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| 1. | All | | | | **All comments made by Seattle regarding the 2013-2018 NPDES Permit and Appendices apply correspondingly to the SMMWW.** |
| 2. | 1 / 1-6 | 1.5.4 Flow Control BMP's | "Because we have found it very difficult to predict and track water surface elevation changes, the new regulatory strategy is to simply try to match the *pre-developed* surface and groundwater inputs that drive the water surface elevations in wetlands." | The added sentence changes "maintain the natural hydroperiod" to "match pre-developed conditions". Page 2-42 in the MR7 section 2.5.7 refers to "preserve pre-project wetland hydrologic conditions" which is different than pre-developed. MR8 - Section 2.5.8 (pg 2-42) states that "The hydrologic analysis shall use existing land cover condition. | It appears Ecology's intent is to require existing conditions to be matched so language in 1.5.4 should be changed from "pre-developed" to "existing" conditions. The last sentence of paragraph 3 on page 1-6 should also be deleted as pre-development hydrology isn't the issue anymore. |
| 3. | 1 / 2-4 | 2.3 Definitions Related to Minimum Requirements | "Bioretention BMPs – *Engineered facilities* that store and treat stormwater *by passing it through a specified soil profile*." | This definition could also apply to infiltration trenches, which are filled with a specified media. In addition, bioretention systems have historically been used more for flow control than for treatment. This definition implies that they are only used for treatment. | "Bioretention BMPs – Engineered facilities that retain or ~~store and~~ treat stormwater to attenuate or reduce pollutant loading by passing it through a specified soil profile...." |
| 4. | 1 / 2-7 | 2.3 Definitions Related to Minimum Requirements | "*Pervious Surface* – A surface which allows stormwater to infiltrate into the ground. Examples include lawn, landscape, pasture, native vegetation areas, and permeable pavements." | Terminology: The City of Seattle uses, "permeable pavement surface" to permeable sidewalks with minimal storage reservoir. Similarly, City of Seattle uses "permeable pavement facility" to be a larger permeable pavement system with deeper storage reservoir that can receive offsite runon. | Define and reconcile all terms. |
| 5. | 1 / 2-26 | 2.5 Minimum Requirements Element #10 | "b. Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems tributary, to, or directly into surface waters of the state, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters." | Proposed text appears to *require* discharge of non-turbid de-watering water to surface waters.<br><br>There are concerns about both infrastructure capacity and the possible downstream damage to aquatic resources where there are increased flow rates due to new groundwater discharges. | "b. Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems (*with owner/operator approval*) tributary, to, or directly into surface waters of the state, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters *or interfere with the operation of the system*." |

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| 6. | 1 / 2-32 | 2.5.3 Minimum Requirement | "All known, available and reasonable source control BMP's must be selected, designed, and maintained according to this manual." | Is AKART for source control BMPs defined elsewhere in this document? Does this mean comply with Volume IV of the manual? | Delete AKART and refer to Volume IV. |
| 7. | 1 / 2-35 | 2.5.5 MR # 5: On-Site Stormwater Management | LID Performance Standard - Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. | The LID performance standard is a flow control standard but the LID BMPs are put into the treatment volume. | Combine Volumes 3 & 5 into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). Also, rewrite bioinfiltration as a new category of LID BMPs that have flow control AND treatment as primary benefits. |
| 8. | 1 / 2-35 | 2.5.5 MR # 5: On-Site Stormwater Management | Mandatory List #1 | Due to the quantifiable stormwater benefits of trees, Seattle suggests that tree planting be a requirement of both Mandatory Lists #1 & #2.<br><br>BMP T5.13 is not named; reader must go to Volume V to figure out what this is. | "Lawn and landscape areas:<br>• *Post-Construction Soil Quality and Depth in accordance with BMP* T5.13 in Chapter 5 of Volume V, of the Stormwater Management Manual for Western Washington (SMWW[2]) at all projects.<br>• *Provide a minimum of one tree for every 1,000 sf of lawn and landscape area. Trees shall be planted in accordance with Section 7.7.3 of Appendix III-C of Volume III.*" |

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| 9. | 1 / 2-35 | 2.5.5 MR # 5: On-Site Stormwater Management | Mandatory List #2 | Due to the quantifiable stormwater benefits of trees, Seattle suggests that tree planting be a requirement of both Mandatory Lists #1 & #2.<br><br>BMP T5.13 is not named; reader must go to Volume V to figure out what this is. | "Lawn and landscape areas:<br>• *Post-Construction Soil Quality and Depth in accordance with BMP* T5.13 in Chapter 5 of Volume V, of the Stormwater Management Manual for Western Washington (SMWW[2]) at all projects.<br>• *Provide a minimum of one tree for every 1,000 sf of lawn and landscape area. Trees shall be planted in accordance with Section 7.7.3 of Appendix III-C of Volume III."* |
| 10. | 1 / 2-37 | 2.5.5 MR # 5: On-Site Stormwater Management Mandatory List #2 | "3. Bioretention BMP's that have a minimum horizontally projected surface area below the overflow which is *at least 5%* of the total surface area draining to it." | Putting in minimum sizing criteria does not account for site-specific parameter (e.g. infiltration rate). The 20:1 ratio of drainage area to bottom area of the cell is really large especially if there are well-draining soils. | Remove minimum sizing criteria and add design criteria for the Bioretention BMP |
| 11. | 1 / 2-37 | Section 2.5.5 Minimum Requirement #5: O-site Storwmater Management, Mandatory List #2 | Item #3 under both Roofs and Other Hard Surfaces<br>"… If the short-term native soil infiltration rate is less than 0.3 in/hr, do not use this option unless the roof is classified as pollution-generating impervious surface."<br>Change to : | Feasibility criteria should be included in the SMMWW (or Section 8) to be consistent with other BMPs. | "… If the short-term native soil infiltration rate *does not meet the feasibility criteria in Section 8*, do not use this option unless the roof is classified as pollution-generating impervious surface*, in which case this BMP shall be used with an underdrain.*" |
| 12. | 1 / 2-37 | Section 2.5.5 Minimum Requirement #5: O-site Storwmater Management, Mandatory List #2 | Item #5 under Roofs<br>"For a commercial building, a vegetated roof or an impervious roof with runoff routed below permeable pavement…." | Should not be limited to permeable pavement. | Change to:<br>"For a commercial building, a vegetated roof or an impervious roof with runoff routed below ~~permeable~~ pavement…." |
| 13. | 1 / 2-37 | 2.5.5 MR # 5: On-Site Stormwater Management | "5. For a commercial building, a vegetated roof or an impervious roof with runoff routed below permeable pavement. If the latter option is not used, a cost analysis is necessary to claim infeasibility of a vegetated roof." | What are the criteria for evaluating the argument? | Provide a guideline to regulators for feasible cost. Should it be below a certain % of construction costs? Or below a certain % of overall project costs? |

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| 14. | 1 / 2-38 | 2.5.6 MR # 6: Runoff Treatment | "Projects in which the total of pollution generating hard surface (PGIS) is 5,000 sf or more in a threshold discharge area of the project." | It is unclear whether 5,000 sf PGIS means new or new plus replaced. In other sections of the manual this is clearly spelled out. | "Projects in which the total new plus replaced ~~of~~ pollution generating hard surface (PGIS) is 5,000sf or more in a threshold discharge area of the project." |
| 15. | 1 / 2-39 | 2.5.6 MR # 6: Runoff Treatment | "Water Quality Design Storm Volume: The volume of runoff predicted from a *24-hr storm with a 6-month return* frequency." | Why is the single event model still allowed for wet pool facilities, now that Ecology has changed to continuous modeling for everything else? Seems inconsistent. | Delete the 6-month, 24-hr storm volume language. |
| 16. | 1 / 2-44 | 2.5.7 MR # 7: Flow Control | "This standard requirement is waived for sites that will reliably infiltrate all the runoff from hard surfaces and converted pervious surfaces" | What is meant by "reliably infiltrate all runoff"? | Define. |
| 17. | 1 / 3-2 | 3.1.1 Step 1 – Collect and analyze Information on Existing Conditions | "The site analysis *shall include, at a minimum,* the following information: " | | "The site analysis shall include, at a minimum, the following information unless the Administrator has waived as appropriate: |
| 18. | 1 / 3-2 | 3.1.1 Step 1 – Collect and analyze Information on Existing Conditions | | The issue of potentially mobilizing contaminants already present in the underlying soil and/or groundwater is not addressed. | Suggest adding requirement to check for contaminated site issues in the vicinity of a proposed infiltration system to avoid mobilizing contaminants already present in soil and groundwater. |
| 19. | 3 / C-12 | Section 7.4.1 Rainwater Harvesting - Design Criteria | "100% reuse of the annual average runoff volume (use continuous runoff model to get annual average for drainage area)." | | Clarify that while 100% reuse is preferable the requirement is to meet the meet performance standard. |
| 20. | 3 / C-12 | Section 7.4.1 Rainwater Harvesting - Design Criteria | "System designs involving interior uses must have a monthly water balance that demonstrates adequate capacity for each month and reuse of all stored water annually." | | Clarify that while 100% reuse is preferable the requirement is to meet the meet performance standard. |
| 21. | 3 / C-12 | Section 7.4.1 Rainwater Harvesting - Other Criteria | "Restrict use to 4 homes/acre housing and lower densities when the captured water is solely for outdoor use." | This is overly restrictive both in density and enduse. | Rainwater harvesting can be achieved at many site and building scales using many reuse types including irrigation and makeup water. |
| 22. | 3 / C-All pages | Throughout document | Insufficient technical guidance | Rainwater harvesting and cisterns materials need to be more fully developed. | Add language |

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| 23. | 1 / D-7 | Guidelines for Wetlands when Managing Stormwater. | "Criterion 1: total volume of water into a wetland during a single precipitation event should not be more than 20% higher or lower than the pre-development volumes."<br><br>"Criterion 2: Total volume of water into a wetland on a monthly basis should not be more than 15% higher or lower that the pre-development volumes" | It is not clear how these standards were developed. | Municipalities have been required to adopt local "environmentally sensitive ordinances" to mitigate impacts to important ecological resources. Considering a forested land cover scenario for estimating pre-development discharges may not be appropriate. Many wetlands in Seattle have presumably reached some level of equilibrium given the current level of development. Modeling to design for a condition that hasn't existed for more than 100 years may have unintended consequences for some wetlands.<br><br>Language prohibiting drainage discharges that adversely impact a wetland using the wetland's current condition as a baseline would be a better standard, given that DOE has stated "these criteria are based on risk to the resource rather than an actual understanding of the impacts". |
| 24. | 1 / F-1 – F-4 | Appendix I-F Feasibility Criteria for Selected LID BMPs | Feasibility Criteria for Bioretention BMP's and Rain Gardens, Permeable Pavement, Vegetated Roofs. | Feasibility criteria should be included within the applicable BMP section(s) in Volumes III and/or V, and not in the Appendix of Volume I. | Move feasibility criteria for each BMP (bioretention/rain garden, permeable pavement/infiltration below pavement, vegetated roofs) from Volume I to applicable sections that include other BMP design criteria. |
| 25. | 1 / F-1 | Appendix I-F Feasibility Criteria for Selected LID BMPs | Appendix 1 Section 8.I.A<br>"Where the site cannot be reasonably designed to locate bioretention facilities on slopes less than 15%, or if bioretention is within the road right-of-way and the right-of-way cannot be feasibly designed to locate bioretention facilities on slopes less than 8%." | Placing bioretention on slopes greater than 8% requires an unreasonable number of weirs to get the desired performance. | Change to:<br>"Where the site cannot be reasonably designed to locate bioretention facilities on slopes less than ~~15%, or if bioretention is within the road right-of-way and the right-of-way cannot be feasibly designed to locate bioretention facilities on slopes less than~~ 8%." |
| 26. | 1 / F-2 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "In areas with "industrial activity" as identified in 40 CFR 122.26(b)(14)." | Permeable pavements can be used in industrial setting for detention given sufficient impermeable liner sufficient to prevent infiltration into underlying soil followed by an adequate water quality treatment system. This was done at Maryland Navy Shipyard using a lined detention trench that conveyed water to treatment system. | Allow for consideration of these systems given adequate engineering design. |

