (to $11.3*)**

*Ecology estimated a potential savings of $2.4 million for a representative embayment. The cost savings for another real embayment could potentially be zero, but could also be larger than this. It would be zero in the case that site-specific attributes of a site drive the cleanup level down to the same level as under the baseline (e.g., in cases with limited regional concentrations).

<u>Conclusions and key assumptions</u>

<u>Site identification and investigation</u>

- The adopted revisions to the sediment cleanup objective are similar to the MTCA human health policies that are currently applicable to sediment cleanup actions. Consequently, the Ecology does not anticipate that the adopted rule amendments will significantly increase or decrease the average size of sites initially identified. However, the size of the site required to be further investigated and remediated may decrease under the adopted rule amendments.
- The size of individual sites may increase or decrease depending on site location and the contaminants of concern.
- Unit costs (costs/acre) will not be significantly different than the baseline costs.
- PLPs may elect to investigate and remediate cleanup units located within larger cleanup sites. Cleanup units may be defined by regional background levels. This may occur more frequently under the adopted rule revisions (see discussion below).
- The adopted rule amendments provide the flexibility to establish cleanup standards that exceed the sediment cleanup objective. Site-specific cleanup levels can be establish at levels equal to the SCO, CSL (regional background), or a value in between these levels. The cleanup standards define areas for further investigation and remediation, but do not change the size of the site (as defined by the SCO).
- Ecology anticipates that the adopted rule revisions will increase the number of situations where PLPs will seek to resolve their MTCA obligations for cleanup units within a larger site.
- The baseline rule provides the flexibility for PLPs to implement this type of approach.
- Clarifying human health protection methods and policies will increase the potential utility of this approach.
- Regulatory uncertainty will limit use of this provision until a few agreements are successfully completed.
- Further site characterization and active remediation costs will be lower than baseline costs.
- Long term monitoring costs may decrease.

- Cleanup costs will be incurred sooner as active cleanup at a site or site unit are expected to occur quicker than under the baseline rule.
- Due to the high variability in the sediment environment, this site specific example may not be representative of areas across the state.
- For many contaminants of concern, sediment cleanup levels are currently based on natural background concentrations.
- Under the baseline, a PLPs' obligation at a site is not fulfilled until the SQS has been met.
- Use of regional background concentrations to establish sediment cleanup standards will be limited by the adopted revisions that eliminate cost as a consideration when setting cleanup standards. PLPs may incur costs to perform additional sampling to define regional background.

Sediment Recovery Zones

- Ecology has not established any sediment recovery zones since 1991.
- Clarification of human health protection may increase need for sediment recovery zones. However, rule revisions will decrease the number of situations where sediment recovery zones must be established.
- Current rules (MTCA and SMS) require periodic reviews and monitoring to be performed when levels remain above the cleanup standards defined by current MTCA health risk policies.

3.5.2.2 Fish consumption rates

The fish consumption rate is a key exposure parameter used to calculate risk-based concentrations protective of human health. The MTCA rule has a default of 54 grams per day based on a recreational use scenario, but the MTCA rule allows for upwards adjustments of the default fish consumption rate based on the reasonable maximum exposure (RME) scenario (for example, a tribal use scenario).

The adopted rule amendments are consistent with the current MTCA RME requirements which include developing a site specific fish consumption rate based on tribal fish consumption. In addition, both the MTCA rule and the adopted rule amendments allow for site specific adjustments of other exposure parameters such as fish diet fraction (portion of fish consumed coming from a site). To illustrate the effect of differing exposure parameters such as the fish consumption rate and fish diet fraction, Ecology used the following analysis to identify the different risk-based concentrations calculated using these exposure parameter values actually used, or proposed to be used, at three real sites:

- An urban marine embayment.
- A rural marine embayment

- An urban estuarine shoreline[7]

These case studies are representative of the different types of environments found in Washington State. Each site has sufficient data of a quality suitable for assessing human health risk, and they are actual sediment cleanup sites where human health risk has been (or is currently being) addressed.

For the purpose of this analysis, Ecology made considerable effort to employ the same values used to calculate risk-based concentrations at the sites – including some actual exposure parameters (fish consumption rate, body weight, and fish diet fraction) used, or proposed to be used, at the sites – and using site data to calculate the baseline and adopted rule amendment impacts.

Although Ecology used site-specific input parameters, the same equations were used to calculate baseline risk-based concentrations for all case studies, and for the adopted rule amendments, to provide an accurate comparison. That means Ecology used actual data from existing sediment cleanup sites, but used a standardized approach to calculate risk-based concentrations. As a result, the risk-based concentrations calculated for this analysis will differ from those used at specific sites. This is because to date no standardized approach has existed, and cleanups have occurred with risk assessment methods that vary significantly across sites, and specific exposure parameters such as the biota sediment accumulation factors can vary greatly.

For each chemical at each site, Ecology calculated a risk-based concentration that is protective of human health, using the following equations. (Variables are defined in Table 4.)

- Risk Based Concentration (cPAH/dioxin) =

  (CR x BW x AT x UCF x S_{foc}) / (SF_o x FCR x FDF x EF x ED x SL x BSAF)

- Risk Based Concentration (arsenic) =

  (CR x BW x AT x UCF) / (SF_o x FCR x FDF x EF x ED x BAF)

- Risk Based Concentration (mercury) =
  (HQ x BW x AT x UCF x RfDo) / (FCR x FDF x EF x ED x BAF)

Table 4: Exposure parameter inputs for risk-based cleanup levels, by location and chemical

Exposure Parameter	Abbreviation	Urban Shoreline	Urban Embayment	Rural Embayment
Fish consumption rate (g/day)	FCR	97.5	173	499
Fish diet fraction	FDF	1	1	1

[7] Ecology also attempted to include a freshwater representative site, but data at the few freshwater sites with human-health impacts were insufficient to perform this analysis.

Body Weight (kg)	BW	81.8	81.8	79	
Exposure Duration (years)	ED	70	70	70	
Exposure Frequency (days/year)	EF	365	365	365	
Unit Conversion Factor (ug/kg)	UCF	1000	1000	1000	
Averaging Time (days)	AT	25,550	25,550	25,550	
Shellfish lipid fraction	S_L	1.3	1.3	1.3	
Fraction of organic carbon in sediment	SF_{oc}	3.0	3.0	3.0	
Cancer Risk / Hazard Quotient	CR / HQ	10 -6 / 10 -5	10 -6 / 10 -5 / HQ 1	10 -6 / 10 -5	
		Arsenic	**Dioxin**	**cPAH**	**Mercury**
Reference Dose (mg/kg-day)	RfDo	N/A	N/A	N/A	0.0003
Oral Slope Factor (kg-day/mg)	SFo	1.5	150000	7.3	N/A
		Arsenic Fish	**Dioxin Clams/Crab**	**cPAH Clams/ Fish**	**Mercury[8] Crab Muscle[9]**
Biota Sediment Accumulation Factor / Bioaccumulation Factor	BSAF/BAF	0.53	0.13 / 0.79	0.11 / 0.07	9.03

Conclusions and key assumptions.

- Under a range of fish consumption rates, risk based concentrations protective of human health at a 10^{-5} risk level fall below natural and regional background levels for many bioaccumulative chemicals.
- Ecology anticipates that the adopted rule revisions may impact cleanup standards based on non-cancer health risks.
- Ecology does not anticipate this will significantly change the type and scope of sediment cleanup actions relative to the current rule requirements.
- The vast majority of sediment cleanup sites are located in Usual and Accustomed areas for one or more tribes.
- Ecology will continue to establish sediment cleanup levels based on a tribal exposure scenario at most sites under the baseline and adopted rules

[8] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment.

[9] The BSAF mercury value was for 100% consumption of muscle and viscera. This did not include the hepatopancreas which would lower the BSAF value.

since this represents the reasonable maximum exposure scenario under the current MTCA rule and law.

- For many bioaccumulative chemicals, sediment cleanup standards are currently based on natural background concentrations.
- Risk assessments are based on very conservative assumptions, and risk assessments for bioaccumulative chemicals in the sediment environment are surrounded by high uncertainty and variability. This is because the transfer of bioaccumulative contaminants from sediment to tissue and subsequently to humans is highly variable and dependent on a number of site specific factors. Extrapolating results from a risk calculations across the state may not be feasible.

3.5.3 Sediment cleanup at a freshwater sediment site for benthic community protection

The existing SMS rule lacks freshwater chemical or biological standards for protection of the benthic community. Instead, the rule has a narrative standard for freshwater sediments.

3.5.3.1 Freshwater sediment cleanup sites

There are many contaminated freshwater sediment sites in Washington State under Ecology or Environmental Protection Agency (EPA) oversight. Due to the lack of adopted freshwater sediment standards in the existing SMS rule, the narrative standard requires a site-specific evaluation to establish cleanup standards. This creates inconsistency in how sediment sites are identified and cleaned up. In addition, the lack of freshwater sediment standards limits how the EPA uses the existing SMS rule at federal sediment cleanup sites in the state.

Ecology is adopting numeric chemical and biological criteria for freshwater sediment to protect the benthic community in the adopted rule amendments. In order to understand the differences between the baseline and adopted SMS rule, Ecology conducted an analysis that focuses on the cost difference to identify and characterize a freshwater cleanup site based on benthic community protection. This was based on the following assumptions.

- Baseline: Since the current SMS rule does not have adopted numeric criteria for benthic community protection, the process to characterize or identify a cleanup site is more comprehensive. It must include analyzing both chemistry and bioassays at all sampling stations.
- Adopted rule amendments: Numeric chemical and biological criteria for benthic community protection will likely allow a site to be initially characterized by analyzing chemistry, and then analyzing for bioassays for

only samples that exceed the chemical criteria. The rule requires specific types of sites to default to bioassays, so the costs for these types of sites would be similar to the baseline rule.

Ecology used the chemical and biological data that were included in the development of the freshwater sediment chemical and biological criteria. This included 34 surveys, with as few as two samples, and as many as 233 samples each. Ecology divided these data into three groups, based on the number of samples in a survey, since there are different bioassay laboratory costs for different batch sizes. (Typically labs have different pricing for batches of less than ten, 10 – 20, and over 20 samples.)

Table 5: Pricing and sample size for bioassay and chemistry samples at freshwater sites

# of Samples (Grouping)	Chemistry cost per sample	Bioassay cost per sample	Average number of samples	Average percent of samples with chemistry exceedances
< 10	$1,600	$2,350	4.1	76
≥ 10 < 20	$1,600	$2,120	15.8	65
≥ 20	$1,600	$1,990	59.5	49

For each sample size necessary for freshwater site characterization, Ecology used the values in Table 5 to calculate total costs associated with characterization. Ecology calculated all costs at the average sample size. Under the baseline, all samples would need analysis for chemistry and bioassays. Under the adopted rule amendments, only those samples with chemistry exceedances require bioassay analysis.

Table 6: Total freshwater sediment cleanup site characterization costs by sample size

# of Samples (Grouping)	Cost to analyze chemistry for all samples	Cost to analyze bioassays for all samples	Cost to analyze bioassays for samples with chemistry exceedances	Baseline Rule Total Costs	Adopted Rule Total Costs
< 10	$6,560	$9,635	$7,323	**$16,195**	**$13,883**
≥ 10 < 20	$25,280	$33,496	$21,772	**$58,776**	**$47,052**
≥ 20	$95,200	$118,405	$58,018	**$213,605**	**$153,218**

For the different sample sizes, cost savings range between $2 thousand and $60 thousand less per site under the adopted rule amendments.