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| 27. | 1 / F-2 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Within 100 feet of a drinking water well, or a spring used for drinking water supply." | Non-PGIS permeable pavements such as trails would work fine near drinking water wells. | Differentiate setback if for PGIS surfaces. |
| 28. | 1 / F-3 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Where the site cannot reasonably be designed to have a porous asphalt surface at less than 5 percent slope, or a pervious concrete surface at less than 6 percent slope, or a pervious paver surface (where appropriate) at less than 10 percent slope. Portions of pavements that must be laid at greater than 5 percent slope must prevent drainage from upgradient base courses into its base course." | Slope is not defined as surface slope or bottom of excavation slope. | Clarify whether slope refers to surface slope or to slope at the bottom of the excavation at native soil. |
| 29. | 1 / F-3 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Where regular, heavy applications of sand occur to maintain traction during winter." | Define "heavy" and "traction" | |
| 30. | 1 / F-3 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Where infiltrating water below new permeable pavement area would threaten existing below grade basements." | Should not be limited to permeable pavement. | "Where infiltrating water below new ~~permeable~~ pavement area would threaten existing below grade basements." |
| 31. | 1 / F-3 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Where infiltrating and ponded water below new pavement area would compromise adjacent pavements." | While there may be some instances of oversaturation, this is not a given and should not be used as a sole reason to avoid permeable pavement.<br><br>Permeable pavement surfaces such as sidewalks and patios with minimal storage reservoirs would be no different than landscaping adjacent to impermeable surfaces. | |

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| 32. | 1 / F-3 | Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices (I.B) | "Where permeable pavements do not provide sufficient strength to support heavy loads at industrial facilities such as ports." | Too restrictive. Ports in Port Angeles and Portland are using high strength pervious pavers systems in port and heavy use setting that have sufficient strength. Pervious concrete can also be designed for heavy loads H25 etc.<br><br>http://www.landandwater.com/features/vol51no1/vol51no1_2.html<br><br>http://www.peninsuladailynews.com/apps/pbcs.dll/article?AID=2011312029985 | Permeable pavements, like all pavements should be designed to handle the load anticipated for the intended use. |
| 33. | Glossary – 39 | | PGIS | Roofs have historically not been considered pollution generating, however SPU has found that solids collected from some roofs in industrial areas contain elevated levels of metals (copper, lead, mercury, and zinc) and PCBs. | None |
| 34. | 2 / 3-2 | 3.1.3 What is an Adequate Plan? | *"The drawings show, on a site map, BMPs should be installed. The drawing notes describe the performance site BMP's should achieve, and actions to take of the performance goals are not achieved."* | Not clearly written. | "The drawings should show~~,~~ on a site map, the specific BMP's which shall be installed. Provide text notes on the drawings to describe the performance standards the BMP's should achieve, and actions to take if the performance goals are not achieved." |
| 35. | 2 / 3-3 | 3.1.4 BMP Standards and Specifications | | Control de-watering is one of the 13-required elements. Inclusion of control of groundwater during construction as bullet item. | Include as bullet item:<br>*"• Groundwater associated with construction activity. "* |
| 36. | 2 / 3-8 | 3.3 Step-By-Step Procedure | Data Collection<br>Data Analysis | Section 3.3 Data collection and data analysis are broader requirements than what is required to prepare the Construction SWPPP. Step 1 should refer to the information collected as part of the Preparation of Stormwater Site Plans, | 3.3 Step-by-Step Procedure:<br>1) Review data collected in Step 1 for the Stormwater Site Plan (Reference Volume 1, Chapter 3.1.1)<br>2) Analyze data for Construction SWPPP concerns |
| 37. | 2 / 3-13 | 3.3.3 Step 3 - Construction SWPPP Development and Implementation | "Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site, as required by local permitting authority." | Include groundwater as discharge component for requirement to control flow rates. Groundwater dewatering from excavations/ trenchlines can cause erosion and damage aquatic resources when not properly controlled (release rates). | "Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff and groundwater from the project site, as required by local permitting authority." |

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| 38. | 2 / 3-14 | 3.3.3 Step 3 - Construction SWPPP Development and Implementation | "Additional Guidance – Conduct downstream analysis if changes in offsite flows could impair or alter conveyance systems, streambanks, bed sediment, or aquatic habitat. *See Chapter 3 for offsite analysis guidelines."* | This should refer to Volume I. | "See Volume 1 ~~Chapter 3~~ for offsite analysis guidelines." |
| 39. | 2 / 3-22 | 3.3.3 Step 3 - Construction SWPPP Development and Implementation | "Suggested BMP's<br>BMP C202: Channel Lining<br>BMP C209: Outlet Protection" | Element #8 page 3-22 Additional Guidance describes check dams but doesn't list them in the BMPs | "Suggested BMP's<br>BMP C202: Channel Lining<br>BMP C207: Check Dams<br>BMP C209: Outlet Protection"<br>Include check dam BMP |
| 40. | 2 / 3-24 | 3.3.3 Step 3 - Construction SWPPP Development and Implementation | Discharge foundation, vault and trench de-watering water, which has similar characteristics to stormwater runoff at the site into a controlled conveyance system before discharge to a sediment trap or sediment pond. | Proposed text appears to *require* discharge of non-turbid de-watering water to surface waters.<br><br>There are both infrastructure capacity concerns with large groundwater discharges as well as the possible downstream damage to aquatic resources where there are increased flow rates due to new groundwater discharges. | With owner/operator approval, clean, non-turbid de-watering water, such as well-point ground water, may be discharged to systems tributary to, or directly into surface waters of the State, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters or interfere with the operation of the system. |
| 41. | 2 / 3-20 | 3.3.3 Element #7 | In the first bullet, please further specify 'all storm drain inlets made operable during construction'. Does this mean all storm drain inlets that have potential to receive drainage water discharge from the construction site? | The permanent drainage system may not have a requirement for treatment, and as areas are stabilized "filtering or treated" as a requirement may not be possible. | Protect all storm drain inlets made operable during construction so that construction, or turbid, stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment. |
| 42. | 2 / 3-24 | 3.3.3 Element #10 | First bullet doesn't specify that this refers to groundwater encountered during excavation for these structures, which is what assumedly this element is addressing. | This could be interpreted to mean effluent collected in existing underground utility vaults and from foundation drains. | "Discharge foundation, vault, and trench de-watering water, which have similar characteristics to stormwater runoff at the site, into a controlled conveyance system before discharge to a sediment trap or sediment pond." |
| 43. | 2 / 3-24 | 3.3.3 Element #10 | BMP's are limited to sediment trap or sediment pond. | There is often not enough room for these facilities in urban environment. | …which have similar characteristics to stormwater runoff at the site into a controlled conveyance system before discharge to an appropriate treatment BMP ~~sediment trap or sediment pond.~~ |
| 44. | 3 / iv & 3 / v | Table of Contents | | Table of contents repeated twice. | |

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| 45. | 2 / 3-24 | 2.5 Minimum Requirements Element #10 | "b. Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems tributary, to, or directly into surface waters of the state, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters." | Proposed text appears to *require* discharge of non-turbid de-watering water to surface waters.<br><br>There are concerns about both infrastructure capacity and the possible downstream damage to aquatic resources where there are increased flow rates due to new groundwater discharges. | "b. Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems (*with owner/operator approval*) tributary, to, or directly into surface waters of the state, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters *or interfere with the operation of the system.*" |
| 46. | 3 / iv & 3 / v | Table of Contents | | Table of contents repeated twice. | |
| 47. | 3 / 2-12 | 2.2.3 Guidance for flow-related standards | "Minimum Requirement #5 allows the user to demonstrate compliance with the LID performance Standard of matching the developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak'." | Definitions and descriptions should be consistent Appendix 1 of the Permit and the SMMWW. | "Minimum Requirement #5 allows the user to demonstrate compliance with the LID performance Standard of matching the developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak'. Refer to the Standard Flow Control Requirement section in Minimum Requirement #7 for information about the assignment of the pre-developed condition." |
| 48. | 3 / 3-12 | 3.1.2 Downspout Dispersion Systems | "For purposes of maintaining adequate separation of flows discharged from adjacent dispersion devices, the outer edge of the vegetated flowpath segment for the dispersion trench must not overlap with other flowpath segments, *except those associated with sheet flow from a non-native impervious surface"* | What is meant by "sheet flow from a non-native impervious surface"? | The need to keep flowpaths separate from distinct tributary areas is understood. Does this refer to an off-site impervious surface that is not within the control of the project? |
| 49. | 3 / 3-65 | 3.3 Infiltration Facilities for Flow Control and Treatment | Section 3.3.2 Description: | This description needs to be clear about what is included, specifically if bioretention and permeable pavement are included as "infiltration facilities". Most of the text in the section suggests that this section is specific to large scale infiltration facilities, but including the small-scale PIT and reference to bioretention and permeable pavement facilities makes it unclear what facilities are included and subject to the requirements of the section. | Please clarify. |

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| 50. | 3 / 3-65 | 3.3 Infiltration Facilities for Flow Control and Treatment | …provided that the infiltrated stormwater *does not cause a violation of ground water quality standards*…at a minimum, *pre-treatment for removal of TSS* is necessary prior to discharge to the infiltration facility. | Protection of ground water quality. The manual states that infiltration systems cannot cause a violation of ground water quality standards, but the required pre-treatment BMPs only remove TSS, which would not necessarily protect ground water quality. This is a basic disconnect between the flow control infiltration devices and the treatment infiltration devices and how well flow control infiltration devices ensure protection of water quality for discharges from PGIS. | Not clear how to rectify. Please affirm that as-written the pre-treatment requirement meets AKART standard. |
| 51. | 3 / 3-68 | 3.3 Infiltration Facilities for Flow Control and Treatment | In addition, *the overflow/bypass must meet the LID perfor0mance standard* if it is the option chosen to meet MR # 5, or if it is required of the project. | Requirement for meeting LID performance standard for overflow/bypass. Infiltration systems sized to meet the flow control standard are already infiltrating/treating the majority of the stormwater. Why then would LID be required for the small amount that is bypassed? This seems like overkill | Delete this requirement. |
| 52. | 3 / 3-70 | Section 3.3.3.7: Construct the facility and Conduct Performance Testing | The constructed facility must be tested and monitored to demonstrate that the facility performs as designed. If the facility performance is not satisfactory, the facility will need to be modified or expanded as needed in order to make it function as designed. | There is no precedent for a facility, which is designed and constructed in accordance with the manual, to be revised once a permit is issued. What would Ecology require if the facility could not be modified? The express reason for factors of safety and correction factors, is to accommodate the changes between design and construction. How is "satisfactory" defined? Within the factor of safety, the initial design infiltration rate? | Delete proposed new language and retain language as provided within the current Manual. |
| 53. | | | | | |
| 54. | 3 / 3-72 | 3.3.5 Site Characterization Criteria | Surface Features Characterization | | Under Surface Features Characterization, add #6 - Winter evaluation of site to note any observed springs or seeps. |

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| 55. | 3 / 3-72 | 3.3.5 Site Characterization Criteria | "Subsurface Characterization:1. Subsurface explorations to a depth below the base of the infiltration facility of at least 5 times the maximum design depth of ponded water proposed for the infiltration facility, *or at least 2 feet into the saturation zone.*<br>*2. Continuous sampling to a depth below the base of the infiltration facility of 2.5 times the maximum design ponded water depth, or at least 2feet into the* saturated zone." | Saturation zone has not been defined. | Define saturation zone.<br><br>Edit #2 to say "saturation zone" instead of "saturated zone" for consistency. |
| 56. | 3 / 3-72 | 3.3.5 Site Characterization Criteria | Subsurface Characterization 2. For trenches, *at least one test pit or test hole per 50 feet of trench length* (in no case less than two per trench) | Performing one test pit or test hole per 50 feet of trench length is excessive as a minimum requirement. | Change to one test pit or test hole per 250 feet of trench length. |
| 57. | 3 / 3-73 | 3.3.5 Site Characterization Criteria | 3. The licensed professional *may consider additional methods of analysis* to substantiate the presence of stratification that will significantly impact the design of the infiltration facility. | What methods is the author referring to? Field tests? Calculations? | Add examples of "analysis". |
| 58. | 3 / 3-73 | 3.3.5 Site Characterization Criteria | 4. If gradient and flow direction are not required, and there is low risk of down-gradient impacts, *one monitoring well is sufficient.* | Provide additional discretion to local jurisdiction. | Change "is sufficient" to "may be sufficient". |
| 59. | 3 / 3-73 | 3.3.5 Site Characterization Criteria | "*If the ground water in the area is known to be greater than 50 feet below the proposed facility*, detailed investigation of the ground water regime is not necessary. | Does this include perched ground water layers? | "If the confining ground water layer in the area is known to be greater than 50 feet below the proposed facility, detailed investigation of the ground water regime is not necessary. |
| 60. | 3 / 3-74 | 3.3.5 Site Characterization Criteria | Infiltration Rate Determination: Such site testing is necessary to refine preliminary infiltration rate estimates based on soil size distribution *or textural analysis.* | The textural analysis method was deleted in "Soil Testing". | Delete "or textural analysis". |
| 61. | 3 / 3-74 | 3.3.5 Site Characterization Criteria | Soil testing: Percent clay content. | Why is this a requirement for soil characterization if the designer is not relying on grain size for infiltration estimates? | Make the first bullet read "Grain-size distribution (ASTM D422…) and percent clay content (include type of clay, if known). (If using the grain size analysis method…)" |

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| 62. | 3 / 3-78 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | | This section has many terms that are confusing because the definitions are not given in the document and the text seems to refer to them in different ways. The terms are:<br>1) Saturated Hydraulic Conductivity<br>2)Initial Saturated hydraulic Conductivity<br>3) Design Saturated Hydraulic Conductivity<br>4) Short Term Saturated Hydraulic Conductivity<br>5)Initial Infiltration Rate<br>6)Design Infiltration Rate<br>7)Short Term Infiltration Rate<br>8)Long Term Infiltration Rate | Define each of these terms and be consistent in how they are used. For example, if initial = short term, then just pick one of those and always use the same terminology so the reader is not confused. |
| 63. | 3 / 3-79 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | In the Detailed Approach (Section 3.3.8), the long-term infiltration rate is derived by correction factors and additional equations to convert the initial SHC to an infiltration rate, and the applying an additional correction factor. | The sentence "In the Detailed Approach…" is confusing. | Revise to say "In the Detailed Approach (Section 3.3.8), the long-term infiltration rate is derived by applying correction factors and additional equations to the initial SHC." |
| 64. | 3 / 3-83 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | 5th bullet: Add water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate) while maintaining the same pond water level. (usually 17 hours) | Why is 17 hours stated as "usual"? Where is the reference for this? In our experience, the time to reach saturation depends on the soil type, density, and groundwater conditions at the time of testing. | Delete "Usually 17 hours". |
| 65. | 3 / 3-83 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | 5th bullet: | 5th bullet: the data collected when the water is turned off is not utilized in the example calculations. Does this data need to be collected if it is not recommended for calculation of the SHC? | Make this data collection optional. |
| 66. | 3 / 3-84 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Data Analysis: Calculate and record the *infiltration rate* in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized. | Terminology | Change to read "Calculate and record the saturated hydraulic conductivity…" |

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| 67. | 3 / 3-84 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Example: Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of *(9.8+12.3)/2=11.1 inches per hour* | Example calculations are unclear because unit conversions are not shown. | Show calculations for how you get the value of 9.8 and 12.3 in/hr. |
| 68. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | In the case of bioretention, excavate to the estimated elevation at which the *imported native soil* will lie on top of the underlying native soil. | Doesn't meet design criteria. | Revise "imported native soil" to read "imported bioretention soil." |
| 69. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria "Infiltration Test" | "...Note that the permeable pavement design guidance recommends compaction not exceed 90%... " | Specify what compaction test, standard proctor or modified proctor for the requirement, | Define proctor type |
| 70. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | The horizontal surface area of the bottom of the test pit should be *12 to 32 square feet*. | The suggested surface area for the test pit is quite large, with the lower end of the range larger than feasible to perform in a built environment (i.e. in right of way parking strips) | Change range from 12 to 32 sf to 8 to 32 sf. |
| 71. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | *Add water to the pit* so that there is standing water for at least 6 hours. | How much water? Should it be at a constant height? | Please clarify. |
| 72. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point *(between 6 inches and 1 foot)* on the measuring rod. | 6th bullet: what's the reasoning for the 6 inches to 1 foot? Why not say that it should be similar to the design height of water in the infiltration facility? | Add an explanation for the height restriction so the engineer understands the design concern. If it is to reduce possible horizontal flow, then state that in the guidelines. |

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| 73. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Small-scale PIT. | Is data analysis similar to the large-scale method? | Refer to large-scale section for data analysis. |
| 74. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | 4th paragraph: "If the soil layer being characterized has been exposed to heavy compaction…" | Doesn't belong in this section. | Move entire paragraph to Section 3.3.8, #7. |
| 75. | 3 / 3-85 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Correction Factors | Reference the section with Step 5 for clarity. | Step 5 (Section 3.3.4) |
| 76. | 3 / 3-88 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Correction Factors / Table 3.7 | Based on the changes in CF values, the minimum correction factor is now 0.27, which is equivalent to a safety factor of nearly 4. Is that what was intended? | Consider altering the CF criteria. |
| 77. | 3 / 3-88 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Correction Factors / Table 3.7 | Seattle requires a design rate of at least 0.25 in/hr. Based on the proposed CFs, LID will be discouraged.The CF proposed appear to be overly restrictive and in conflict with Appendix 1 of the NPDES permit which states bioretention or permeable pavement are feasible anywhere the short-term rate is greater than 0.3 in/hr. Based on the proposed CFs, a site with a short-term rate of 1 in/hr would be corrected down to a long-term/design rate of 0.218, which is below Ecology's (and SPU's) threshold for feasibility. | Consider altering the CF criteria. |

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| 78. | 3 / 3-88 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Uncertainty of test method ($Cf_t$) accounts for uncertainties in the testing methods. For the full scale PIT method, $Cf_t = 0.50$; for the small scale PIT method, $Cf_t = 0.33$. | The Test Method correction factor is too restrictive and does not seem to be based on any data. By including this factor, sites that have sufficient infiltration rates for small scale infiltration will be quickly eliminated and the goal for implementing more LID will not be achievable. The recommended infiltration tests are currently the best method for determining short-term infiltration rates and applying such a high CF seems counterintuitive. Adjusting the short-term rate based on the frequency of testing is more appropriate. Ecology should lay out procedures that, when followed by the design professional, yield accurate results. | Delete the "Test Method" correction factor or modify to allow for more accurate representation of the short term infiltration rate. |
| 79. | 3 / 3-88 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Correction Factors | What if the designer does a PIT at the facility location? Can they use a $CF_t = 1$? This CF and the CF range does not address the scale of the project. | Add an option to use CFv = 1 if test is done in exact location of facility or if subsurface is very well characterized. |
| 80. | 3 / 3-88 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Site variability and number of location tested – This might be the case where the site conditions are highly variable due to a *deposit of ancient landslide debris, or buried stream channels.* | Conditions may be highly variable for a whole range of factors, not just ancient landslide debris and buried stream channels. These sentences imply that those are the ONLY reasons for high variation. | Delete the "ancient landslide debris and buried stream channels", or revise language to read: Site variability and number of location tested – This might be the case where the site conditions are highly variable due to *conditions such as*, a deposit of ancient landslide debris, or buried stream channels." |
| 81. | 3 / 3-89 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | Degree of influent control to prevent siltation and bio-buildup – The maintenance schedule calls for removing sediment when the facility is infiltrating at only 90% of its design capacity. | Requirement to maintain when the facility is infiltrating at <90% of design capacity. This requirement is a bit onerous. First, most facilities are not monitored to measure infiltration rate over time. Second, filter infiltration rate starts to decline as soon as the facility is put in operation. A 10% reduction in infiltration rate will occur fairly rapidly. Systems should be designed to account for clogging based on anticipated solids loading, which admittedly is difficult, but the correction factors are supposed to take these issues into account. | Provide an alternative the relies on visual inspection. |

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| 82. | 3 / 3-89 | 3.3.6 Design Saturated Hydraulic Conductivity – Guidelines and Criteria | #2. Correction Factors for Soil Grain Size Method: | The CF for test method is excluded when using grain size, so a method that has less certainty has no CF for test method and has an overall CF less than the PITs. | If using CF for test method, require it for grain size method too. |
| 83. | 3 / 3-89 | 3.3.7 Site Suitability Criteria | For site selection and design decisions a geotechnical and hydrogeologic report should be prepared by a *qualified engineer* with geotechnical and hydrogeologic experience, or a licensed geologist, hydrogeologist, or engineering geologist. | Implies the engineer does not need to be licensed. | Change "qualified engineer" to read "licensed engineer" |
| 84. | 3 / 3-90 | 3.3.7 Site Suitability Criteria | SSC-1 Setback Criteria | Exclusions for sole source aquifers and contaminated sites are not included in the set back criteria. | Suggest excluding infiltration systems over sole source aquifers, particularly those intended for flow control, where pretreatment is only required for TSS removal. This level of pretreatment is not protective of ground water quality. Also exclude infiltration from within xx feet of a contaminated site (soil or groundwater) to prevent existing contamination from migrating offsite or further down gradient. |
| 85. | | | | | |
| 86. | 3 / 3-91 | 3.3.7 Site Suitability Criteria | SSC-4 – For infiltration facilities *used for treatment purposes*, the short-term soil infiltration rate should be *12 in./hr*, or less, to a depth of 2.5 times the maximum design pond water depth, or a minimum of 6 ft. below the base of the infiltration facility. | 1. Why are infiltration rates/drawdown times only established for treatment facilities? Wouldn't these same issues apply to flow control facilities? 2. 12 in/hr infiltration rate seems very high. At this rate, there would likely be very little attenuation for treatment, which would not be very protective of ground water quality. Are these rates consistent with the CEC and organic content requirements of SSC-6? | Consider modifying the soil infiltration rate limit and setting comparable requirements for flow control facilities. The infiltration rates/drawdown times could also be revised to reflect different requirements if the tributary area is PGIS, or non-PGIS. |

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| 87. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | Entire section. | This section is confusing because it discusses procedures for bioretention and permeable pavement but includes no design requirements or reference to where the design requirements area. The use and requirements for LID appear to be sufficiently different to have varying requirements for infiltration testing, correction factors, design procedures, frequency of testing, etc. | Clarify how this section works with Chapter 5 and 7 (permeable pavement, raingardens and bioretention). Combining Volume 3 & 5, and including a subsection for infiltrating BMP's would resolve this. Suggest using bioinfiltration as a new category of LID BMPs that have flow control AND treatment as primary benefits. |
| 88. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | Section 3.4.2: "Testing shold occur between *Dec 1 and April 1."* | Depending on the weather this will not always yield the highest gw levels. | Recommend that testing be performed "at the end of winter when the groundwater is generally at its highest elevation." |
| 89. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | *Projects subject only to MR #1 -#5* should use rain gardens wherever feasible. Simple procedures to test for high ground water and infiltration rate are provided in the "Rain Garden Handbook for Western Wa. Homeowners" | The threshold for using the Rain Garden Handbook test seems too high, currently the language allows this method for up to 5000sf of impervious area. | Threshold should be lowered to projects with 2,000 sf of new and replaced impervious area, project greater than that should be required to do the small scale pit test. |
| 90. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | Long, narrow bioretention facilities, such as one following the road right-of-way, *should have a test location every 50 feet.* | This frequency seems excessive. | Change frequency to one every 250 feet. |
| 91. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | "However, if the site subsurface characterization, including soil borings across the development site, indicate consistent soil characteristics and depths to seasonal high groundwater conditions, the number of test locations may be reduced." | Section 3.3.5 provides criteria geotechnical evaluation, however 3.4 also provides criteria for geotechnical evaluation. In this respect, it is not clear what of Section 3.3.5 Site Characterization Criteria is required for bioretention or permeable pavement. Additionally, those requirements need to be appropriately scaled to the project size. | Clarify application of Section 3.3.5 requirements to Section 3.4. |
| 92. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | | | Section 3.4.2: 4th paragraph "…and depths to seasonal high groundwater conditions add "*or the hydraulic restriction layer."* |
| 93. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | If a *single bioretention faciltiy serves a drainage area exceeding 1 acre,* a groundwater mounding analysis should be done in accordance with section 3.3.8. | Define what is meant by "single bioretention facility" - one or many cells or many interconnected cells. | |