3.5.3.2 Conclusions and key assumptions

- Under the baseline, all sites would be required to analyze for both chemistry and bioassays to comply with the SMS narrative standard.
- Monitoring costs may decrease under the adopted rule amendments due to the need to conduct fewer bioassays.

3.5.3.3 Dredged material management for freshwater

For the baseline, the 2006 Sediment Evaluation Framework approved by DMMP/RSET (an update from the 2003 Interim SQVs) was used. Samples are screened using chemistry, and exceedances are followed up with bioassays. For compounds with marine standards that did not have freshwater standards, the dredge programs used the marine standards. For the adopted rule amendments Ecology used the numeric chemical and biological criteria.

Analytical Requirements

The adopted rule amendments include criteria for more chemicals than under the baseline. Specifically, total petroleum hydrocarbons (TPHs) and the butyltin group of chemicals would be added to the list of chemicals that must be analyzed. Because analyzing the butyltin group is a new requirement, the analytical costs are anticipated to increase. The cost for analyzing PAHs is anticipated to decrease because TPHs will be analyzed versus individual PAHs.

Exceedances

Table 7 includes an analysis of how the baseline and adopted rule amendments compare in terms of exceedances of the criteria, at the sediment quality standard. For this analysis, the baseline is defined as the values in the Sediment Evaluation Framework (RSET, 2006). Three common contaminants found in dredge material were evaluated which includes mercury, DDT, and PCBs. This analysis does not conclude which dredge projects would have failed or passed, but provides a general understanding of the relative criteria exceedances for a select number of commonly found contaminants. Analysis of dredge material includes using the chemical criteria as a screen. If the dredge material fails the chemical criteria, then bioassays are required to verify toxicity. For purposes of this narrative, it is assumed that a higher percent of failed chemical exceedances would result in higher monitoring costs because of the additional expense of analyzing bioassays.

Table 7: Comparison of exceedances of the sediment quality standard

	Baseline Rule	Adopted Rule Amendments
Mercury SQS Criteria (mg/kg)	0.28	0.66
PCBs SQS Criteria (ug/kg)	60	110
DDT SQS Criteria (ug/kg)	N/A – no criteria	100
Mercury: Percent of SQS Exceedances	19%	10%
PCBs: Percent of SQS Exceedances	53%	40%
DDT: Percent of SQS Exceedances	N/A – no criteria	5%

Key assumptions

- The chemicals used in this analysis are representative of all chemicals required to be analyzed.

Conclusions

- Monitoring costs for freshwater dredge material are not expected to significantly change under the adopted rule.
- The percent of sediment standard exceedances is not expected to significantly change under the adopted rule.
- Promulgating freshwater benthic criteria will facilitate more consistent and effective decision making for dredged material management under the adopted rule.

3.5.4 Soil and ground water cleanup on an upland site

- Ecology does not anticipate that the adopted SMS rule revisions will significantly impact requirements for soil and ground water cleanup standards at MTCA sites that are adjacent to a river, lake, stream or bay.
- The adopted rule revisions provide the flexibility to establish site-specific cleanup standards for some chemicals that are higher than the maximum allowable level under current regulation.
- Sediment cleanup standards are established on a site-specific basis. The site-specific standards are based on a RME scenario, EPA toxicity values, MTCA risk policies and consideration of natural background concentrations/analytical limits.
- Under the adopted rule, the sediment cleanup objective requirements are as stated previously. (baseline).
- Under the adopted rule revisions, the CSL requirements are similar to the Method C provisions in the current MTCA rule. However, the CSL may be higher than allowed under the baseline rule because regional background levels may exceed risk-based concentrations and analytical limits. In these situations, the site-specific sediment cleanup level might be higher than allowed under the baseline rule.
- Soil and ground water cleanup standards must be established at concentrations that prevent exceedances of sediment cleanup standards based on protecting human health, surface water, and sediment benthic communities. At a significant number of upland sites, surface water standards under MTCA will be protective of sediment.

3.5.5 Cleanup at a freshwater site

Due to limitations in data and sampling, Ecology was not able to confidently complete a modeling of cleanup costs at a freshwater site. Ecology assumed the preceding embayment examples are as representative as possible of the impacts of the adopted rule amendments on cleanup at a freshwater site. As a result, Ecology expects a cost-savings at freshwater sites, because the CSL is likely to be set at regional background concentrations. Ecology estimated the costs of establishing those regional background concentrations above, in section 3.5.1.

Ecology acknowledges additional concern in public comment, relating to the establishment of numeric freshwater criteria, versus narrative. Ecology expects, in practice, this change will have no impact, as a site manager may require use of biological criteria on a site-specific basis. Under both the baseline (risk-based) and the adopted rule amendments, bioassays are required if a chemical exceedance occurs, and that bioassay determines site identification. Ultimately, the process and outcomes would not be significantly different under the baseline and proposed rule.

For example, at a site with unusual contaminants, such as butyltins, exceedances of the chemical benthic criteria would require bioassay testing to confirm the exceedance and identification as a cleanup site. If the butyltins were contributing to toxicity, below or above the chemical cleanup screening level, the bioassay would confirm identification as a cleanup site. This framework will not change under the adopted rule.

3.5.6 Analytical costs for compliance

Table 8 shows general analytical costs for a cleanup site to conduct compliance monitoring that may be associated with the adopted rule amendments. Due to the added clarity and requirements for assessing risk to human health and the environment under the adopted rule amendments, it is assumed that PLPs will be required to use more sensitive analytical techniques to more accurately detect contaminants at very low levels, or detect specific types of chemicals. For purposes of this cost benefit analysis, the cost of analyzing PCB congener versus Total Aroclors was compared. The following assumptions were made to conduct this analysis:

- According to the 2008, Sediment Cleanup Status Report (Ecology 2008), there are 115 sediment cleanup sites in Puget Sound. Due to the ubiquitous nature of both dioxin and PCBs found in Puget Sound sediment, and for purposes of this cost benefit analysis, it is assumed that 75% of these cleanup sites, for a total of 86, have both dioxin and PCB contamination. Freshwater sites were not included for this analysis due to the variety of contaminants found at these sites that may not include both dioxin and PCBs.
- The new analytical costs will apply to existing sites for compliance evaluation and long term monitoring.

- In order to have a consistent number of sites for comparison between the adopted rule amendments and baseline rule, the existing number of cleanup sites in Puget Sound was used.
- An analytical cost of $900 per sample per contaminant for dioxin and PCB congeners.
- Sites under the baseline rule were not required to test for PCB congeners.
- An average of 5 -10 samples per cleanup to evaluate compliance at a remediated site, every 5 years, for a 20 year monitoring period.
- If dioxin is a chemical of concern, PCBs are a chemical of concern, and vice versa.
- PLPs are responsible for the chemicals of concern identified for the sediment cleanup.

Table 8: Analytical costs associated with sampling sediment to evaluate compliance.

*PCB congener analysis @$900/sample; # PCB Total Aroclor analysis @$200/sample

	Baseline Rule	**Adopted Rule Amendments**
Number of cleanup sites required to test for dioxin and PCBs	86	86
Dioxin analytical costs per cleanup site per compliance sampling event	$4,500 – $9,000	$4,500 – $9,000
PCB analytical costs per cleanup site per compliance sampling event	$1,000# - $2,000#	$4,500* - $9,000*
Total dioxin and PCB congener analytical costs for all cleanup sites per each monitoring event	$473,000 – $946,000	$774,000 – $1,584,000
Total cost for all cleanup sites in Puget Sound over a 20 year compliance monitoring time period	**$1,892,000 – 3,784,000**	**$3,096,000 – 6,192,000**

Ecology conservatively assumed all costs are incurred immediately.

Conclusions and uncertainties

- The cost for compliance monitoring under the adopted rule will increase.
- Compliance monitoring methods are still evolving. Approaches such as area-weighted averaging and/or fish tissue monitoring may limit remediation costs relative to the point-by-point compliance strategy used for cleanup standards based on ecological protection.

- PLPs have the option of performing tissue testing and/or bioaccumulation testing to screen chemicals of concern which may decrease analytical costs for sediment chemistry.
- Site characterization and compliance monitoring costs for the adopted rule do not include emerging bioaccumulative contaminants that may be added to the list of chemicals of concern at sediment cleanup sites.

3.5.7 Dredged material for marine sediment

Across the state, harbor areas, ports, and marinas naturally deposit silt from upstream sediment and upland soil draining to both marine and freshwater bodies. Because of this sediment deposition process, routine maintenance dredging is needed on a regular basis to remove the mud and sand that builds up and causes safety problems for navigation. This dredging helps keep navigation and commerce viable. This material is managed by the Dredged Material Management Program (DMMP) and consist of the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency (EPA), Ecology, and WA Department of Natural Resources. The DMMP provides the structure and system to manage publicly approved, environmentally protective open-water disposal sites in Puget Sound, Grays Harbor, and Willapa Bay.

The DMMP considers many factors to determine when evaluating dredging projects:

- Historical uses and existing sediment chemistry data in the area.
- Nearness to existing federal and state cleanup sites.
- Make up of materials at the site.
- How much and where material is adopted to be disposed.

The disposal alternatives approved by DMMP based on the above criteria include:

- Open-water at an approved site.
- Transferred to land for fill projects.
- Used for beneficial shoreline uses.
- An approved landfill.

Additionally, the DMMP evaluates antidegradation when there is potential for elevated chemical concentrations in the surface exposed by dredging.

The DMMP is a subgroup of the larger Regional Sediment Evaluation Team. In 2006 the RSET adopted interim guidance for freshwater sediments based on the 2003 freshwater guidance (Ecology 2003). In 2010, the DMMP revised the framework for assessing dioxins in dredged material in the Puget Sound region.

3.5.7.1 Dredged material management dioxin and PCB case study

Ecology analyzed the potential cost impacts of the rule revisions on dredged material disposal from cleanup sites and navigational dredge projects. For comparison purposes of this cost benefit analysis the baseline and adopted rules are as follows:

For the baseline rule, the requirements for dredged material disposal sites includes the SMS requirements in WAC 173-204-400, 173-204-410, and 173-204–420. The requirements for disposal are established using best available dredged material guidance and applicable federal and state rules. This guidance includes the Puget Sound dredged disposal analysis (PSDDA) requirements and the Users' Manual for Dredged Material Management (DMMP guidance), as amended. In addition, the sediment quality goal for the disposal site is the Sediment Cleanup Objective and the disposal site must not exceed the Cleanup Screening Level.

The DMMP guidance was developed to be consistent with the SMS and MTCA requirements and established the sediment quality goal for the disposal site at the Sediment Cleanup Objective but does not have an established Cleanup Screening Level. While the SMS rule allows establishment of a Sediment Impact Zone (SIZ) for dredge disposal sites for the benthic criteria chemicals, it does not specifically allow one for bioaccumulative chemicals. Therefore, a SIZ for dioxins is not allowed under the baseline rule. Specifically, the DMMP guidance defined the Sediment Cleanup Objective as follows:

- For dispersive sites: Dioxin concentrations could not exceed a maximum concentration of 4 ppt TEQ in any single dredge material management unit from the dredged area.
- For non-dispersive sites: The volume weighted average concentration of dioxin in material from each dredging project could not exceed 4 ppt TEQ, and could not exceed a maximum of 10 ppt TEQ for any dredged material management unit.