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| 94. | 3 / 3-115 | 3.4 Site Procedures for Bioretention and Permeable Pavement | If a single bioretention faciltiy serves a *drainage area exceeding 1 acre, a groundwater mounding analysis* should be done in accordance with section 3.3.8 | The 1 acre threshold is too large and seems in conflict with LID facilities that are small-scale and distributed. | Change threshold for mounding analysis to greater than 10,000sf |
| 95. | 3 / 3-116 | 3.4 Site Procedures for Bioretention and Permeable Pavement | Each design infiltration rate is the measured infiltration rate multiplied by the appropriate correction factors. For these native soils below bioretetntion soils, the variability correction factor, $CF_v$ and the test correction factor, $CF_t$, come into play. | The discussion of CFs for bioretention is inconsistent with Section BMP T7.30 p. 7-21 "Determining subgrade infiltration rates". This section says to use a CF of 1. | Make consistent the CF requirements for bioretention between the flow control and treatment sections. |
| 96. | 3 / 3-116 | 3.4 Site Procedures for Bioretention and Permeable Pavement | A small-scale PIT should be performed for *every 2,500sf of permeable pavement,* but not less than 1 test per site. | What if the pavement is only receiving what falls on it? PITs should not be necessary, as this is like rain falling on grass. | "When permeable pavement infiltrates only direct rainfall, and does not receive run-on from adjacent areas, a PIT test is not necessary" |
| 97. | 3 / 3-116 | 3.4 Site Procedures for Bioretention and Permeable Pavement | "Where drainage plan submittals included assumptions in regard to size and location of permeable pavement, approval of the plat or short-plat should identify the *bioretention* obligation of each lot.." | | Change bioretention to permeable pavement |
| 98. | 3 / 3-117 | 3.4 Site Procedures for Bioretention and Permeable Pavement | "As an alternative, walks, patios, and driveways with little storage capacity in the gravel bedding beneath them, can simply be entered as lawn/landscape areas in the continuous runoff model." | Requiring a runoff model for very small sites is overly complicated and may reduce the implementation of infiltrating systems.. | In instances where a sidewalk or small parking area (1 or 2 stalls) is located over well draining soils on a small site, continuous simulation should not be required; call it landscaping. |
| 99. | 3 / 3-117 | 3.4 Site Procedures for Bioretention and Permeable Pavement | "There has been a suggestion that the designer needs to take a broad view of the site in regard to where volumes of water, infiltrated by bioretention/rain garden facilities and porous pavements, will travel. Some type of guidance in regard to assessing the potential for excessive shallow interflow emerging at slopes, development cuts, or in basements seems advisable. Also, the potential for water piling up above a shallow water table should be evaluated. Should this guidance appear as part of Site Planning and Layout? What would it include other than the generalized cautions noted above?" | Agreed | Consider the following text: "A professional engineer shall be required to evaluate upstream, onsite and downstream hydrologic connectivity of surficial conveyance channels and points of concentration to reduce the risk of localized flooding." |
| 100. | 3/ Ref-1 | Volume III References | | Vol III references are missing Massman 2003, Pitt 2003. | |

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| 101. | 3 / C-2 | 7.1 Permeable Pavements | "b) With underlying perforated drain pipes for stormwater collection:<br>• at or below bottom of base layer Impervious surface<br>• elevated within the base course Impervious surface" | The key is, "elevated above the base course". Credit as landscape should be given for instances where perf pipe is sufficiently high to manage required storm events. However, if the system is dewatering, then credit should be impervious. | See notes to left |
| 102. | 3 / C-6 | 7.1.2 Design Criteria for Permeable Pavements | " Grid/lattice systems filled with gravel, sand, or a soil of finer particles with or without grass: The fill material must be at least a minimum of 2 inches of sand, gravel, or soil. It should be underlain with 6 inches or more of sand or gravel to provide an adequate base. The fill material should be at or slightly below the top elevation of the grid/lattice structure. " | Should be installed per manufacturer's recommendation to prevent damage to system. | " Grid/lattice systems filled with gravel, sand, or a soil of finer particles with or without grass: The fill material must be at least a minimum of 2 inches of sand, gravel, or soil. It should be underlain with 6 inches or more of sand or gravel to provide an adequate base. The fill material should be installed per manufacturer's recommendation. ~~The fill material should be at or slightly below the top elevation of the grid/lattice structure.~~ " |
| 103. | 3 / C-6 | 7.1.2 | "Slope impervious runoff away from the permeable pavement to the maximum extent practicable.<br>" | Clean runoff should be allowed on permeable pavement granted sufficient management of the pollutant load (and associated surface cleaning) and adequate sizing of the storage reservoir. | Runon from impervious surfaces should be evaluated and modeled accordingly. Where moderate to heavy pollutant loading is anticipated, and adaptive maintenance plan should be instituted to ensure preservation of infiltration rates above 10 inches per hour. |
| 104. | 3 / C-13 | 7.7 Tree Retention and Planting | | Tree retention and planting should be part of the Mandatory List #1 and #2 in Appendix I. The combined interception and retention of rainfall by trees and their associated canopy can be significant. | |
| 105. | 3 / C-17 | 7.8 Soil Quality and Depth | "All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following" | There should be a reference to setback requirements from existing and proposed utilities, poles, structures, etc. | |
| 106. | 5 / 1-3 | 1.4.3 Treatment Methods | Infiltration refers to the use of the filtration, adsorption and biological decomposition properties of *naturally occurring* soils to remove pollutants as stormwater soaks into the ground. | Wrong word selection. | Replace "naturally occurring soils" with "native soils with or without amendments" |

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| 107. | 5 / 1-4 | 1.4.3 Treatment Methods | Addition of "Bioinfiltration". | This new definition of bioinfiltration as a category of treatment BMPs is not consistent with existing use and classification of BMPs. Bioretention, for example, has historically been used as primarily a flow control BMP for Seattle's capital projects. | As noted above in "general comments" combining Volume 3 & 5, and including a subsection for infiltrating BMP's would resolve this. Suggest using bioinfiltration as a new category of LID BMPs that have flow control AND treatment as primary benefits. |
| 108. | 5 / 2-3 | 2.1 Step-by-step selection process for treatment facilities. Table 2.1 | "Apply Infiltration" | BMPs listed in Vol 3 should be added as they can also provide treatment. | Rain Gardens, CAVFS (BMP T7.40), permeable pavement, and infiltration below hard surfaces need to be added |
| 109. | 5 / 2-3 | 2.1 Step-by-step selection process for treatment facilities. Table 2.1 | Apply Phosphorous Control Facility | Removed amended sand filter | Not having design criteria does not seem like an adequate reason for removing this bmp. |
| 110. | 5 / 2-7 | 2.1 Step-by-step selection process for treatment facilities. | Step #5 – Determine if Enhanced Treatment is Required.<br>…Industrial project sites<br>Commercial project sites<br>Multi-family project sites<br>High AADT roads… | List of projects sites that trigger Enhanced don't match up with local land use types and exclude things like institutional uses such as schools, churches etc. | Suggest replacing project types " industrial, commercial and multifamily" with "non-SFR ".<br><br>High AADT would stay the same.<br><br>It seems like this would be consistent with the intent to exclude only SFR projects/zones. |
| 111. | 5 / 2-9, 2-11 | 2.2 Other Treatment Facility Selection Factors | 2nd paragraph and Table 2.1 | Removal of pollutants of concern tables | These are helpful and suggest they not be removed. If the issue is they haven't been updated, then just state a date on them and say more information is available at the national BMP database. |
| 112. | 5 / 2-11 | 2.2 Other Treatment Facility Selection Factors | Exisiting Table 2.3 | Heading needs to be modified to include new terms and all BMP's. | add "bioinfiltration" to "infiltration" column |
| 113. | 5 / 3-2 | 3.2 Oil Control Menu | Gasoline stations, with or without small food stores, will likely exceed the high-use site threshold. | This is not written in the form of a enforceable requirement. | The following is high use unless the responsible party demonstrates to the satisfaction of the local jurisdiction that the project will generate less than 100 vehicles per 1,000sf of gross building area: uncovered parking lot accessory to any fast-food restaurant, convenience market, supermarket, shopping center, discount store, movie theater, athletic club, or bank. |

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| 114. | 5 / 3-5 | 3.3 Phosphorous Treatment Menu | Removal of Amended Sand Filter | Why is this being removed? | Recommend allowing amended sand filters for phosphorus treatment. These systems are not much different than the CAVS and the media filter drain (BMP 8.40), both of which are approved for phosphorus treatment. Design criteria could be the same as specified for sand filters for infiltration rate and for these 2 devices for media amendments. |
| 115. | 5 / 3-6 | 3.4 Enhanced Treatment Menu | Performance Goal: Based on a review of dissolved metals removal of basic treatment options, a "higher rate of removal" is currently defined as greater than 30% dissolved copper removal, and greater than 60% dissolved zinc removal. | 60% dissolved zinc target.<br>too high of a standard and could result in no new TAPE based approvals for emerging technologies. | |
| 116. | 5 / 3-7 | 3.4 Enhanced Treatment Menu | Removal of Amended Sand Filter bullet | Why is this being removed? | Retain Amended Sand Filters |
| 117. | 5 / 3-8 | 3.4 Enhanced Treatment Menu | Bioretention bullet | Reference to an outside document which has not been available for review. | Incorporate minimum requirements/guidelines for bioretention specifications into SMMWW. |
| 118. | 5 / 3-10 | 3.5 Basic Treatment Menu | Note: ~~Any Stormwater runoff that infiltrates through the imported soil mix will have received the equivalent of Enhanced Treatment.~~ | This note previously described how Bioretention met enhanced treatment and some sizing information, the enhanced language was removed (and left in the enhanced treatment menu section 3.4. )Not sure for the need for the design criteria when none is provided for the other listed BMPs | Suggest removing the entire "Note:" under Bioretention |
| 119. | 5 / 3-10 | 3.5 Basic Treatment Menu | Bioretention bullet | Reference to an outside document which has not been available for thorough review. | Incorporate minimum requirements/guidelines for bioretention specifications into SMMWW. |
| 120. | 5 / 3-11 | 3.5 Basic Treatment Menu | Note: Wet vaults may be used for commercial, industrial or road projects with space limitations. Ecology discourages the use of wet vaults for residential projects. | 1) "Discourages" is hard to implement. 2) The use of project types doesn't match up with local land use descriptions.<br><br>It is also unclear if excluding multifamily from the list of projects was on purpose? Mixed Use and townhouse complexes often have extreme space limitations, so it doesn't seem appropriate to exclude them from using wet vaults. | "Wet vaults may be used for projects when there are space constraints that prohibit implementation of other BMP's". |

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| 121. | 5 / 4-1 | 4.1.1 Water Quality Design Storm Volume | "The volume of runoff predicted from a 24-hr storm with a 6-month return frequency" | Why is this still being used? Every other BMP must use continuous flow modeling. King County and COS have both moved to this standard for all BMPs. Designers have to have software anyway so it is not an additional burden. | Remove text relative to 6-month 24-hour storm. This will simplify text and allow removal of tables for precip (appendix 1-B of volume 1) |
| 122. | 5 / 4-2 | 4.1.2 Water Quality Design Flow Rate | "At the time of publication, all BMP's except wetpool-types should use the 15-minute time series from an approved continuous runoff model." | Use of single event modeling for wetpools. | Remove first sentence saying all BMPS except wetpools must use 15-minute time series from a continuous flow model |
| 123. | 5 / 4-5 | 4.2 Sequence of Facilities | Table 4.1 | List of BMPS does not appear to be complete. | Add some text to address emerging technologies |
| 124. | 5 / 4-30 | 4.6 Maintenance Standards for Drainage Facilities | Table 4.5 No. 1 | Revised cleanup standard for trash and debris from 5 CF to 1 CF, but left in text about how that is equal to fill up a standard size garbage can | Remove parenthetical text about garbage can size |
| 125. | 5 / 4-46 | 4.6 Maintenance Standards for Drainage Facilities | Table 4.5 No. 15 | leaf compost media stormfilter maintenance guidelines | remove |
| 126. | 5 / 4-49 | 4.6 Maintenance Standards for Drainage Facilities | Table 4.5 No. 18 | Catch basin inserts maintenance guidelines. | remove |
| 127. | 5 / 4-50 | 4.6 Maintenance Standards for Drainage Facilities | Ecology will consider suggestions submitted from commenter's. | Seattle has extensive Bioretention maintenance standards | See attached Seattle Bioretention Maintenance Standards. |
| 128. | 5 / 4-50 | 4.6 Maintenance Standards for Drainage Facilities | Ecology will consider suggestions submitted from commenter's. | Seattle has extensive Permeable Pavement maintenance standards | See attached Seattle Permeable Pavement Maintenance Standards. |
| 129. | 5 / 5-1 | Chapter 5 | On-Site Stormwater Management | This chapter entitled "on-site Stormwater management" is out of place in the treatment volume of the manual. The chapter includes treatment, flow control and LID sizing criteria, a mix of infiltration and dispersion BMPs and post-construction soil quality which isn't a treatment BMP at all. | Combine Volumes 3 & 5 into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). |
| 130. | 5 / 5-1 | 5.2 Application | The On-Site Stormwater Management BMP's presented in this Chapter *help achieve compliance with MR # 5*. | Why are on-site stormwater BMPs only credited as helping achieve compliance with only minimum requirement #5 when they can also help achieve at least partial compliance with the treatment and flow control requirements? | Add following to first sentence under this section: …." (onsite stormwater management), #6 (stormwater treatment), and #7 (flow control). |

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| 131. | 5 / 5-3 | 5.3.1 Dispersion and Soil Quality BMP's (Required for Manual Equivalency) | (Required for Manual Equivalency) | "Required for Manual Equivalency"<br>Why is this text here? There aren't other sections where equivalency requirements are called out. This causes confusion about Ecology's intentions. | Remove parenthetical text about equivalency |
| 132. | 5 / 5-3 | 5.3.1 Dispersion and Soil Quality BMP's (Required for Manual Equivalency) | BMP T5.10 Downspout Dispersion | This BMP doesn't fit in the water quality section. Ecology's text states: "dispersion attenuates peak flows…allows for some infiltration, and provides some water quality". Credits for each BMP are outlined as flow reduction credits; there is no credit for water quality. In addition dispersion BMPs are also replicated in whole in volume 3 further confusing which requirements apply. | Combine Volumes 3 & 5into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). |
| 133. | 5 / 5-8 | 5.3.1 Dispersion and Soil Quality BMP's (Required for Manual Equivalency) | 3rd and 5th bullet: "For purposes of maintaining adequate separation of flows discharged from adjacent dispersion devices, the outer edge of the vegetated flowpath segment for the dispersion trench must not overlap with other flowpath segments, except those associated with sheet flow from a non-native impervious surface." | The language in these bullets is confusing. What is meant by "non-native impervious surface"? | Please clarify. |
| 134. | 5 / 5-10 | 5.3.1 Dispersion and Soil Quality BMP's (Required for Manual Equivalency) | BMP T5.11 Concentrated Flow Dispersion | This bmp doesn't fit in the water quality section. Ecology's text states: "dispersion attenuates peak flows…allows for some infiltration, and provides some water quality". Credits for each bmp are outlined as flow reduction credits; there is no credit for water quality. In addition dispersion BMPS are also replicated in whole in volume 3 further confusing which requirements apply. | Combine Volumes 3 & 5into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). |
| 135. | 5 / 5-12 | 5.3.1 Dispersion and Soil Quality BMP's (Required for Manual Equivalency) | BMP T5.12 Sheet Flow Dispersion | This bmp doesn't fit in the water quality section. Ecology's text states: "dispersion attenuates peak flows…allows for some infiltration, and provides some water quality". Credits for each bmp are outlined as flow reduction credits; there is no credit for water quality. In addition dispersion BMPS are also replicated in whole in volume 3 further confusing which requirements apply. | Combine Volumes 3 & 5into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). |

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| 136. | 5 / 5-17 | BMP T5.14 Rain Gardens | No language | Text not available for review. Additionally referring to documents not adopted as part of the SMMWW – (Rain Garden handbook for Western Washington Homeowners) poses enforceability concerns. | Provide text for review, and incorporate into SMMWW. |
| 137. | 5 / 5-17 | BMP T5.15 Permeable Pavements | No language | Text not available for review. Additionally referring to documents not adopted as part of the SWMMWW - (LID Technical Guidance Manual) poses enforceability concerns. | Provide text for review, and incorporate into SMMWW |
| 138. | 5 / 5-18 | BMP T5.30 Full Dispersion | This BMP allows for "fully dispersing" runoff from impervious surfaces and cleared areas of development sites that protect at least 65% of the site in a forest or *native condition*". | What is meant by "native conditions"? Does this refer to "native vegetation"? Additionally, this BMP doesn't fit in the water quality section. | This BMP allows for "fully dispersing" runoff from impervious surfaces and cleared areas of development sites that protect at least 65% of the site ~~in~~ as ~~a~~ forest or *native vegetation* ~~*condition*~~". |
| 139. | 5 / 5-18 | BMP T5.30 Full Dispersion | Other types of development that retain 65% or native condition may also use these BMP's to *avoid triggering the flow control facility requirement.* | Allowing the use of full dispersion to avoid triggering flow control facility requirements. This seem contrary to how triggering of thresholds is determined everywhere else. The new terminology for hard surfaces seems it was intended to not allow applicants to reduce new and replaced impervious to below a threshold by installing permeable, but now it is being allowed by using dispersion and retaining native? | need explanation of "may also use these BMPS to avoid triggering the flow control facility requirement" |
| 140. | 5 / 5-22 | 5.3.2 Site Design BMPs | BMP T.5.20 Preserving *"Natural"* Vegetation | Appendix 1 states that "permittees shall identify opportunities to minimize impervious surfaces, *native* vegetation loss, and stormwater runoff in all types of development situations. | Change "natural" to "native" which is the term used in Appendix 1 |
| 141. | 5 / 5 -24 | 5.3.2 Site Design BMPs | BMP T5.21 Design *Guidelines* | How do these site design "guidelines" work in an otherwise regulatory document. What is a local jurisdiction to do with these guidelines? Are they required? | Clarify guideline versus requirement. |
| 142. | 5 / 6-1 | 6.1 Purpose | "This chapter represents the methods that may be used to provide *pretreatment* prior to basic or enhanced runoff treatment facilities. *Pretreatment* must be provided in the following applications." | The only presettling BMP provided is a BMP T6.10 Presettling Basin, which is inappropriate and out of scale for bioretention cells, swales and planter boxes. | Remove this requirement for bioretention cells, swales and planter boxes, or provide alternative, scale appropriate BMP |

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| # | Vol./ Page (s) | Section | SMMWW Language Change | Issue/concern | Comment /proposed permit language change |
| 143. | 5 / 6-1 | 6.1 Purpose | "For sand filters and *infiltration* BMP's to protect them from excessive siltation and debris." | "for sand filters and infiltration BMPS…" Ecology has broken out infiltration from bioinfiltration BMPs. Is it Ecology's intention to not list bioinfiltration here? Specifically at issue is Bioretention. Currently, pretreatment is required prior to Bioretention if the facility is to be used for basic or enhanced treatment. If the BMP is to be used for flow control only it is not required. The size of a full pretreatment facility can be prohibitive in many Bioretention applications. | Recommend leaving bioinfiltration BMP's out of the pretreatment requirement.<br><br>Another option is to reduce the size of the presettling basin "T6.10" from 30% of the 6-mnth/24-hour storm to something less. |
| 144. | 5 / 6-1 | 6.2 Application | *Catch basin inserts may be appropriate in some circumstances to provide oil or TSS control, depending on the type of insert.* | Catch basin inserts are still in this section, however they are not listed as a acceptable BMP for Pretreatment in section 6.3. | Remove CB insert sentence. |
| 145. | 5 / 6-2 | 6.3 BMP's for Pretreatment | BMP T6.10 Design Criteria #2. "If the runoff in the presettling basin will be in direct contact with the soil, it must be lined per the liner requirement in Section 4.4." | Why is a liner required if runoff comes in contact with soil? This is not required for standard wet pool designs. Soil contact provides additional treatment capability, which would enhance performance. This seems to be an unnecessary restriction | Delete #2. |
| 146. | 5 / 7-4 | 7.1 Purpose | "Design details regarding BMP T7.30, Bioretention swales and planter boxes." | Missing "bioretention cells". | "Design details regarding BMP T7.30, Bioretention swales, bioretention cells and planter boxes." |
| 147. | 5 / 7-5 | 7.1 Purpose | | Section 7-4, the title was corrected from bio-infiltration to bioretention, but the Chapter 7 title still needs to be changed to bioretention. | Update the Chapter 7 title from Bio-Infiltration to Bioretention. |
| 148. | 5 / 7-5 | 7.1 Purpose | "an infiltration basin is preferred over a trench for ease of maintenance reasons". | This sentence could be read as both infiltration basins and trenchs are preferable to bio-infiltration. | Add bioinfiltration into the preference list. |
| 149. | 5 / 7-6 | 7.4 BMP's for Infiltration and Bioretention Treatment | BMP T7.10<br>BMP T7. 20 | These BMPs are referenced out to the flow control section, but bioinfiltration is not. | Combine Volumes 3 & 5 into one comprehensive manual to address all permanent stormwater BMP's (water quality, flow control and on-site stormwater management). |
| 150. | 5 / 7-7 | 7.4 BMP's for Infiltration and Bioretention Treatment | The first two bullets bioretention cells, bioretention swales | These paragraphs should contain most of the same information, so the last sentence of the 2nd bullet should also be included in the first bullet. | Recommend combining into one bullet with a sentence that describes the difference between a cell and a swale. |

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| 151. | 5 / 7-7 | 7.4 BMP's for Infiltration and Bioretention Treatment | BMP T7.30 – Where the surrounding native soils have adequate infiltration rates, bioretention can be used as a primary or supplemental retention system | Confusing language. Think this means that BR systems can help partially or fully comply with flow control and treatment requirements. | Suggest changing to "…bioretention can be used to help comply with flow control and treatment requirements." |
| 152. | 5 /7-9 | 7.4 BMP's for Infiltration and Bioretention Treatment | BMP T7.30 – Site Suitability | Siting infiltration facilities in areas where soil may be contaminated or where infiltration could affect mobility of contaminants present in groundwater. This also applies to Volume 3, Section 3.3. | Suggest incorporating language to identify contaminated sites within certain distance of the infiltration facility (using standard agency site lists) before siting an onsite infiltration facility. |
| 153. | 5 /7-9 | 7.4 BMP's for Infiltration and Bioretention Treatment | BMP T7.30 – Site Suitability- A minimum separation of *1 foot from the seasonal high water mark* to the bottom of the bioretention area is recommended where the contributing area of the bioretention has less than 5,000sf of PGIS<br>A minimum separation of *3 feet from the seasonal high water mark* to the bottom of the bioretention area is recommended where the contributing area of the bioretention area is equal to or exceeds any of the following limitations. | These bullets should refer to separation from the hydraulic restriction layer rather than seasonal high water mark. | Change seasonal high water mark to hydraulic restriction layer. |

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| 154. | 5 / 7-11 | 7.4 BMP's for Infiltration and Bioretention Treatment | Design Criteria for Bioretention | The requirements described under "Flow entrance and pretreatment:" are different that those required in Chapter 6. | Clarify the requirements for pretreatment for bioretention. Remove the requirement under Chapter 6. See below for recommended language: |

Recommended language:

<u>Flow Entrance/Presettling</u>

Flow entrance design will depend upon topography, flow velocities, flow volume, and site constraints. Flows entering a bioretention facility should be less than 1.0 foot per second to minimize erosion potential. Vegetated buffer strips are the preferred entrance type because they slow incoming flows and provide initial settling of particulates.