For the adopted rule amendments, the Sediment Cleanup Objective would be the same as the baseline above and the sediment quality goal for the disposal site. However, the disposal site would have a defined Cleanup Screening Level, which is a maximum chemical or biological effect concentration allowed at the disposal site under an authorized SIZ. Because the adopted rule amendments have an established Cleanup Screening Level, the rule allows an authorized SIZ. For the purposes of this cost benefit analysis, the Cleanup Screening Level for dioxin has been established consistent with a Puget Sound wide Regional Background concentration of 11 ppt TEQ for PCB.

Because the agency has not made a decision to authorize SIZs for disposal sites, the Cleanup Screening Level is used as a maximum allowed chemical concentration for the sampled dredged sediment at non dispersive sites, rather than the maximum allowed chemical concentration for the disposal site as follows:

- For dispersive sites: Dioxin concentrations could not exceed a maximum concentration of 4 ppt TEQ in any single dredge material management unit from the dredged area.
- For non-dispersive sites: The volume weighted average concentration of dioxin in material from each dredging project could not exceed 4 ppt TEQ, and could not exceed a maximum of 11 ppt TEQ for any dredged material management unit.

Table 9 shows results from an analysis of dredge projects in the dredging years 2010 and 2011 that were used to compare the baseline and adopted rules. The DMMP reviewed a total of 17 maintenance or navigational and cleanup site dredge projects in Puget Sound which were analyzed for dioxin. For purposes of this cost benefit analysis, material was determined to be unsuitable for open-water disposal if the requirements under the baseline and adopted rule amendments stated above were not met. The cost differential was determined based on the increased costs of upland landfill disposal at a maximum cost of $120.20 yd^3.

It was assumed that the volume of material determined unsuitable for open-water disposal would still be dredged but disposed of in an upland landfill. Under the adopted rule, the sediment quality goal would remain the Sediment Cleanup Objective of 4 ppt TEQ, but the maximum allowed concentration for a dredged material management unit would be 11 ppt TEQ for non dispersive sites.

Table 9: Sediment, in terms of cubic yards and number of projects, deemed suitable and unsuitable for open-water disposal based on concentrations of dioxin.

	Baseline Rule SCO: 4/10 ppt TEQ dioxin	**Adopted Rule SCO: 4/10 ppt TEQ dioxin**	**Adopted Rule SCO/CSL: 4/11 ppt TEQ dioxin**
Unsuitable Volume (yd^3)	153,570	153,570	153,570
Suitable Volume (yd^3)	1,378,796	1,378,796	1,378,796
Unsuitable (# of projects)	5	5	5
Suitable (# of projects)	12	12	12
Cost	**$18,459,114**	**$18,459,114**	**$18,459,114**

Ecology conservatively assumed all costs are incurred immediately.

Table 10 shows results from an analysis related to potential costs to characterize dredge material for dioxin as well as PCB congeners. For a three year period from

2007 – 2009, the amount of dredge projects required to be tested for dioxin increased from 10% to 38%, which predominantly included projects from urban areas. At this time, all urban projects are required to test for dioxins, and all projects going to dispersive sites must obtain dioxin data as well. It is predicted that dioxin testing will not increase. However, it is expected that more analysis for PCB congeners may be required, rather than Total Aroclors, to accurately assess human health risks. The following assumptions were made to conduct this analysis presented in Table 9:

- An average number of projects of 20 per year.
- An average analytical cost of $200 per sample for Aroclor analysis.
- An average analytical cost of $900 per sample for PCB congener analysis.
- An average cost of $900 per sample for Dioxin analysis.
- An average of 1 sample per DMMU.
- An average of 4 DMMUs per project.
- Assumption that all projects are required to test for PCB Total Aroclors, therefore the adopted rule may require testing for PCB congeners instead of PCB Total Aroclors.

Table 10: Analytical costs associated with dredge material sampled for potential open-water disposal.

*PCB congener analysis @$900 per sample; # PCB Total Aroclor analysis @ $200 per sample.

	Baseline Rule	**Adopted Rule**
Percent of projects required to test for dioxin	38%	38%
Number of projects required to test for dioxin	$\geq$ 8	$\geq$ 8
Dioxin analytical costs per project	$3,600	$3,600
Total dioxin analytical costs for all projects	**$28,800**	**$28,800**
Percent of projects required to test for PCB Aroclors	100%	0%
Percent of projects required to test for PCB congeners	0%	100%
Number of projects required to test for PCB Aroclors	20	0
Number of projects required to test for PCB congeners	0	20
PCB analytical costs per project	$800#	$3,600*
Total PCB analytical costs for all projects	$16,000	$72,000
Average total dioxin and PCB congener analytical costs for all projects for a three year period 2007 - 2009	$44,800	$100,800
Average total dioxin and PCB congener analytical costs for all projects for a twenty year period	**$298,636**	**$671,932**

Ecology conservatively assumed all costs are incurred immediately. The difference between these costs (the impact of the adopted rule amendments) is approximately $373 thousand total across all projects over 20 years. This is the total across all projects over 20 years.

3.5.7.2 Key assumptions

- This analysis was conducted with a limited number of bioaccumulative chemicals due to lack of data. It is uncertain if this analysis is predictive of future monitoring requirements for other bioaccumulative chemicals and/or emerging contaminants.
- The past number of dredge projects submitted to the DMMP is representative of the future number of dredge projects.

3.5.7.3 Conclusions

- Disposal options for dredged material and monitoring costs would not significantly change under the adopted rule amendments.
- Analytical costs may increase under the adopted rule amendments.

3.5.8 Source control

3.5.8.1 NPDES permitted dischargers for potentially liable parties (PLPs)

Ecology anticipates that, for dischargers that are identified PLPs for a sediment cleanup site, monitoring requirements will change in order to protect the cleanup and comply with cleanup standards. In addition, Ecology anticipates these facilities will need to implement new and updated best management practices and conduct potential treatment of the discharge to prevent recontamination of the cleanup site above the cleanup standard. However, the requirement for PLPs to conduct source control of a discharge exists under both the baseline and adopted rule amendments.

The features of a discharger can be highly variable based on the sediment cleanup standard, contaminants in the discharge, type of treatment and best management practices employed, volume of water and contaminant load to receiving water, physical aspects of the facility, and receiving water and sediment characteristics. Therefore, anticipating the costs of any additional treatment or best management practices would be facility specific and highly variable. It is assumed that the differential between the baseline and adopted rule amendments is based on the cleanup standard and the required analytical methods and the cost would be roughly proportional to the concentration of the cleanup standard.

Ecology acknowledges that, under the adopted rule amendments, the analytical methods required to verify compliance with a cleanup standard for bioaccumulative chemicals will change. Table 11 includes an analysis of a representative contaminant that may require more sensitive analytical methods. Assumptions made to conduct this analysis include:

- According to the 2008, Sediment Cleanup Status Report (Ecology 2008), there are 115 sediment cleanup sites in Puget Sound. Due to the ubiquitous nature of both dioxin and PCBs found in Puget Sound sediment, and for purposes of this cost benefit analysis, it is assumed that 75% of these cleanup sites, for a total of 86, have both dioxin and PCB contamination. Freshwater sites were not included for this analysis due to the variety of contaminants found at these sites that may not include both dioxin and PCBs.
- One to three NPDES permitted discharges (outfalls) per cleanup site would be sampled for chemicals of concern.
- A total of two to four effluent and collection basin samples per discharge would be required per permit cycle (every 5 years) to verify compliance with the sediment cleanup standard over a 20 year monitoring time period.
- PLPs are responsible for the chemicals of concern identified for the sediment cleanup.
- An average cost of $900 per sample for both dioxin and PCB congeners, and $200 per sample for Total Aroclors.

Table 11: Analytical costs associated with effluent and catch basin sampling to verify compliance with the sediment cleanup standard.

*PCB congener analysis @$900 per sample; # PCB Total Aroclor analysis @$200 per sample

	Baseline Rule	**Adopted Rule Amendments**
Percent of PLPs required to test discharge for dioxin	100%	100%
Percent of PLPs required to test discharge for PCBs	100%	100%
Dioxin analytical costs per PLP/cleanup site	$7,200 - 43,200	$7,200 – 43,200
PCB analytical costs per PLP/cleanup site	$1,600 – 9,600#	$7,200 – 43,200*
Total analytical costs per PLP/cleanup site	$8,800 – 52,800	$14,400 – 86,400
Total analytical cost for all cleanup sites in Puget Sound over a 20 year monitoring time period	**$756,800 – 4,540,800**	**$1,238,400 – 7,430,400**

3.5.8.2 NPDES permitted dischargers (non PLPs)

According to an Ecology report (Ecology, 2011) the majority of ubiquitous contaminants, such as PCBs, are entering Puget Sound through storm water runoff. It follows that a significant source of potential recontamination of sediment cleanup sites is from stormwater runoff, including permitted and unpermitted dischargers and nonpoint sources. These permitted stormwater dischargers include facilities under both Phase I and II municipal permits, individual industrial permits, and general industrial permits. In addition, both municipal and industrial wastewater discharges may be a source of sediment contamination.

Part IV of the SMS rule, which has not been changed in this rulemaking, requires that NPDES dischargers monitor effluent to protect sediment quality and that permits are conditioned to prevent the creation of new sediment cleanup sites. The impact the adopted rule may have on these dischargers is highly uncertain due to many facility and sediment site specific variables. These include, but are not limited to:

- Current and future number of permitted and unpermitted dischargers that may be subject to new requirements
- The type of NPDES permit (individual or general industrial or municipal stormwater, industrial or municipal wastewater)
- Specific nature of the discharge including:
  - Volume of water discharged
  - Chemicals discharged
  - Treatment and best management practices employed
  - Acreage draining to and from the facility
- Analytical limitations of effluent sampling
- The load of contaminants discharged that actually result in sediment contamination from these varied sources including receiving water and sediment physical and chemical characteristics

3.5.8.3 Key assumptions

- A limited number of bioaccumulative chemicals were used in this analysis with the assumption they are representative of other chemicals that may require different analytical methods. However, uncertainties remain regarding any future additions of new chemicals to the cleanup or monitoring process. Site specific costs to protect sediment cleanups from discharges may potentially increase which could include implementation of new treatment and/or best management practices. This is highly site specific so the potential for new requirements is uncertain

3.5.8.4 Conclusions

For NPDES permitted dischargers that are PLPs:

- Discharge monitoring and analytical costs may increase under the adopted rule and costs will be incurred sooner because cleanup will occur sooner.
- Cleanup standards are not expected to be more conservative under the adopted rule. They may remain the same as the baseline rule or be established at a higher level. Therefore costs to attain and maintain a cleanup standard at the sediment cleanup site are not expected to increase.

For dischargers that are not identified PLPs for a sediment cleanup site, Ecology does not anticipate significant new permitting requirements near term for the majority of these facilities outside of the current permitting and TMDL efforts Ecology is undertaking.

3.6 Summary

How is the rule beneficial overall?

- Cleanup timing and background concentrations (3.2): The adopted rule will establish achievable short-term cleanup goals, and over time eliminate hot spots in excess of background concentrations. Then (likely beyond the typical 20-year scope of Ecology analyses) future cleanups can proceed to more protectively stringent human health-based cleanup levels. **Overall, the adopted rule results in more protective concentrations of contaminants being achieved sooner.**
- Property value and exchange benefits (3.3): By bringing cleanup properties to less contaminated levels sooner, Ecology expects the adopted rule to **increase property values sooner**, and **reduce transaction costs of property buying and selling**, including time cost and lost productivity in industry, as well as prospective redevelopment of property for residential and commercial use.

What happens to the number of sites?

- Number of sites under only benthic criteria (3.4.1): While it is not the baseline, Ecology acknowledges public concern regarding the difference between sites identified under the historic benthic criteria-only interpretation of the SMS rule, and the adopted rule amendments. Ecology modeled sites in Puget Sound identified under benthic criteria only, as 3 dioxin sites and 26 mercury sites. These chemicals were used because they are likely driving chemicals for cleanup. Data for statewide modeling was not available, however, approximately 70 existing sites are in the process of cleanup, and could encounter the changes in costs and cost-savings below. Ecology has assumed this is true for all 70 sites, although this number could be smaller.

- Number of sites under benthic criteria and human health criteria (3.4.2): To illustrate and estimate the number of sites under the baseline of both the benthic criteria and the narrative human health risk (interpreted using the MTCA rule provisions on human health) as factors in setting the cleanup standard, Ecology modeled sites in Puget Sound identified under these combined standards. Ecology identified 23 dioxin and 60 mercury sites in this modeling. Data for statewide modeling was not available.
- Change in number of sites (3.4.3): Ecology modeled sites in Puget Sound identified under the adopted rule amendments, as 16 dioxin and 41 mercury sites. Data for statewide modeling was not available. Compared to the number of sites identified under the baseline (bullet above), this modeling indicates a **reduction of 30 – 32 percent in the number of sites**. If scaled to statewide sediment cleanup sites, this would be a reduction of 45 – 48 sites statewide. (Model results also indicated an **86 – 90 percent reduction in total site acreage**, but Ecology chose the more conservative reduction in the number of sites for this analysis.)

<u>What is the cost impact to a site?</u>

- Site characterization (3.5.1):
    - Ecology estimated a prospective **cost-savings of $148 thousand to $840 thousand per site**.
    - Ecology also identified a **possible cost to PLPs or Ecology of $200 thousand to $250 thousand to be the first to establish regional background concentrations** for an embayment or equivalent region. This cost would not be incurred by most PLPs, and could be avoided entirely by use of natural background at Puget Sound sites.
- Cleanup: Ecology modeled, to the extent possible, the impact of the adopted rule amendments on the costs of cleanup at different sites. Overall, Ecology expects a **cost-savings of $0 to $2.4 million at a typical sediment cleanup** of wide variety.
    - Sediment cleanup at a representative embayment site (3.5.2): Ecology identified a potential cost savings of $0 to $2.4 million in cleanup.
    - Sediment cleanup at a freshwater sediment site for benthic community protection (3.5.3): Ecology identified a potential cost savings of $2 thousand to $60 thousand in analytic costs.
    - Soil and ground water cleanup on an upland site (3.5.4): Ecology does not expect the costs of upland cleanup to be impacted by the adopted rule amendments.
    - Cleanup at a freshwater site (3.5.5): While sufficient data and sampling was not available for Ecology to perform a separate modeling for cleanup at a freshwater site, Ecology expects the marine example above (with an estimated cost-savings of up to $2.4 million) to be illustrative of the impacts of the adopted rule amendments on a freshwater site. Also, Ecology does not expect

the establishment of numeric freshwater criteria to affect the process or outcomes of freshwater site sampling and analysis.

- Analytical costs for compliance (3.5.6): Ecology estimated the total cost for all cleanup sites in Puget Sound over a 20-year period monitoring for compliance as $1.2 million to $2.3 million higher under the adopted rule. If this modeling is scalable to statewide cleanup monitoring, this translates to **$1.6 million to $3 million total increased cost statewide over 20 years**.
- Dredged material for marine sediment (3.5.7): Ecology estimated the total cost as **$373 thousand higher for all projects over 20 years** under the adopted rule.
- Source control (3.5.8): Ecology estimated the total cost for all cleanup sites in Puget Sound over 20 years as $482 thousand to $2.9 million higher for NPDES dischargers that are PLPs under the adopted rule amendments. If this is scalable statewide, this represents an **increased cost of $629 thousand to $3.8 million statewide over 20 years**. Ecology does not anticipate significant new permitting requirements for NPDES dischargers that are not identified as PLPs.

CHAPTER 4: Conclusions

4.1 Introduction

As discussed in Chapter 1, the Washington Administrative Procedure Act (RCW 34.05.328) requires Ecology to evaluate significant legislative rules to "[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented."

4.2 Conclusion

Based on qualitative and quantitative assessment of the likely costs and benefits (see Chapter 3 of this document), Ecology concludes that there is reasonable likelihood that estimated benefits of the adopted rule amendments exceed their costs.

CHAPTER 5: Least Burdensome Alternative Analysis

RCW 34.05.328(1)(e) requires agencies to "…[d]etermine, after considering alternative versions of the rule and the analysis required under (b)[10], (c)[11], and (d)[12] of this subsection, that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives stated under (a) of this subsection."

Ecology distributed the proposed rule amendments and a preliminary cost-benefit analysis (including the preliminary least burdensome alternatives (LBA) analysis) for public review and comment in August 2012. Several individuals and organizations provided comments on the scope and depth of the preliminary LBA analysis. Ecology considered those comments when preparing the final LBA analysis.

Ecology evaluated how the rule revisions are likely to impact sediment cleanup standards and cleanup actions (See Chapter 2). Based on that analysis, Ecology elected to divide the LBA analysis into two parts:

- Revisions to the policies and methods for establishing sediment cleanup standards based on human health protection.
- Revisions to the policies and methods for establishing cleanup standards for freshwater sediments based on benthic toxicity.

This chapter describes Ecology's evaluation of rulemaking alternatives and conclusions on whether the rule represents the least burdensome alternative that will achieve the statutory goals and objectives in the Model Toxics Control Act.

This chapter is organized into four sections:

- Evaluation Approach (Section 5.1)
- Statutory Goals and Objectives (Section 5.2)
- Sediment Cleanup Standards for Human Health Protection (Section 5.3)
- Sediment Cleanup Standards to Protect Freshwater Benthic Communities (Section 5.4)

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[10] RCW 34.05.328(1)(b) requires agencies to "…[d]etermine that the rule is needed to achieve the general goals and specific objectives stated under (a) of this subsection, and analyze alternatives to rule making and the consequences of not adopting the rule;…"

[11] RCW 34.05.328(1)(c) requires agencies to "…[p]rovide notification in the notice of proposed rule making under RCW 34.05.320 that a preliminary cost-benefit analysis is available. The preliminary cost-benefit analysis must fulfill the requirements of the cost-benefit analysis under (d) of this subsection. If the agency files a supplemental notice under RCW 34.05.340, the supplemental notice must include notification that a revised preliminary cost-benefit analysis is available. A final cost-benefit analysis must be available when the rule is adopted under RCW 34.05.360..."

[12] RCW 34.05.328(1)(d) requires agencies to "…[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented…"

5.1 Evaluation approach

Ecology evaluated the new provisions for human health protection and freshwater sediments. The two evaluations were performed to determine whether the final rule represents the least burdensome alternative that will achieve the MTCA goals and specific objectives. The evaluation process included the following four steps:

1. Describe the policy options that Ecology considered during the rulemaking process. These options are summarized in Appendix C;
2. Combine the policy options into a range of rulemaking alternatives;
3. Evaluate whether the rulemaking alternatives achieve the general MTCA goals and objectives. Ecology considered three main MTCA goals when preparing this evaluation:
    - Meets the minimum requirements for cleanup standards (RCW 70.105D.030(2)(e));
    - Protect human health and the environment (See RCW 70.105D.010 & 0.30);
    - Periodically update minimum cleanup standards for remedial actions based on new scientific information and changes to state and federal laws (RCW 70.105D.030(2)(e)).
4. Evaluate whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA.

5.2 Statutory goals and objectives

MTCA provides Ecology with the authority to accomplish several statutory objectives (RCW 70.105D.030(1)). The following objectives are particularly relevant to the SMS rulemaking:

(a) Investigate, provide for investigating, or require potentially liable persons to investigate any releases of hazardous substances, including but not limited to inspecting, sampling, or testing to determine the nature or extent of any release or threatened release…;

(b) Conduct, provide for conducting, or require potentially liable persons to conduct remedial actions (including investigations under (a) of this subsection) to remedy releases or threatened releases of hazardous substances…. In conducting, providing for, or requiring remedial action, the department shall give preference to permanent solutions to the maximum extent practicable and shall provide for or require adequate monitoring to ensure the effectiveness of the remedial action;

The MTCA statute directs Ecology to "…[p]ublish and periodically update minimum cleanup standards for remedial actions at least as stringent as the cleanup standards under section 121 of the federal cleanup law, 42 U.S.C. Sec. 9621, and at least as stringent as all applicable state and federal laws, including health-based standards under state and federal law". Several statutory provisions provide guidance on implementing this directive:

- Minimum Cleanup Requirements: The MTCA law establishes minimum requirements for cleanup standards (RCW 70.105D.030(2)(e)). These include:
  - Relationship to Federal Standards: The MTCA law states that the federal cleanup standards establish the minimum requirements for state cleanup standards. Ecology believes that the discussions surrounding the passage of the initiative make it clear that the authors intended for the state to assess what cleanup standards will be most protective, rather than automatically deferring to existing federal standards.
  - Relationship to Other Health-Based Standards: The MTCA law states that the health based standards established under state and federal laws represent minimum requirements for state cleanup standards. The importance of this minimum requirement is reinforced by the fact that the authors of the Initiative elected not to incorporate the CERCLA waiver provisions into the MTCA law.
- Protection of Human Health and the Environment. The primary objective for MTCA cleanup actions is to protect human health and the environment. There are two MTCA provisions that provide direction on complying with this statutory objective:
  - Protection of Highly Exposed or Highly Susceptible Population Groups: The opening section of the MTCA law states that "[e]ach person has a fundamental and unalienable right to a healthful environment…" To fulfill this mandate, Ecology believes it is necessary to establish methods and procedures that will result in cleanup levels that protect the whole population – including susceptible or high exposure population groups.
  - Responses to Threats or Potential Threats to Human Health or the Environment: The MTCA law directs Ecology to "…[c]onduct, provide for conducting, or require potentially liable persons to conduct remedial actions … to remedy releases or threatened releases of hazardous substances." Ecology believes that the lack of certainty or perfect evidence "…does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time..." (Hill, B.A. 1965). This is also consistent with the advice of the MTCA Policy Advisory Committee, a statutorily mandated committee, who

recommended that Ecology "…err on behalf of protection of human health and the environment" (MTCA PAC, 1996).