Four primary types of flow entrances can be used for bioretention cells:

- Dispersed, low velocity flow across a grass or landscape area: This is the preferred method of delivering flows to the bioretention cell. This method can provide initial settling of particulates.
- Sheet flow across pavement or gravel and past wheel stops for parking areas
- Drainage curb cuts for driveway or parking lot areas: Curb cuts shall include rock or other erosion protection material in the channel entrance to dissipate energy.
- Pipe flow entrance: Piped entrances shall include rock or other erosion protection material in the channel entrance to dissipate energy and/or provide flow dispersion.

Woody plants should not be placed directly in the entrance flow path because they can restrict or concentrate flows and can be damaged by erosion around the root ball.

Minimum requirements associated with the flow entrance/presettling design include the following:

- If concentrated flows are entering the cell, engineered flow energy dissipation (e.g., rock pad or flow dispersion weir) must be incorporated
- A minimum 1-inch grade change between the edge of a contributing impervious surface and the vegetated flow entrance is required
- Until the upstream catchment area is thoroughly stabilized, flow diversion and erosion control measures must be installed to protect the bioretention area from sedimentation
-

| Drainage to a single cell/entrance | Presettling requirement |
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| Less than or equal to 2,000 sf | A 1-foot diameter rock pad at bottom of cell (continuation of required rock along slope from entrance) |
| Greater than 2,000 sf up to 10,000 sf | Presettling area* sized per the following:<br>Arterials – 0.5% of drainage area<br>Residential – 0.25% of drainage area |
| Greater than 10,000 sf | Follow pretreatment requirements in Chapter 5 |

* Presettling area is defined as an area specifically designed to capture and hold the flows as it first enters the cell. The bottom of the presettling area should be large rock (XX define size) or concrete with a porous weir that ponds the water to 12 inches in depth

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| 155. | 5 / 7-12 | 7.4 BMP's for Infiltration and Bioretention Treatment | "Curb cut width <*need recommendation on this*>" | | Recommend 18 inch, with 12 inch minimum |

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| 156. | 5 / 7-12 | 7.4 BMP's for Infiltration and Bioretention Treatment | *"Avoid piped flow entrance in this setting."* | | Add the following to end of sentence "If used recommend catch basin or other structure with sediment trap." |
| 157. | 5 / 7-15 | 7.4 BMP's for Infiltration and Bioretention Treatment | Table 7.1 General Guideline for Mineral Aggregate Gradation | These guidelines are more restrictive than Seattle's specification for mineral aggregate, although they meet City of Seattle specs. Seattle has found that they do not need to be so restrictive and could create challenges in finding a product that meets the tighter specs. | Use City of Seattle gradation |
| 158. | 5 / 7-15 | 7.4 BMP's for Infiltration and Bioretention Treatment | c. Compost to aggregate ratio and organic matter content.<br>*Organic matter content: 5-8% by weight.* | Test method not specified | Specify test method. |
| 159. | 5 / 7-15 | 7.4 BMP's for Infiltration and Bioretention Treatment | 5th bullet under Bioretention soil mixes:<br>*Minimum soil depth of 18 inches.* | Covered in next section | Remove from this section |
| 160. | 5 / 7-15 | 7.4 BMP's for Infiltration and Bioretention Treatment | 6th bullet under Bioretention soil mixes: *Initial saturated hydraulic conductivity* of less than 12 inches per hour. | Be clear what is meant by initial saturated hydraulic conductivity, is this the measured uncorrected rate? | Please clarify. |
| 161. | 5 / 7-15 | 7.4 BMP's for Infiltration and Bioretention Treatment | Soil Depth: Soil depth must be a minimum of 18-inches to provide water quality treatment and good growing conditions for selected plants. | | Add bullet - "Soil depth must be a minimum of 12 inches when bioretention area is for flow control only."<br><br>The conflicting design requirements for LID BMP's when they are used for either water quality or flow control could be resolved by combining Vol. 3 & 5 into single manual and making cross references to individual design/construction standards. |
| 162. | 5 / 7-18 | 7.4 BMP's for Infiltration and Bioretention Treatment | Orifice and other flow control structures. *The minimum orifice diameter should be 0.25 inches* to minimize clogging and maintenance requirements. | For underground structure, City of Seattle has a minimum requirement of 0.5 to reduce potential for clogging. | Increase minimum orifice size from 0.25 inches to 0.5 inches. |

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| 163. | 5 / 7-21 | 7.4 BMP's for Infiltration and Bioretention Treatment | Installation: If the design includes curb and gutter, the curb cuts and inlets should be blocked until BSM and mulch have been placed *and planting completed* (when possible), and dispersion pads are in place. | Time for plant establishment is not recommended. | Add to end of paragraph, "Ideally give the plants 3 months before introducing water into the cell." |
| 164. | 5 / 7-23 | 7.4 BMP's for Infiltration and Bioretention Treatment | Determining subgrade infiltration rates. | The threshold for using the small scale PIT is inconsistent with Vol III Section 3.4, which allows the method described in the Rain Garden Handbook for small facilities. | Make requirements consistent, see comments on correction factors – ie method in RG Handbook is suitable for BMP's mitigating < 2,000sf impervious, but small scale PIT method required for BMP's mitigating > 2,000sf. |
| 165. | 5 / 7-24 | 7.4 BMP's for Infiltration and Bioretention Treatment | Determining subgrade infiltration rate – Bioretention swales: approximately 1 small scale PIT *per 50 feet* of swale. | 50 feet is too frequent. | Revise to 1 small scale PT per every 250 feet. |
| 166. | 5 / 8-1 | 8.2 Description | ~~*Sand*~~ filtration | Removing "Sand" from the title allows for addition of media filter drains to this section, but it also opens the door to Bioretention as it is filtration treatment device. The extreme example is Bioretention planters which are listed in the infiltration devices but in reality are only filtration devices. | |
| 167. | 5 / 8-13 | 8.3 Performance Objectives | A typical *sand* filtration system consists of a, a pretreatment system, flow spreader(s), a sand bed, and the underdrain piping. | Use of "sand" filtration instead of simply filtration. | This section needs to have the descriptor "sand" removed throughout as it should be more generic as the change in the title suggests |
| 168. | 5 / 8-13 | 8.3 Performance Objectives | 80% TSS removal at Event Mean Concentrations of 30-300 mg/L meets the basic treatment performance goal. | On page 3-9 the treatment performance goal is stated as "80% of TSS for influent concentrations that are greater than 100 mg/L but less than 200 mg/L".<br><br>The reference to the Austin and KC studies are removed, but the text still discusses experience for sand filters for both regions. | Either leave in 1998 and 2000 references to the studies, or remove all of the reference to data achieved for the study.<br><br>Also - use of EMC versus the actual performance goal of "influent concentrations" is confusing. The basic sand filter performance objective is actually just that stated for all basic treatment BMPS, leaving it at that would be simpler. |
| 169. | 5 / 8-14 | 8.5 Best Management Practices | rest of 8.3 | Same issue as stated above for performance standards for P, oil and metals. Language is confusing. | Replace potential treatment results with actual performance objectives as the section title suggests. |

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| 170. | 5 / 8-21 | 8.5 Best Management Practices | Best Management Practices | Best Management Practices for ?? | Suggest adding "for sand filters" in the title to this section. This has been done in other similar sections, which helps reader identify location. Should be done for all similar sections. |
| 171. | 5 / 8-21 | 8.5 Best Management Practices | BMP T8.20 Sand Filter Vault - Design criteria | Why specifically call out "hydraulics and additional criteria" under design criteria? | Suggest simply referencing the sand filter basin (BMP T8.10) without identifying specific subsections, as most if not all apply to sand filter vaults. |
| 172. | 5 / 8-27 | 8.5 Best Management Practices | BMP T8.20 Sand Filter Vault - Additional design criteria (*See also Section 8.6)* | Where is Section 8.6? | Suggest simply referencing the sand filter basin (BMP T8.10) without identifying specific subsections, as most if not all apply to linear sand filters. |
| 173. | 5 / 8-27 | 8.5 Best Management Practices | BMP T8.40 Media Filter Drain – the dolomite and gypsum additives serve to buffer *acidic pH conditions* and exchange light metals for heavy metals. | It is unclear why runoff would have low pH. Low pH is not typically a problem in western Washington unless there is some site specific cause. | Recommend deleting acidic pH discussion. Primary reason for incorporating dolomite and gypsum is to provide calcium carbonite to increase metals precipitation. While raising pH often improves precipitation for many metals, that does not necessarily mean that pH of runoff is acidic. Metals ppt simply occurs at higher pH. |
| 174. | 5 / 8-27 | 8.5 Best Management Practices | BMP T8.40 Media Filter Drain – The trench's perforated underdrain pipe is a protective measure to ensure free flow through the media filter drain mix. It may be possible to omit the underdrain pipe if it can be demonstrated that the pipe is not necessary to maintain free flow through the media filter drain mix and underdrain trench | | BMP T8.40 Media Filter Drain – The trench's perforated underdrain pipe is a protective measure to ensure free flow through the media filter drain mix <u>and to prevent prolonged ponding...</u>" |
| 175. | 5 / 9-3 | 9.4 Best Management Practices | Guidance for bypassing off-line facilities – Swales designed in an off-line mode should not engage a bypass until the flow rate exceeds *a value determined by multiplying Q, the off-line water quality design flow rate predicted by the WWHM, by the ratio determined in Figure 9.6b.* | Has monitoring generated the information needed to eliminate need for these adjustment factors? Also, off-line biofiltration swales can also be in retrofit applications where a portion of the runoff from a larger drainage basin is diverted to a swale for treatment. | |

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| 176. | 5 / 9-27 | 9.4 Best Management Practices | BMP T9.50 Narrow Area Filter Strip | Narrow area filter strips are removed from the SMMWW, but it doesn't appear that any changes were made to the design criteria for basic filter strips that "result in filter strips that a proportionally longer as the contributing drainage becomes narrower". The solution was to just remove it? Instead of using the interim guidelines from the last manual? This makes urban application difficult if not impossible. | Continue to use, or update, the interim guidelines from the last manual. |
| 177. | 5 / 10-4 | 10.3 BMP's for Wetpool Facilities | BMP T10.10 Wetponds – Basic and Large, Design Criteria, *"..the wetpool volume provided shall be equal to or greater than the total volume of runoff from the water quality design storm – the 6-month, 24-horu storm event.* | Why is the single event model still allowed for wet pool facilities, now that Ecology has changed to continuous modeling for everything else? | Recommend deleting the 6-month, 24-hr storm volume language. |
| 178. | 5 / 10-6 | 10.3 BMP's for Wetpool Facilities | The first cell *must* be lined in accordance with the liner requirements contained in Section 4.4. | The first cell must be lined now. Is this for groundwater protection? What if the cell is below the groundwater table? | Change back to "may" |
| 179. | 5 / 12-2 through 12-6 | 12.5 Emerging Technologies | PULD – Pilot Use Level Designation | The descriptions for what is required for PULD BMPs don't match. Section 12.4 removed reference to requirements for additional field testing but the PULD section in 12.5 still references additional testing. | |