- Use of Current Scientific Information: The MTCA law requires Ecology to periodically update the minimum cleanup standards to incorporate new scientific information and changes to state and federal laws (RCW 70.105D.030(2)(e)). The authors of Initiative 97 believed that cleanup decisions should be based on current scientific information. The current MTCA rule includes several provisions that reflect a continued commitment to using up-to-date scientific information to support regulatory determinations.

5.3 Sediment cleanup levels based on human health protection

5.3.1 Comparison of the current requirements and the final rule

Under the current SMS rule, site-specific sediment cleanup standards based on human health protection are established on a case-by-case basis using applicable policies in the MTCA rule. Ecology has incorporated many of the current MTCA methods and policies into Section 561 of the SMS rule. Key features of the current and revised SMS rule are summarized in Appendix C. The major differences include:

- Decision Framework. The revised SMS rule includes a two-tiered decision framework for establishing cleanup standards based on human health protection. The current MTCA rule requirements for sediments are applied in a one-tiered framework.

- Reasonable Maximum Exposure (RME) Scenario. The revised SMS rule requires risk-based cleanup levels must be based on a tribal exposure scenario. Under the current SMS and MTCA rules, Ecology must select the appropriate exposure scenario for each site.

- Toxicity Values. The revised SMS rule requires that toxicity values used to calculate risk-based cleanup levels must selected in accordance with the current EPA toxicity hierarchy. The current MTCA rule includes an older toxicity hierarchy that is similar, but less comprehensive than the more recent EPA hierarchy.

- Background Concentrations. The revised SMS rule provides the flexibility to consider regional background levels when establishing sediment cleanup standards. The current SMS and MTCA rules provide less flexibility to consider background levels.

5.4.2 Description of rulemaking alternatives

The assessment of human health risks is complicated by scientific uncertainties and variability in exposure and susceptibility. There are often several plausible scientific options for resolving specific issues. Given the uncertainty and variability in current risk assessments, it is not surprising that there are a wide range of opinions on the proposed approach for establishing sediment cleanup standards based on human health protection. During the public comment period, Ecology received comments from some people who stated that Ecology's proposal is too conservative. They stated that the proposed rule would increase cleanup costs and cause project delays. Other people stated that Ecology's efforts to improve the workability of the SMS rule have produced a rule that is not sufficiently protective.

Ecology received a wide range of comments on how to structure Section 561. Those comments generally addressed one or more of the following issues: (1) Target cancer risk levels; (2) Hazard quotient/hazard index; (3) Reasonable maximum exposure scenario; and (4) Background concentrations. The range of policy options reflected in the public comments is summarized in Table C-2. Ecology reviewed the comments and identified four rulemaking alternatives that reflect different combinations of those policy options.

- **"No Action" Alternative (Current Rule)**. Cleanup standards based on human health protection are currently established using the MTCA Method B methods and policies. Under the current rule, risk-based cleanup levels for individual substances will be established using a target cancer risk of level of one-in-one million, hazard quotient of one and a reasonable maximum exposure scenario that is defined on a site-specific basis. The risk-based cleanup levels for individual substances may need to be adjusted downward to ensure that total site risks do not exceed a cancer risk of one-in-one hundred thousand and a hazard index of one. Risk-based cleanup levels may also need to be adjusted upward based on natural background concentrations or analytical considerations.
- **Final SMS Rule:** Cleanup standards based on human health protection will be established using the two-tiered SMS decision framework. Under this approach, site-specific cleanup standards will be established as close as practicable to the Sediment Cleanup Objective (SCO), but in no case higher than the Cleanup Screening Level (CSL). The SCO will be established using the current MTCA Method B policies and methods except that a tribal exposure scenario must be used to calculate risk-based cleanup levels at most sites. For the CSL, risk-based cleanup levels for individual substances will be established using a target cancer risk of level of one-in-one hundred thousand, hazard quotient of one and a tribal exposure scenario. The risk-based cleanup levels for individual substances may need to be adjusted downward to ensure that total site risks do not exceed a cancer risk of one-

in-one hundred thousand and a hazard index of one. Risk-based cleanup levels may need to be adjusted upward based on regional background concentrations or analytical considerations.

- **<u>"More Protective" Alternative</u>**. Cleanup standards based on human health protection would be established using a modified version of the current MTCA Method B methods and policies. This alternative differs from the current rule requirements in three main ways: (1) Cleanup levels based on non-cancer risks would be established using a hazard quotient of 0.2 instead of 1. Cleanup levels for individual substances would still be adjusted downward using a hazard index of 1; (2) Risk based cleanup levels would be calculated using a tribal exposure scenario; and (3) Risk-based cleanup levels could be adjusted upward based on non-anthropogenic background levels (instead of MTCA natural background levels or regional background levels).
- **<u>"Less Protective" Alternative</u>**. Cleanup standards based on human health protection would be established using a modified version of the final SMS rule. This alternative differs from the final SMS rule in two main ways: (1) The total site risk for Cleanup Screening Levels would be defined as one-in-ten thousand (10-4) and a hazard index of ten (10) and (2) Risk-based cleanup levels corresponding to the Cleanup Screening Levels would be based on a general population exposure scenario.

5.3.3 Evaluation of rulemaking alternatives

Ecology evaluated the four rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. The four rulemaking alternatives reflect different combinations of the policy options summarized in Table C-2. Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA law?
- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are summarized in Table 12.

Table 12: Rule Alternatives for Cleanup Standards Based on Human Health

Rulemaking Alternatives	Meets Statutory Goals & Objectives			Least Burdensome Alternative
	Minimum Requirements	Level of Protection	Scientific Information	
No Action Alternative.	Yes	Yes	Yes	No

Final SMS Rule	Yes	Yes.	Yes.	Yes.
More Protective Alternative	Yes	Yes.	Yes.	No.
Less Protective Alternative	No	No.	Yes.	Not applicable.

Ecology believes the SMS rule revisions represent the least burdensome alternative for complying with the MTCA statutory goals and objectives. The revised SMS rule provides a workable approach for establishing sediment cleanup standards based on human health protection. The revised rule incorporates the current MTCA human health risk policies and terminology into the SMS rule. This will reduce the burden of having to comply with two sets of regulatory requirements. The revised rule also provides the flexibility to account for real-world constraints when establishing cleanup standards. In particular, the revised rule includes provisions that account for the presence of background concentrations not related to site-specific releases of hazardous substances. Ecology estimates that this will reduce the overall cleanup costs by focusing active cleanup measures in areas with the worst contamination problems. Ecology also estimates that this will produce more rapid risk reductions and lower long-term health risks than the current SMS and MTCA rules.

Ecology believes that the "no action" alternative also achieves the MTCA goals and objectives. However, the current SMS and MTCA rules provide less flexibility to take into account background concentrations. However, people conducting cleanup actions would have to continue to comply with two sets of requirements. The case studies prepared by Ecology indicate that cleanup site boundaries under the current rules are larger than under the final revised SMS rule. Larger sites are more burdensome because of the increased transaction costs caused by the greater number of potentially liable persons (PLPs) and increased cleanup costs associated with larger cleanup areas and project delays. Project delays also result in prolonged exposure to elevated levels of hazardous substances.

Ecology believes that the third or "more protective" alternative meets the MTCA goals and objectives. However, this alternative provides even less flexibility to take into account background concentrations than the current SMS and MTCA rules.

Ecology believes that the fourth or "less protective" alternative would not effectively achieve the MTCA goals and objectives. In particular, this alternative would result in disproportionate risks for population groups who consume larger amounts of fish and shellfish. Allowing the use of a hazard index greater than one may not meet the minimum requirements under CERCLA.

5.4 Sediment cleanup levels for freshwater sediments based on benthic toxicity

5.4.1 Comparison of the current requirements and the final rule

Under the current SMS rule, cleanup standards for freshwater sediments are established on a case-by-case basis. Ecology makes site-specific decisions using a combination of biological and chemical testing. Ecology has incorporated many of the features of the current SMS rule into Section 563. Key features of the current and revised SMS rule are summarized in Appendix C. The major differences include:

- Decision Framework: The current and revised rule both include the two-tiered SMS decision framework for establishing site-specific cleanup standards.
- Chemical Criteria: The revised SMS rule includes chemical criteria for the Sediment Cleanup Objective and Cleanup Screening level (CSL). Under the current SMS rule, Ecology uses a variety of existing sediment quality values to interpret the SMS narrative standards. For example, chemical measurements are compared to the 2003 Interim Sediment Quality Values (Ecology 2003) and/or Consensus Based Sediment Quality Values (MacDonald, et al. 2000).
- Biological Criteria: The revised SMS rule includes biological criteria for the Sediment Cleanup Objective and Cleanup Screening level (CSL). Under the current rule, Ecology uses a variety of tests and interpretation criteria to interpret the SMS narrative standards. For example, biological test results are compared to biological criteria adopted by the Regional Sediment Evaluation Team (RSET, 2009), statistical comparisons to control or reference samples, and/or site-specific criteria (such as the reference envelope approach).
- New Scientific Information/Alternate Test Methods: The current and revised SMS rule provides the flexibility to use newer test methods to support site-specific decisions. In the revised rule, Ecology has identified several situations (e.g., sediments impacted by metals mining, smelting and milling) where it will be necessary to use alternative methods to evaluate sediment toxicity.

5.4.2 Description of rulemaking alternatives

Ecology had to resolve many regulatory issues when preparing Section 563. The most significant issues in terms of regulatory impacts can be categorized into two main areas: (1) chemical criteria; and (2) biological criteria. Ecology identified three rulemaking alternatives that reflect different combinations of the policy options summarized in Table C-4.

- **"No Action" Alternative (Current SMS Rule)**. Under this alternative, cleanup standards for freshwater sediments would be established on a case-by-case basis. The "no action" alternative is the current SMS rule.
- **Final SMS Rule:** Cleanup standards for freshwater sediments will be established using the SMS two tiered decision framework. The final SMS rule includes new chemical and biological criteria that correspond to "no adverse effects" (sediment cleanup objective) and "minor adverse effects" (cleanup screening level). The biological criteria identify tests and interpretation criteria that can be used to identify sediments with no adverse effects and minor adverse effects. As with the current SMS rule requirements for marine sediments, the biological test results can be used to override evaluations based on chemical criteria. In addition, Ecology has identified several situations (e.g., sediments impacted by metals mining, smelting and milling) where it will generally be necessary to use alternative methods to evaluate sediment toxicity.
- **"More Protective" Alternative**. Cleanup standards for freshwater sediments would be established using the chemical and biological criteria recommended by the Confederated Tribes of the Colville Reservation (CTCR) and the Department of the Interior (DOI). Under this alternative, sediments would be evaluated using the sediment quality values described in MacDonald et al. (2000) and/or biological criteria based on the application of a reference envelope approach.

5.4.3 Evaluation of rulemaking alternatives

Ecology evaluated the three rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general MTCA goals and specific objectives. Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA law?
- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are summarized in Table 13.

Table 13:Rulemaking Alternatives for Freshwater Sediment Cleanup Standards Based on Benthic Toxicity

Rulemaking Alternatives	Meets Statutory Goals & Objectives			Least Burdensome Alternative
	Minimum Requirements	Level of Protection	Scientific Information	
No Action Alternative.	Yes	Yes	Yes	No

Final SMS Rule	Yes	Yes.	Yes.	Yes.
More Protective/More Burdensome	Yes	Yes.	Yes.	No.