## 1.0 Introduction

| page | Existing language | Comment |
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| | 1.0 Introduction | |
| 2 | "…the reader should interpret the term "applicable" when referring to specific operational or structural source controls as meaning "mandatory" or "required". | It would be clearer for Ecology to simply replace all Manual references with the term "required." |
| 4 | Paragraph beginning "All sites covered under the Industrial Stormwater General Perimt…" | It is not just the Industrial Stormwater General Permit that should be required to include & implement the applicable BMPs –sites with other types of Ecology industrial Permits such as an Individual Stormwater permit, a General Permit for Boatyard Activities, etc. should also implement the full set of required BMPs. Treatment that might be specified in an Ecology Permit is more effective after operational or structural BMPs are used to minimize the extent of contamination.<br>Suggested wording: "All *industrial* sites covered under ~~the Industrial Stormwater General~~ *an Ecology* Permit must include ~~applicable~~ *required* BMPs in their SWPPP and implement the BMPs." |
| 5 | 1st sentence "Facilities covered under the Industrial Stormwater General Permit who trigger corrective action should consider implementing one or more recommended BMPs as a means…" | Suggest this recommendation be made a requirement and apply to all Ecology industrial Permitees, as follows: "Facilities covered under ~~the Industrial Stormwater General~~ *an Ecology* Permit who trigger corrective action ~~should consider~~ *must* implement~~ing~~ one or more recommended BMPs as a means…" |
| | 2.0 Selection of Operational and Structural Source Control BMPs | |
| 1 | Paragraph 2, 1st sentence | The list of operational source control BMPs in this sentence should be in the same order in which they are presented on pages 2-7. |
| 1 | Paragraph 2, last sentence | Consider adding the following clause: "Owners should select cost-effective source control BMPs *based on the activities in which they are engaged and* on an assessment of ~~*the*~~ pollutants and their sources. |
| 1 | Paragraph 3 , 1st sentence | Don't just specify the Industrial Stormwater General Permit. Suggest the following language: "…comply with Ecology's ~~*Stormwater General*~~ Permit requirements…" |
| 1 | Paragraph 3, 2nd sentence | Consider used more affirmative language: "…will also be required ~~if~~ *when* incorporated into local government ordinances…" |
| 1 | Sidebar | Remove –is confusing rather than clarifying |
| 1 | Paragraph 4, 1st sentence | "*Industrial* ~~F~~facilities covered under ~~the Industrial Stormwater General~~ *an Ecology* Permit must |

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| | | include …" |
| 1 | 2nd sentence | "If a facilities sampling triggers Level 1 or Level 2 Corrective Action requirements, the recommended operational (Level 1) and structural (Level 2) source control BMPs ~~should be considered~~ must be used…" |
| 1 | Paragraph 5, 1st sentence | Consider changing "land use" to "land use *activities*" |
| 2 | Applicable(Mandatory) Operational Source Control BMPs, | Formatting in this section should be changed to be consistent with the rest of the Manual. The side bars should really be headings, and each heading should have a required and a recommended BMP section. As is, the intent of this section is hard to follow and confusing. Using the conventional formatting would help to clarify the intent. |
| 2 | 1st paragraph | Just use "Required" in title. Replace "Ecology's Industrial Stormwater General Permit" with "*an Ecology Permit*" |
| 2 | Bullet 3 | Seattle agrees that vacuum sweepers are more effective, but some businesses are very small and will have difficulty with this requirement. We suggest that you leave an option for use of manual sweeping. Perhaps saying "…or equally effective sweeping regime." would provide this flexibility? |
| 2 | Bullet 4, 1st sentence | In list of where not to hose down pollutants—could the list include "*streets*? |
| 2 | Bullet 4, 2nd sentence | "Convey pollutants before discharge to a treatment system…" Does this really mean to "*convey any excess water from dust suppression activities to a treatment system*..? |
| 3 | Side bar "preventative maintenance, " new bullet, 2nd sentence | As worded, pressure washing seems to be a required BMP under the category of preventative maintenance. Is that really what Ecology means? If so, Seattle recommends adding an option of on-site treatment, as follows:<br>"Collect the resulting washwater for *on-site treatment or* off-site disposal…" |
| 4 | Heading "recommended additional preventative maintenance BMPs" | 1. The word "additional" in the title doesn't add anything, suggest you delete it in all the headings<br>2. 2. Two of the BMPs should be required: the 1st in the list and the 5th--"~~Where feasible, s~~Store potential stormwater pollutant materials…", and "Empty drip pans…" |
| 5 | Sidebar Spill prevention and cleanup | Seattle suggests that Ecology consider adding the following as a required BMP:<br>"Prepare and post a spill cleanup plan in an area that can be easily seen" |

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| 5 | Recommended BMP, paragraph 2 | The second paragraph "*Industrial ~~F~~*facilities covered under ~~Industrial Stormwater General~~ *an Ecology* Permit *or when required by local government*…" should follow the 1st paragraph as part of that BMP. Change language as edited |
| 6 | Bullet 2 from the top of the page | "Verify…in the ~~Industrial~~ SWPPP are accurate." Why limit to an Industrial SWPPP? |
| 7 | Pollutant Source Specific BMPs | This should be heading 2.2 Pollutant Source… |
| 7 | Add prior to the first site-specific BMP a clarification of how related BMPs are handled in the Manual: | One suggested wording could be-- "Note: Source-specific BMPs for over 30 pollution-generating activities are given in the pages which follow. Many businesses, however, perform more than one of these activities on their site. Because BMPs for related activities are not mentioned for a specific source does not mean that additional BMPs are not required. BMPs that apply to all activities conducted on a site must be employed." For instance, if a site engaged in boat maintenance and stores materials outdoors, the site must employ BMPs for material storage, even though material storage BMPs are not included in the list of required and recommended BMPs for boat maintenance. |
| 7 | Last paragraph | Again, Seattle suggests that this requirement apply to all industries with an Ecology Permit. Suggest changing the wording to require industries with an Ecology Permit to implement all applicable source control BMPs required in the Manual in addition to any BMPs specified in their Permits. BMPs prior to treatment can add a margin of safety as well as make treatment more economical for the Permitee. |
| 8 | Applicable operational BMPs | Perhaps explain that there are separate Permits for boatyard and for shipyards. |
| 8 | Add to required operational BMPs | Boat washing commonly occurs prior to painting. A BMP related to boat washing needs to be added. Suggest wording such as " Boat washing should be done in such a manner that soap, detergents or other chemicals are not rinsed or hosed into the water. Applied soap can be sponged off with a wet sponge, towels or rags. Alternatively, the boat can be taken out of the water and washed in an area where runoff enters a sanitary sewer or soaks into the ground." |
| 10 | Recommended additional operational BMPs | Consider taking "additional" out of the title in ALL BMPs to simplify: "Recommended ~~additional~~ operational BMPs" |
| 12 | 3rd bullet | Add: "A State Waste Discharge Permit may, however, be required in certain instances." |

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| 13 | Required treatment BMPs, 1st bullet | Add "…if approved by the local sewer authority" as Ecology did on p. 14, 1st bullet |
| 13 | 2nd bullet | The word "residues" is used several times. It should be defined. Depending on the definition, this bullet may need to be in the required section rather than the recommended section. |
| 14 | BMP for commercial printing | This BMP probably could be deleted. It revolves around the proper storage of waste which is covered by other BMPs. If not deleted, the first three bullets under recommended BMPs are for related activities and should be deleted in keeping with the organizational recommendation for p. 7 |
| 17 | BMPs for streets/ highways | Consider modifying the 4th bullet as follows: "…as soon as possible after the road surface clears or at least in early spring." Reason: Seattle finds that retrieving roadway grit in the rainy season to be difficult and operationally inefficient. Early spring brings more opportunities to perform this work efficiently. If adopted, remove the 1st bullet under recommended BMPs as it is already required. |
| 18 | BMPs for dust control | Consider referring to the BMPs for ESC |
| 18 | | 4th bullet "In disturbed land areas ~~A~~apply stormwater containment…" Also refer to ESC BMPs. |
| 18 | Recommended BMPs, last bullet | Probably fits better under the deicing activity. Not really used with unpaved roads & parking lots. |
| 18 | Recommended operational BMPs for dust generating areas | Last bullet: Seems to be a better fit for the stockpiled material activity rather than here. |
| 21 | BMPs for dust control | Consider adding these BMPs: "Maintain onsite controls so that no vehicle track-out occurs." And "Dispose of collected solids in accordance with Federal, State and local solid waste standards." |
| 24 | 1st bullet | Confusing wording. Consider: "Drains that convey contaminated stormwater to a treatment system must have an automatic shutoff valve and spill control sump at the discharge point of the treatment system, which must be closed in the event of a spill."<br>Consider moving the bullet to be before the last bullet, since both address discharge from the fuel island. |
| 24 | 4th bullet, 2nd sentence | "The roof or canopy…and ~~preferable~~ extend ~~several~~ additional five feet to reduce…"<br>The minimum height of the canopy shall be 13'6" per IBC section 406.5.3. The roof or canopy should, at a minimum, cover the spill containment pad (within the grade break or fuel dispensing area) and extend ~~several~~ five additional feet past the grade break to reduce the |

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| | | introduction of windblown rain. Convey all roof drains to storm drains outside the fueling containment area. |
| 25 | 1st partial sentence, last sentence | Does Ecology really mean "greater than" a significant amount of oil and grease? Suggest ending the sentence after "visible sheen." |
| 25 | 2nd full bullet, second sentence | Consider alternative wording: "Convey any fuel-contaminated stormwater to a sanitary sewer, as approved by the local sewer authority, and comply with pretreatment regulations prohibiting discharges that could cause a fire or explosion (WAC 173-216-060)." |
| 25 | 3rd full bullet | This BMP seems to fit better in the loading/unloading BMP, p. 34 |
| 25 | BMPs for Vehicles 10 feet in height or greater | This BMP would be better if it didn't specify a particular height, but was simply called "BMPs for Tall Vehicles ~~10 feet in height or greater~~." |
| 27 | BMPs for Illicit Connections to Storm Drains | Changes heading to "BMPs for *eliminating* Illicit Connections to Storm Drains" |
| 27 | Description of pollutant sources, 1st sentence , 1st sentence under Pollutant control approach & 2nd bullet | Unfortunately, sometimes illicit connections are permitted; suggest: "Illicit connections are ~~unpermitted~~ sanitary or process wastewater discharges…" |
| 27 | Required operational BMPs | Suggest rewording first bullet to include *identifying* illicit connections: *"Identify and* eliminate ~~unpermitted~~ illicit connections and wastewater discharges to storm drains…" |
| 27 | Recommended operational BMPs | These are really guidelines for finding illicit connections, not BMPs, except the last bullet is redundant and should be eliminated. Either label them as guidelines or eliminate. |
| 28 | Applicable(required) operational BMPs for landscaping<br>1st bullet | This is not part of a new or redevelopment proposal, so wouldn't the engineered system be voluntary and thus recommended? |
| 29 | 1st & 2nd bullet | Should be required. |
| 30 | Missing BMP | There should be a BMP on rooftop moss control—it was mentioned as an aspect of vegetation mgmt on p. 28. |
| 31 | 3rd bullet | Should be required. |
| 31 | 4th bullet | Was already required on p. 30. Delete from recommended list. |
| 31 | | The information about fescues shouldn't be part of a required BMP—maybe put it as a footnote? |
| 32,33 | | Information is mixed in with the required BMPs throughout this section. Consistently put the required BMP first, then follow with information about why it's required. Delete or put in a separate |