Ecology believes the rule revisions represent the least burdensome alternative for complying with the MTCA statutory goals and objectives. The chemical criteria in the revised rule were designed to predict which sediments will fail biological tests taking into account the potential for both false negatives and false positives. False negatives arise when the chemical criteria predict that sediments are not toxicity, but the sediments fail one or more bioassays. A high false negative rate is problematic from an environmental protection standpoint. The chemical criteria in the final rule were developed using a false negative rate of 20%. This is similar to the false negative rates used to establish other current sediment quality values.

The chemical criteria in the final rule have a much lower false positive rate than other current sediment quality values. False positives arise when the chemical criteria predict that sediments are toxic, but sediments pass all of the bioassays. False positives increase regulatory burdens because they result in (1) an increased level of biological testing needed to confirm or refute predictions based on the chemical criteria or (2) greater amount of cleanup for sediments with little or no toxicity. Ecology estimates that the reduced regulatory burden associated with the reduced false positive rate is larger than small increase in analytical costs associated with the revised rule.

Ecology believes that the second or “no action” alternative could effectively achieve the MTCA goals and objectives on a site-specific basis. However, case-by-case interpretation of the narrative standards creates additional transaction costs and project delays.

Ecology believes that the third or “more protective” alternative meets the MTCA goals and objectives. The chemical criteria recommended by the CTCR and DOI are generally more protective than the chemical criteria in the SMS rule. This produces a lower false negative rate than the final SMS rule (i.e., fewer sediment stations are likely to be incorrectly classified as non-toxic when biological tests show some level of toxicity). However, application of the chemical criteria recommended by the CTCR and DOI would likely produce a much higher false positive rate than the final SMS rule. As discussed above, a high false positive rate increases the regulatory burden for persons having to comply with the regulatory requirements.

The third alternative includes biological criteria for several tests or endpoints that are more protective than the criteria in the final SMS rule. Applying the recommended approach requires cleanup proponents to conduct additional testing in reference areas. The additional testing costs could represent a significant percentage of the overall cleanup costs for small projects.

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Appendix A: Embayment-Specific Examples of Cleanup Level Impacts

Ecology analyzed the impacts of the adopted rule on cleanup levels in three alternative embayment scenarios (each based on real embayment data). The examples illustrate that it is likely most cleanup levels will not change or will prospectively become less stringent for the contaminants driving cleanup.

A.1 Urban shoreline example

This site contains arsenic, cPAHs, PCBs, and dioxins. It is a highly urbanized environment and includes multiple sources and responsible parties. Primary contributors to contamination are historic industrial operations. This is an estuarine river environment that supports industrial and residential use, recreation, and tribal fishing. It is in a heavily urbanized area.

Ecology chose the chemicals for this calculation – arsenic and cPAHs – based on the quality of data available. That is, although PCBs are also a chemical of concern at this site, the data available was not of sufficient quality to perform accurate risk-based calculations or determine background concentrations, because most data available in the EIM database was based on total Aroclors, and background data was primarily based on PCB congeners.

Table 14 summarizes the risk-based concentrations Ecology calculated using the fish consumption rate at the real site, the background concentration being considered for the actual site, a risk-based concentrations calculated using the site specific fish consumption rate at two risk levels, and regional background concentrations that would be considered under the adopted rule amendments decision framework. Baseline and adopted rule amendments risk based concentrations were calculated using a 97 g/ day fish consumption rate.

Table 14: Arsenic and cPAH cleanup standards for a representative urban shoreline site

	Arsenic[13] (ppm)	**Arsenic Cleanup Standard Baseline Rule**	**Arsenic Cleanup Standard Adopted Rule**	**cPAH (ppb TEQ)**	**cPAH Cleanup Standard Baseline Rule**	**cPAH Cleanup Standard Adopted Rule**
Baseline Rule 10-6 Risk Based Concentration **97 g/day FCR**	2.43 E-03			3.79		
Adopted Rule Amendments 10-6 Risk Based Concentration **97 g/day FCR**	2.43 E-03			3.79		

[13] Arsenic speciation was not taken into account to calculate the risk based concentration. It was assumed 100% was bioavailable.

Adopted Rule Amendments 10-5 Risk Based Concentration **97 g/day FCR**	2.43 E-02			37.9		
Baseline Rule Natural Background	7.3	7.3		8.48	8.48	
Adopted Rule Amendments **SCO** Natural Background	7.3			8.48		
Adopted Rule Amendments **CSL** Regional Background	7.3		7.3	42.59		42.59

For purposes of this analysis, it is assumed that PQL would be lower than the background concentrations. Because PQL and risk-based concentrations fall below their respective background concentrations, backgrounds are used to set cleanup standards[14] -- the CLS (adopted rule amendments) and SQS (baseline) -- for both arsenic and cPAHs. The cleanup standard for arsenic does not change, while the cleanup standard for cPAHs goes up (becomes less stringent) under the adopted rule amendments because the cleanup level is based on regional background.

If arsenic was the chemical driving this cleanup, cleanup behavior would not likely change, while if cPAH was driving this cleanup, remediation activities would likely stay the same or decrease under the adopted rule amendments.

A.2 Urban marine embayment example

This site contains mercury and dioxins. It is an urban embayment with a long history of industrial marine operations. It is currently undergoing extensive cleanup operations. This embayment supports recreational, commercial fishing, subsistence fishing, residential and industrial activities, and major municipal port activities.

Table 15 summarizes the risk-based concentrations calculated with the fish consumption rate used at the actual site, the background concentration being considered at the actual site, risk-based concentrations calculated using the site specific fish consumption rate for two risk levels, and regional background concentrations that would be considered under the adopted rule amendments' SMS framework. Note that, for dioxin, risk-based concentrations and natural background concentrations are below PQL. Baseline and adopted rule amendments risk based concentrations were calculated using a 173 g/ day fish consumption rate.

[14] Under the baseline, the cleanup standard is set as close as practicable to the SQS, based on technical feasibility, cost and net environmental protection. However, because a PLPs obligation at a site is not completed until the SQS is met, for purposes of this analysis the baseline cleanup standard is established at the SQS.

Under the adopted rule amendments, the cleanup level is initially set at the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the cleanup level is set at the CSL to determine the maximum potential difference between the baseline and adopted rule amendments.

Table 15: Dioxin and mercury cleanup standards for a representative urban marine embayment site

	Dioxin (ppt TEQ)	Dioxin Cleanup Standard Baseline Rule	Dioxin Cleanup Standard Adopted Rule	Mercury (ppm)[15]	Mercury Cleanup Standard Baseline Rule	Mercury Cleanup Standard Adopted Rule
Baseline Rule 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Adopted Rule Amendments 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Adopted Rule Amendments 10-5 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-02			0.016		
Baseline Rule Natural Background / PQL	2.0 / 5.0	2.0/5.0		0.104 / 2.0 E -02	0.104	
Adopted Rule Amendments SCO Natural Background / PQL	2.0 / 5.0			0.104 / 2.0 E -02		
Adopted Rule Amendments CSL Regional Background / PQL	14.6		14.6	0.104 / 2.0 E -02		0.104

Because PQL and risk-based concentrations fall below their respective background concentrations, backgrounds are used to set cleanup standards[16] -- the CLS (adopted rule amendments) and SQS (baseline) – for dioxin and mercury. The cleanup standard for mercury would not change under the adopted rule amendments, while the cleanup standard for dioxin increases (becomes less stringent). If dioxin was the chemical driving cleanup at this site, remediation activity would stay the same or decrease

[15] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment

[16] Under the baseline, the cleanup standard is set as close as practicable to the SQS, based on technical feasibility, cost and net environmental protection. However, because a PLPs obligation at a site is not completed until the SQS is met, for purposes of this analysis the baseline cleanup standard is established at the SQS.

Under the adopted rule amendments, the cleanup level is initially set at the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the cleanup level is set at the CSL to determine the maximum potential difference between the baseline and adopted rule amendments.

under the adopted rule amendments, while if mercury was the driving chemical, remedial action would not change.

A.3 Rural marine embayment example

This site is a rural Puget Sound embayment with contamination from a single long-term industrial operation. The embayment supports thriving shellfish and forage fish populations, with a primarily rural, residential, and tribal population.

Table 16 summarizes the human health risk-based concentrations calculated with the fish consumption rate used at the actual site and two risk levels, the background concentration at the actual site, and background concentrations that would be considered under the adopted rule amendments' SMS decision framework. Note that, for dioxins, risk-based concentrations and natural background are below PQL. Baseline and adopted rule risk based concentrations were calculated using a 499 g/day fish consumption rate in accordance with decisions at the actual site.

Table 16: Dioxin and cPAH cleanup standards for a representative rural marine embayment site

	Dioxin (ppt TEQ)	Dioxin Cleanup Standard Baseline Rule	Dioxin Cleanup Standard Adopted Rule	cPAH (ppb TEQ)	cPAH Cleanup Standard Baseline Rule	cPAH Cleanup Standard Adopted Rule
Baseline Rule 10-6 Risk Based Concentration **499 g/day FCR**	0.0187			0.455		
Adopted Rule Amendments 10-6 Risk Based Concentration **499 g/day FCR**	0.0187			0.455		
Adopted Rule Amendments 10-5 Risk Based Concentration **499 g/day FCR**	0.187			4.55		
Baseline Rule Natural Background / PQL	1.17 / 5.0	5.0		5.32	5.32	
Adopted Rule Amendments SCO Natural Background / PQL	1.17 / 5.0		5.0	5.32		5.32
Adopted Rule CSL Regional Background	1.17 / 5.0		5.0	5.32		5.32

Because PQL and risk-based concentrations fall below their respective background concentrations, backgrounds are used to set cleanup standards[17] -- the CLS (adopted

[17] Under the baseline, the cleanup standard is set as close as practicable to the SQS, based on technical feasibility, cost and net environmental protection. However, because a PLPs obligation at a site is not completed until the SQS is met, for purposes of this analysis the baseline cleanup standard is established at the SQS.

Under the adopted rule amendments, the cleanup level is initially set at the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For rule amendments) and SQS (baseline) – for dioxin and cPAHs. For this representative site, cleanup standards do not change for dioxin or cPAHs under the adopted rule amendments.

Ecology does not expect a change in cleanup behavior under the adopted rule amendments at sites like this where there is not a clear distinction between regional and natural background and site specific fish consumption rates are used to calculate human health risks.

purposes of this analysis, the cleanup level is set at the CSL to determine the maximum potential difference between the baseline and adopted rule amendments.

Appendix B: Puget Sound Modeling of Number of Sites

Ecology estimated the impacts of the adopted rule amendments on sediment cleanup across the Puget Sound, as one illustration of the likely costs and benefits.

B.1 Background concentrations

Ecology calculated one value each for both natural and regional background for all of Puget Sound in order to consistently identify sites for comparison. Ecology acknowledges that the intent of Regional Background is to be location-specific, but for purposes of this cost benefit analysis, it was necessary to have comparable results across Puget Sound regardless of sub-location.

Ecology analyzed two bioaccumulative chemicals (dioxin and mercury) based on:

1. Availability of sufficient high quality data.
2. Ubiquitous nature of the chemicals in Puget Sound sediment.

B.1.1 Baseline

Under the baseline of combined SMS benthic and the narrative human health risk (interpreted using the MTCA human health criteria), Ecology calculated a baseline cleanup standard for dioxin and mercury across Puget Sound. The SMS chemical criteria for dioxin, at the CSL benthic criteria (200 ppt TEQ[18]), corresponds to toxicity in fish. The SMS chemical criteria for mercury, at the CSL (0.59 ppm[19]), corresponds to toxicity to benthic organisms.

Under the baseline rule, the sediment quality standard is the highest of: a risk based cleanup level (which is the lowest value for either human health, benthic risk, or ARARs), practical quantitation limit, or natural background. The first step is to determine your risk based cleanup level. Because the human health risk criteria is the lowest of the risk based cleanup level, it is selected. The next step is to determine the sediment quality standard. Because the natural background is the highest of the risk based cleanup level, PQL or natural background, it is selected. Under the baseline, the cleanup standard is set as close as practicable to the SQS, based on technical feasibility, cost and net environmental protection. However, because a PLPs obligation at a site is not completed until the SQS is met, for purposes of this analysis the baseline cleanup standard is established at the SQS.

Ecology used data from the Environmental Information Management (EIM) database, including samples from Ecology-approved reference areas, OSV *BOLD*

[18] Parts per trillion, total equivalent toxicity. There are multiple forms of dioxin. TEQ combines and converts their concentrations to a single toxicity-equivalent concentration for human health.
[19] Parts per million.

(DMMP 2009) sampling stations, and other stations that were determined to be similarly influenced by anthropogenic sources as the reference areas.

Ecology calculated the 95^{th} upper confidence limit on the mean of the data for each chemical, and used MTCA natural background values:

- 0.01 ppm for mercury.
- 2.0 ppt TEQ for dioxin

B.1.2 Adopted rule amendments

Under the adopted rule amendments, the cleanup level is initially set at the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the cleanup level is set at the CSL to determine the maximum potential difference between the baseline and adopted rule amendments. The CSL is the highest of: the risk/effects based criteria; PQL; or regional background. Using the highest of those factors, for purposes of this analysis, the CLS/cleanup level is set at regional background. For determining regional background, Ecology used the EIM database to download sediment data for all of Puget Sound. Ecology then removed data within 500 meters of shore, as this data could be directly influenced by sources such as cleanup sites, stormwater discharges, and other discharges, and would not appropriately represent the adopted definition of regional background. Ecology also performed standard data cleaning procedures to remove outlier data. For purposes of this cost benefit analysis, Ecology calculated the 90^{th} upper tolerance limit on the 90^{th} percentile as regional background:

- 0.23 ppm for mercury.
- 11.0 ppt TEQ for dioxin.

B.2 Number of sites in Puget Sound

Ecology identified cleanup sites in Puget Sound by using the current provisions in the existing SMS rule for identifying sites and the corresponding provisions under the adopted rule.

B.2.1 Baseline

Under the baseline rule, cleanup sites are identified if the average of three sample stations that were spatially and chemically similar exceeded the CSL benthic criteria.

Additionally, if each of three sample stations that were spatially and chemically similar exceed the narrative standard of “no significant risk to human health”, the location was identified as a cleanup site. Ecology interpreted the SMS narrative standard of "no significant risk to human health" as the MTCA human health criteria. These are the highest of:

- Natural background.
- PQL.
- 10^{-6} human-health risk level for individual carcinogens, or a hazard quotient of 1 for noncarcinogens.

In some cases, the PQL could be higher than the MTCA natural background. However, since this PQL determination is site-specific and variable, for purposes of this cost benefit analysis, Ecology is using the MTCA natural background because it provided a consistent value for all of Puget Sound.

- For mercury, Ecology identified clusters if stations no more than 500 feet apart were above this level.
- For dioxin, Ecology identified clusters if stations no more than 1000 feet apart were above this level. Ecology made this change due to the lack of data for dioxin.

B.2.2 Adopted rule amendments

Under the adopted rule amendments if each of three sample stations that are spatially and chemically similar exceed the Cleanup Screening Level (CSL), Ecology identified a cleanup site (cluster of potential concern).[20] The CSL is the highest of:

- Regional background.
- PQL.
- Risk-based concentration, which is the lowest of:
    - 10^{-5} human health total site risk level for carcinogens, or a hazard quotient of 1 for noncarcinogens.
    - Current SMS cleanup screening level for benthic criteria.
    - ARARs.

In some cases, the PQL could be higher than the adopted rule amendments' regional background. However, since this determination is site specific and variable, for purposes of this cost benefit analysis, Ecology is using SMS regional background because it provided a consistent value for all of Puget Sound.

- For mercury, Ecology identified clusters if stations no more than 500 feet apart were above this level.

[20] See adopted WAC 173-204-560(4) and WAC 173-204-510(2)(c).

- For dioxin, Ecology identified clusters if stations no more than 2,000 feet apart were above this level. Ecology made this change due to the lack of data for dioxin.

B.3 Acreage and site boundaries

Ecology used the cluster analysis detailed above to identify sites requiring further investigation and cleanup. Ecology defined site boundaries requiring remediation by:

- <u>Baseline:</u> Ecology identified SMS benthic criteria sites by chemical concentrations at or above the existing SMS CSL, and the boundaries of the site by chemical concentrations above the SMS benthic SQS. Ecology identified and bounded baseline sites based on human health/background using chemical concentrations at or above MTCA natural background cleanup standard.[21]

- <u>Adopted rule amendments:</u> Ecology identified sites requiring further investigation and cleanup by clusters at or above the adopted regional background level. Ecology identified boundaries of clusters using chemical concentrations above adopted SMS regional background, or concentrations above MTCA natural background. The adopted rule allows a site specific cleanup standard to be established between the CSL and SCO tiers, and the CSL could be bounded by regional background. For purposes of this cost benefit analysis, Ecology used regional background as the cleanup standard. Conclusions on cost differences for the adopted rule would be based on a maximum rather than a minimum cost difference.

B.4 Remedy determination and cost differential

Ecology used baseline and adopted cleanup acreages from Table 1 to determine remedial actions required for cleanup, estimate the total costs of these remedies, and calculate the difference due to the adopted rule amendments. Remedies selected typically include a mix of technologies

- Dredging.
- Capping.
- Long-term monitoring.

The baseline allows an analysis to be conducted to select a remedy based on cost, technical feasibility, and environmental protection. The baseline and adopted rules differ on the specifics of calculating the remedial action this way, however, the basic approach is similar. Ecology determined that the area for active cleanup (involving dredging) would not significantly change between the baseline and adopted rule amendments cleanup acreages. However, monitoring behavior and capping were

[21] For this analysis, the practical quantitation limit was not used as this determination is site specific.

likely to change. Tables 17 and 18 summarize the likely remediation behavior under the baseline and adopted rule amendments, and the associated costs, for dioxin and mercury, respectively.

Costs for dredging included nearshore and offshore excavation, dewatering, re-handling, upland staging for disposal transport, environmental controls, transport, and disposal at an upland landfill. Costs for thin-layer capping included cap material purchase, transport, material placement, and environmental controls. Costs for monitoring included operation and mobilization of monitoring vessels, sampling, analysis, quality assurance and control, and report writing.

Table 17: Puget Sound-wide remediation under baseline and adopted rule amendments, for Dioxin

	Baseline (Based on MTCA Natural Background)	Adopted Rule Amendments (Based on Regional Background)
Acreage of site	16,167	1,749
Volume dredged ($yard^3$)	186,336	70,663
Area Capped (acres)	96.3	29.2
Monitoring Years	192.5	43.8
# Samples per Monitoring Event	90	40
Monitoring Events	57.75	10.22

Table 18: Puget Sound-wide remediation under baseline and adopted rule amendments, for Mercury

	Baseline (Based on MTCA Natural Background)	Adopted Rule Amendments (Based on Regional Background)
Acreage of site	20,592	2,874
Volume dredged ($yard^3$)	237,300	115,916
Area Capped (acres)	122.6	47.9
Monitoring Years	245.15	71.95
# Samples per Monitoring Event	90	40
Monitoring Events	73.55	16.77

B.5 Key assumptions

- When conducting this analysis, both regional and natural background were used as the defaults for the SCO and CSL values. This was done due to the site specific nature of establishing human health risk based concentrations, for example bioavailability of total mercury versus methyl mercury. It was assumed the risk based concentrations were below background which may not be the case site specifically.

- The cleanup standard, and the standard that defined an area for remediation, was established at the CSL. The adopted rule allows a cleanup standard to be established within a range of the SCO and CSL. Site specific decisions may establish the cleanup standard closer to the SCO.
- This analysis was conducted with a limited number of bioaccumulative chemicals with the assumption that they may be representative of other bioaccumulative chemicals. Considering the potential number and widespread nature of other contaminants that have yet to be fully investigated due to lack of data, there are uncertainties with this assumption.

B.6 Conclusions

- Ecology does not anticipate that the adopted SMS rule revisions will significantly increase or decrease the number of sediment cleanup sites initially identified. Ecology anticipates that the number and area of sites requiring further investigation and cleanup may be reduced under the adopted rule. However, the number of cleanup sites may increase under the adopted rule relative to the number of sites identified using the SMS benthic criteria.
- Ecology anticipates that clarifying the current listing policies will result in earlier site decisions relative to the current rule.
- The adopted rule revisions will provide the flexibility to use higher listing thresholds for sites requiring further investigation and cleanup for widely distributed bioaccumulative chemicals than allowed under current regulations. However, most sediment contains a wide range of contaminants and this will limit the impact of this revision.
- The adopted listing criteria are similar to the MTCA human health policies that are currently used to implement the narrative provisions in the SMS rule for identifying cleanup sites based on human health protection.

Statewide Impacts

While Ecology did not have adequate data to perform a similar analysis statewide, Ecology believes a similar result would hold in other areas of the state. The benefits and costs resulting from the adopted rule at a representative embayment would be further scaled to include other locations in the state. Since Ecology believes the benefits of the adopted rule exceed the costs at the embayment-level (see above and sections 3.4 – 3.10), scaled up for the state, this conclusion should hold.