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| | | section information that doesn't relate to the requirement. |
| 33 | Last bullet | Move into a recommended section or word as mandatory if the intent is that only a trained person is to apply fertilizers. |
| 33 | Integrated pest management | This needs to state the required elements of an IPM rather than "an IPM program might consist" |
| 34 | 1st bullet | "…containers, logs or other material ~~covering the ground~~ *stored there*." Spills from vehicles that are loading and unloading are also a problem. |
| 36 | 3rd bullet | Does Ecology mean that they should install curbs? Wording is confusing. |
| 36 | Last 2 bullets | Should be required, not recommended |
| 39 | BMPs for log sorting and handling | There are no requirements given in this section. This is a storage activity, so could just refer to storage BMPs p.2-61 or 67, or consider adding the following language if kept as a separate Activity: "To prevent or reduce the erosion of soil and the generation of wood waste, bark debris, and leachate:<br>• Pave the high activity areas where practical to facilitate cleaning. Slope to minimize the formation of leachate and ponding under piles.<br>• If feasible, cover piles with rooks, canopies, silos, tarps, etc. to prevent contact with stormwater.<br>• Sweep and clean all areas regularly." |
| 40 | Bullet 6 | Delete the last two sentences on snow melt. Not an issue in western WA. |
| 40 | Required structural BMPs, 2nd bullet | Maintenance of refrigeration engines. Doesn't seem structural—consider moving to required operational BMPs above. |
| 40, 41 | "For additional applicable BMPs refer to the following BMPs:" | Generic comment: Suggest adding language to p. 7 as a more consistent way to handle referral to other activities. Omit this section. |
| 41 | Recommended operational BMPs, 1st bullet, 2nd sentence | "Remove liquids from vehicles retired for scrap." This should be required. |
| 41 | 3rd BMP | Doesn't seem to apply here. Consider moving it to the beginning to apply generically to all BMPs? |
| 41 | Recommended operational BMPs, 4th bullet, | Hosing should not be not allowed. Move to required BMPs and reword as: "Do not hose down work areas." 2nd sentence is OK. |
| 42 | 3rd bullet | "Within utility corridors, ~~consider preparing~~ *prepare* maintenance procedures…" |
| 43 | Last bullet | Change to "Apply erosion control BMPs from p. 3-124 of Volume III, Erosion Control." |
| 44 | Last bullet | Please don't require the uncontaminated ditch |

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| | | cleanings be screened into 2 piles—soil and vegetative matter. Fine to put in the recommended section, starting the bullet with "Consider…"? |
| 46 | 1st bullet Required operational | "Inspect *at least annually* and clean…" Annual inspection would be consistent with the NPDES Permit. Go back to the original wording of the last sentence; the rewrite changes the meaning. |
| 46 | 4th bullet | "…and ~~discharge to a sanitary sewer~~ *dispose of solids in accordance State and local regulations* if approved…" It would be more economical in the long run to dispose of sediment as solid waste rather than introduce it to the sanitary sewer. |
| 47 | 1st full bullet | Delete—previous bullet handles cleaning catch basins. |
| 47 | Bullet 2 | "Post warning signs…" should be recommended, not required. |
| 47 | Additional required BMPs | Handle at beginning of section. Omit section. |
| 48 | Outside manufacturing, Required operational BMPs | Add new bullet "business and public agencies who engage in these activities may be required to obtain an NPDES permit from the Dept of Ecology. |
| 48 | Structural BMPs-1st bullet | This seems like an operational BMP. |
| 49 | 1st bullet | "Ensure that the local fire dept ~~approved~~ *approves* all mobile…" |
| 49 | Last paragraph, 1st long sentence | "Locate….110% of the fueling tank volume, ~~or~~ *and* cover~~ing~~ the storm drain to ensure…" |
| 50 | 1st dashed bullet | "Place~~ment of~~ a drip pan…" |
| 50 | 3rd full round bullet | "The responsible manager ~~properly~~ shall sign and date…" |
| 52 | Add BMP | A BMP about proper washing of boats should be added. See suggestion above for p.8 |
| 52 | 5th bullet | Delete "filter fabric"—it has been shown that it doesn't treat but will let contaminated water drip through to the drain. |
| 53 | Recommended operational BMPs, 1st bullet | This BMP should be required. Perhaps to follow bullet 8 on previous page? |
| 54 | 2nd bullet, 2nd sentence | Suggest allowing regular sweeping as well—suggest "*Sweep* or Vacuum ~~sweep~~ parking lots, storage areas |
| 56 | Paragraph 2, 3rd sentence | "Activities that can generate….. and crushing or shredding of vehicles…" |
| 56 | Paragraph 3 | Add PCBs to the list of common pollutants found in recycling & scrap yards. |
| 56 | Required BMPs | Add to last sentence "…Apply the BMPs…..at those facilities *as well as required BMPs for other related activities taking place at the site*." |
| 57 | The phthalate study group has determined that atmospheric fallout is the major | Consider adding this bullet as a recommended BMP: "Visually inspect roof & building materials |

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| | contributor of phthalates. Seattle has also seen air-born pollutants including PCBs & metals. | for sources that could be contributing pollutants: vents, peeling paint, old caulk, and repair, disposing of loose material properly to avoid getting it in catch basin inlets and storm drains." |
| 58 | | Suggest you refer the reader to the BMPs in Construction Erosion Control, including wet weather/dry season considerations. These are pretty minimal. |
| 59 | 1st paragraph | "State Law requires owner…" Add the specific reg & citation if it's not the one specified in the previous sentence. |
| 60 | 1st round bullet, 2nd sentence | "Prepare a summary of the plan and post it at *high-risk locations* and appropriate points in the building, …" |
| 61 | Figure 2.8 | Add "temporary" to the title per the sentence above. |
| 62 | 2nd bullet | "Secure drums stored in an area where unauthorized persons may *not* gain access… *and* in a manner…" |
| 63 | Second bullet and Fig 2.11 | The bullet states that the mounted container must be inside a containment area. Figure 2.11 shows a drip pan, but the barrel is not inside a containment area. A more accurate sketch is recommended. |
| 65 | Description of pollutant sources, 2nd sentence | This sentence now reads like a requirement to heat above ground tanks. If this is not the intent, just use the unedited language. |
| 65 | Pollutant control approach, last sentence | Good to identify this. |
| 65 | Required BMPs, last bullet | Most jurisdictions have adopted the International Fire Code instead of the Uniform Fire Code. |
| 66 | 1st bullet | There needs to be a way to get rid of uncontaminated stormwater. The bullet only speaks to contaminated water. |
| 67 | Required structural BMP options, "Choose one or more of the source control BMP options listed below…" | There are 5 bullets "listed below" on p. 68 & 69—is it the intent that the business can pick any of the 5? If so, there should be an "or" between bullets 3&4 and between 4&5. Consider using numbered bullets rather than a dot, to make it clearer what the alternatives are. However, it seems that bullet 4 might not be a stand-alone alternative. |
| 67 | Required structural BMP options, 2nd sentence | Unclear what "Also included are outside storage areas for solid materials…" means. Does it mean that they also need to implement "one of the following BMPs"? |
| 68 | Add a figure? | The fabric arched covering is a common alternative, and it's also used in E WA for covering hay. Add a sketch if possible. |
| 69 | New BMP | Consider adding: "Increase CB maintenance in areas near stockpiles to prevent material from |

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| | | entering the drainage system and receiving waters." |
| 69 | Recommended BMPs, 2nd bullet | Should be required. Add "*Vacuum or* sweep…" |
| 70 | BMPs for Urban Streets | In description add "…tire *and brake* wear…" |
| 72 | Required structural BMPs, last bullet | "In a paved area, construct~~ed as~~ a spill containment pad *with cover* to prevent the run-on…" |
| 73 | Bullet 3 | Figure 2.15 does not have all the piping & valves referred to in this bullet. An accurate sketch of the drainage configuration described in the bullet would be very helpful as the verbiage is confusing. |
| 75 | BMPs for wood treatment | The text says that Ecology is using the Source Control Manual to set minimum requirements for the individual NPDES Permit. Is this the intent? |
| | Appendix IV-G | Mgmt of Street wastes |
| F-4 | Change numbering of all even-numbered pages to "G" rather than "F" | |
| G-4 | Title | Recommendations for Management of Street ~~Wastes~~ Solids |
| | Definitions | Change from Street Waste to Street Solids throughout definitions & the rest of the document.<br><br>The goal of solid waste management in the State of Washington (RCW 173.350.010) is waste reduction and recycling, to protect public health, to prevent land, air, and water pollution, and conserve the state's natural, economic, and energy resources.<br><br>Defining street solids recovered by maintenance practices as waste may preclude and/or thwart the potential for reuse of processed street solids, which is contrary to part of the goal of the solid waste handling standards. |
| G-5 | 1st Paragraph, half way through starting "There are no specific references for reuse and disposal…" to the end of the paragraph. | This appears to be for informational purposes only, but it is somewhat confusing and not helpful to street solids management. Consider deleting. |
| G-5 | 2nd paragraph | Same—consider deleting |
| G-6 | Table G.1 | Seattle is sending some data collected in 2009 in case Ecology updates this Table. |
| G-7 | Table G-3 | Seattle is sending some data collected from 2003-2011 in case you update this Table. |
| G-12 | 2nd bullet, 2nd sentence | "Reserve this option for street solids ~~waste soils~~ with very low levels of contaminants." "Low level" is not defined—it would be helpful if it were. |
| G-12 | Bullets 3,4 and 5 | Each uses the term "meets the definition of clean soils" but there is no definition provided. Suggest using Table G.4 to provide clearer guidance. For |

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| | | instance, saying "does not exceed the values in Table G.4" |
| G-12 | Bullet 6, 1st sentence | "…provided the street ~~waste~~ solids ~~have been dewatered~~ do not contain free water ." |
| G-12 | Bullet 6, 3rd sentence | "Consult the ~~local~~ appropriate health department and landfill operator to determine conditions of acceptance." Municipalities sometimes take street solids to landfills other than their local one. |
| G-13 | Street Waste Liquids | Change title to Street Cleaning Liquids |
| G-13 | General Procedures, paragraph 2, 1st sentence | Ecology uses the term "storm sewer system" in this document. Consider using Storm drainage system. |
| G-14 | 3rd bullet, 1st sentence | Consider adding some information about the approval process. Which Program at Ecology, contact number? |
| G-14 | 3rd bullet, 1st sentence | Consider adding "Ecology must approve….decant liquids, if discharged back into the storm drainage system." |
| G-18 | Table G.9 | When you redo the Table, consider providing the metals data in micrograms/L—it would be easier to compare to other collected data. |

Seattle data for Table G.1

| Method NWTPH-Dx | Street Sweeping (mg per dry kg) | Catch Basin Solids (mg/dry kg) |
|---|---|---|
| Diesel range | 330 to 520 | 780 to 1700 |
| Motor Oil | 2000 to 2800 | 3500 to 7000 |

Source: Seattle Street Sweeping Pilot Study – Monitoring Report. Prepared by Seattle Public Utilities and Herrera Environmental Consultants. April 22, 2009.
http://www.seattle.gov/util/Services/Drainage_&_Sewer/Keep_Water_Safe_&_Clean/Street_Sweep_Project/index.asp

Seattle data for inclusion in Table G.3 (should Ecology want to update)

Solids from right-of-way catch basins. Data are for ROW catch basins in the LDW collected between 2003 and June 2011. Al units are mg/kg. Source: Beth Schmoyer, Sr. Engineer, SPU

| | As | Cu | Pb | Hg | Zn |
|---|---|---|---|---|---|
| Min | <5 | 9.1 | 3 | <0.03 | 44 |
| Max | 50 | 3,280 | 3,690 | 3.8 | 4,170 |
| Mean | 9.3 | 166 | 154 | 0.16 | 479 |
| Median | 6.9 | 94.8 | 81 | 0.05 | 323 |
| No of samples | 190 | 189 | 190 | 190 | 189 |