Appendix C: Background Information for LBA Analysis

Table 19: Human Health Protection -- Comparison of Original Regulatory Requirements and Adopted SMS Rule

Feature	Original Requirements	Adopted SMS Rule
Decision Framework	The original SMS rule required the SCO and CSL to be established on a case-by-case at concentrations that pose no significant risk to human health. Section 570(5) requires that sediment cleanup standards must be at least as stringent as requirements in other legally applicable regulations.	Ecology proposed to extend the two-tiered decision-making framework in the original SMS rule to include establishing site-specific sediment cleanup standards for human health protection.
Target Cancer Risk Level	The original SMS rule did not identify a specific target cancer risk level for the SCO or CSL, but has a narrative standard. Ecology has interpreted this narrative standard to be the MTCA Method B cleanup levels for individual chemicals which are established using a target cancer risk level of one-in-one million (10^{-6}). Total site risks cannot exceed one-in-one hundred thousand (10^{-5}).	Risk-based cleanup levels for individual carcinogens must be based on an incremental cancer risk of one-in-one million (SCO) and one-in-one hundred thousand (CSL). Total site risks cannot exceed one-in-one hundred thousand (10^{-5}).
Hazard Quotient/ Hazard Index	The original SMS rule did not identify a hazard quotient or hazard index for the SCO or CSL, but has a narrative standard. Ecology has interpreted this narrative standard to be the Method B cleanup levels for individual chemicals which are established using a hazard quotient of one (1). Total site risks cannot exceed a hazard index of one (1)	Risk based cleanup levels must be based on a hazard quotient of one. Total site non-cancer health risks cannot exceed a hazard index of one
Reasonable Maximum Exposure Scenario	The original SMS rule did not identify an exposure scenario. The MTCA rule includes formulae and exposure parameters that are based on a recreational exposure scenario. can be used to calculate surface water cleanup levels	Risk-based cleanup levels must be based on a reasonable maximum exposure scenario. The default RME scenario is a tribal exposure scenario, but Section 561 provides the flexibility to use alternate exposure scenarios
Exposure Parameters	The original SMS rule did not establish default exposure parameters (e.g., fish consumption rates). The MTCA rule includes formulas and default exposure parameters that are used to calculate surface water cleanup levels	The rule does not establish default exposure parameters (e.g., fish consumption rates). The rule identifies several factors that should be considered when making site-specific decisions
Toxicity Values	The original SMS rule did not include criteria for selecting the toxicity values used to calculate cleanup standards. The MTCA rule identifies a hierarchy of toxicity values.	Risk based cleanup levels should be established using toxicity factors that are selected in accordance with EPA's most current toxicity hierarchy.
Other Factors	The MTCA rule states that risk-based cleanup levels should be adjusted upward to reflect natural background concentrations and analytical considerations	Decisions on site-specific cleanup standards should take into account natural and regional background concentrations when establishing SCOs and CSLs, respectively. Decisions on site-specific cleanup standards can take into account analytical limits (the ability to quantify the level of individual chemicals in sediments).

Table 20: Policy Options for Human Health Protection Provisions

Policy Options	Burden on Persons Required to Comply
Target Cancer Risk Level	
1. Target Cancer Risk Level (10^{-6}): Under this option, site-specific cleanup standards for individual chemicals would be established using a target cancer risk of level of one in one million (1×10^{-6}).	Same as Original Rule
2. Target Cancer Risk Level (10^{-5}): Under this option, site-specific cleanup standards for individual chemicals would be established using a target cancer risk of level of one in one hundred thousand (1×10^{-5}).	Decreased Relative to Original Rule
3. Total Site Risk (10^{-5}): Under this option, site-specific cleanup standards for individual substances would be reviewed and, as appropriate, adjusted to ensure that total site risks associated with multiple chemicals/exposure pathways does not exceed a total site risk of one-in-one hundred thousand (1×10^{-5}) .	Same as Original Rule
4. Total Site Risk (10^{-4}): Under this option, site-specific cleanup standards for individual substances would be reviewed and, as appropriate, adjusted to ensure that total site risks associated with multiple chemicals/exposure pathways does not exceed a total site risk of one-in-ten thousand (1×10^{-5}).	Decreased Relative to Original Rule
Hazard Quotient/Hazard Index	
5. Hazard Quotient = 1. Under this option, Ecology would continue to establish cleanup standards using a hazard quotient of one (1). This approach is currently used to establish cleanup standards under the MTCA Cleanup Regulation (See WAC 173-340-700( )).	Same as Original Rule
6. Hazard Quotient = 0.2. Under this option, Ecology would continue to establish cleanup standards using a hazard quotient of 0.2. EPA has used this approach to establish Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Limits (MCLs) under the Safe Drinking Water Act.	Increased Relative to Original Rule
7. Relative Source Contribution (Variable HQ). Under this option, Ecology would use a lower hazard quotient (0.2 to 0.8) for individual hazardous substances based on the amount of exposure that people receive from non-site related-sources of exposure (e.g., diet, air emissions, etc.). This approach is consistent with the approaches used by EPA to establish MCLGs and MCLs and is identified in EPA guidance for water quality standards.	Increased Relative to Original Rule
8. Hazard Index = 1: Under this option, site-specific cleanup standards for individual substances would be reviewed and, as appropriate, adjusted to ensure that total site risks associated with multiple chemicals acting with a similar mode of action does not exceed a hazard index of one (1). This approach is currently used to establish cleanup standards under the MTCA Cleanup Regulation (See WAC 173-340-700(	Same as Original Rule.

9. Hazard Index = 10: Under this option, site-specific cleanup standards for individual substances would be reviewed and, as appropriate, adjusted to ensure that total site risks associated with multiple chemicals acting with a similar mode of action does not exceed a hazard index of ten (10).	Decreased Relative to Original Rule
Reasonable Maximum Exposure	
10. RME –Tribal – General Policy: Under this option, site-specific cleanup standards would be established using a tribal exposure scenario.	Same or Increased Relative to Original Rule
11. RME –Tribal – General Policy and Default Parameters: Under this option, site-specific cleanup standards would be established using a tribal exposure scenario. The SMS rule would establish default values for key parameters such as fish consumption rate & fish diet fraction	Increased Relative to Original Rule
12. RME - Recreational: Under this option, site-specific cleanup standards would be established using the recreational exposure scenario specified in the MTCA Cleanup Regulation (WAC 173-340-730).	Same or Decreased Relative to Original Rule
13. RME – General Population: Under this option, site-specific cleanup standards would be established using a general population exposure scenario.	Decreased Relative to Original Rule
14. RME – Site-Specific. Under this option, the SMS rule would require that site-specific cleanup standards would be established using a RME scenario. The appropriate RME scenario would be determined on a site-specific basis.	Variable
Background Concentrations	
15. Non-Anthropogenic Background: Under this option, risk-based cleanup levels could be adjusted upward to reflect non-anthropogenic background levels.	Increased Relative to Original Rule
16. Natural Background. Under this option, risk-based cleanup levels could be adjusted upward to reflect natural background levels as defined in the MTCA rule.	Same as Original Rule
17. Regional Background. Under this option, risk-based cleanup levels could be adjusted upward to reflect regional background levels. Regional background concentrations reflect widespread low-level contamination not related to the cleanup site.	Decreased Relative to Original Rule
18. MTCA Area Background. Under this option, risk-based cleanup levels could be adjusted upward to reflect area background levels as defined in the MTCA rule.	Decreased Relative to Original Rule

Table 21: Freshwater Sediments -- Comparison of Original Regulatory Requirements and Adopted SMS Rule

Feature	Original Requirements	Adopted SMS Rule
Decision Framework	The SMS narrative standards for freshwater sediments are applied in the two-tiered SMS decision framework.	The chemical and biological criteria for freshwater sediments will be applied in the two-tiered SMS decision framework.
Chemical Criteria	Chemical measurements are compared to the 2003 Interim Sediment Quality Values (Ecology 2003) and/or Consensus Based Sediment Quality Values (MacDonald, et al. 2000).	The adopted SMS rule includes chemical criteria for freshwater sediments that correspond to “no adverse effects” (sediment cleanup objective) and “minor adverse effects” (cleanup screening level). The chemical criteria were developed using the Floating Percentile Method (FPM).
Biological Criteria	Biological test results are compared to biological criteria adopted by the Regional Sediment Evaluation Team (RSET, 2006), statistical comparisons to control or reference samples, and/or site-specific criteria (such as the reference envelope approach).	The adopted SMS rule includes biological criteria that identify test species and endpoints that can be used to identify sediments with “no adverse effects” and “minor adverse effects”. As with the original SMS rule requirements for marine sediments, the biological test results can be used to override evaluations based on chemical criteria. The rule identifies seven approved tests can be used to evaluate contaminated sediments and establishes criteria for interpreting the biological test results consider both statistical and biological relevance.
Alternative Methods/New Scientific Information	The SMS rule also provides the flexibility for Ecology to approve newer tests or endpoints through the Sediment Management Annual Review Meeting or site-specific cleanup decisions.	Ecology would limit the applicability of statewide chemical criteria for certain types of sites (e.g., metals impacted sites). The SMS rule continues to provide the flexibility for Ecology to approve newer tests or endpoints through the Sediment Management Annual Review Meeting or site-specific cleanup decisions.
Other Factors	The MTCA rule states that risk-based cleanup levels should be adjusted upward to reflect natural background concentrations and analytical considerations	Decisions on site-specific cleanup standards should take into account natural and regional background concentrations when establishing SCOs and CSLs, respectively. Decisions on site-specific cleanup standards can take into account analytical limits (the ability to quantify the level of individual chemicals in sediments).

Table 22: Policy Options for Freshwater Sediments

Policy Options	Burden on Persons Required to Comply
Chemical Criteria	
1. Narrative Standard: Under this option, chemical criteria corresponding to "no adverse effects" and "minor adverse effects" would be establishing on site-specific basis.	Same as Original Rule
2. Sediment Quality Values (10% False Negative Rate): Ecology would adopt the freshwater chemical criteria based benthic effects that are based on the floating percentile method with a false negative rate of 10% and overall reliability of 70-80%.	Increased Relative to Original Rule
3. Sediment Quality Values (20% False Negative Rate): Ecology would adopt the freshwater chemical criteria based benthic effects that are based on the floating percentile method with a false negative rate of 20% and overall reliability of 70-80%.	Similar to Original Rule
4. Sediment Quality Values (30% False Negative Rate): Ecology would adopt the freshwater chemical criteria based benthic effects that are based on the floating percentile method with a false negative rate of 30% and overall reliability of 70-80%.	Decreased Relative to Original Rule
5. Consensus-Based Sediment Quality Values: Ecology would adopt the Threshold Effect Concentrations (TEC) and Probable Effect Concentrations (PECs) values.	Increased Relative to Original Rule
6. Alternate Methods: Ecology would limit the applicability of statewide chemical criteria. For example, Ecology could emphasize the use of biological tests and/or site-specific evaluations in certain situations where the statewide values may not reliably predict sediment toxicity.	Similar to Original Rule
Biological Criteria	
7. Narrative Standard: Under this option, biological criteria corresponding to "no adverse effects" and "minor adverse effects" would be establishing on site-specific basis.	Same as Original Rule
8. Minimum Detectable Difference (MDD): Ecology would adopt biological interpretation criteria take into account both statistical significance and biological relevance. Under this option, sediment samples would fail a biological test if the difference between the test sediment and control sediment was (1) statistically significant and (2) greater than a specified thresholds that takes into account the analytical limits of the test.	Similar to Original Rule
9. Reference Envelope Approach: Ecology would adopt biological interpretation criteria take into account both statistical significance and reference sediment characteristics. Under this option, sediment samples would fail a biological test if the difference between the test sediment and control sediment was (1) statistically significant and (2) greater than reference sediment responses (as measured by the 5th percentile of the distribution of reference sediment responses.	Increased Relative to Original Rule

10. Biological Threshold: Ecology would adopt biological interpretation criteria take into account both statistical significance and biological relevance. Under this option, sediment samples would fail a biological test if the difference between the test sediment and control sediment was (1) statistically significant and (2) greater than 20% difference in mortality of growth.	Similar to Original Rule
11. Statistically Significant Difference: Ecology would adopt biological interpretation criteria take into account statistical significance. Under this option, sediment samples would fail a biological test if the difference between the test sediment and control sediment was statistically significant.	Increased Relative to Original Rule