King County Comments
Draft 2012 Stormwater Management Manual for Western Washington

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Permit Appendix 1	1	1	Exemptions Forest Practices	The basis for exemption is stated for *forest practices*. The basis for exemptions for *commercial agriculture* and *oil and gas field activities or operations* should also be stated.	Per Comments
Permit Appendix 1	2	2	Definitions Related to Minimum Requirements Converted Pervious Surface	Need to add "sports fields" Sports fields are already included under the definition of PGPS	Converted Pervious Surface – The surfaces on a project site where native vegetation is converted to lawn ~~or~~ , landscaped areas, or sports fields, or where native vegetation is converted to pasture.
Permit Appendix 1	2	3	***Effective Impervious surface –*** Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces are considered ineffective if: 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion" as described in Chapter 5 of Volume V of the *Stormwater Management Manual for Western Washington (2012)*; 2) residential roof runoff is infiltrated in accordance with Downspout Infiltration Systems in Volume III; or 3) approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated.	With respect to 2) in this definition, residential roof runoff should not be infiltrated without treatment. As written, 2) refers to SMMWW Vol III, 3.1.1 Downspout Infiltration Systems: "Downspout infiltration systems are trench or drywell designs intended only for use in infiltrating runoff from roof downspout drains. They are not designed to directly infiltrate runoff from pollutant-generating impervious surfaces." This statement assumes that roof runoff is not pollution-generating; yet zinc (or galvanized) roofing has been and is recognized as pollution-generating. Roof runoff should be more broadly re-categorized as PGIS, with the possibility of some exceptions if they can be substantiated. Recent related reports from Ecology indicate that zinc is not the only chemical of concern from roof runoff. (Roberts et al., 2011[18], Norton et al., 2011[19]). Further, a substantial amount of additional literature indicates that a wide variety of roof surfaces discharge a number of pollutants at levels commensurate with levels from 'typical' PGIS surface runoff. See our more extensive comments on **PGIS Definition: Roofing, SWMMWW Volume I, Sec, 2.3, Pages 2-6–2-8**; where we provide additional citation to the two cited here. Therefore, infiltrated roof runoff should require the same treatment or specified soil treatment layer prior to infiltration as is required of any other stormwater. We must even consider the possibility that green roofs may discharge pollutants, as infiltrated rainwater will then be sheeting down across a surface that is likely treated with biocides to prevent roofing damage from the green layer above.	Per Comments

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				Gutters and downspouts may leach or erode pollutants as well. Recommend changing the terminology from roofs/roofing to 'roof systems including gutters and downspouts.' With respect to 3), it should be stipulated here that infiltrated runoff from PGIS must be treated prior to infiltration, or infiltrative soil must meet soil treatment criteria. Must also consider how to incorporate spill control (where needed) where runoff from PGIS subject to vehicular traffic is dispersed or infiltrated.	
Permit Appendix 1	2	3	***Erodible or leachable materials***–Wastes, or chemicals that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.	The examples are strongly suggestive that only essentially loose materials are considered erodible or leachable. It seems like the definition should be broadened to more literally include at least some forms of PGIS and PGPS. On one hand, pavement is considered PGIS because it conveys vehicular pollutants (noting that sidewalks and fenced off fire lanes are not considered pollution-generating); in fact, this suggests another category for more specificity; i.e., pollution conveying impervious surface (PCIS). Zinc, copper, and other substances are erodible or leachable from roofing systems (impervious surfaces, including gutters and downspouts). Zinc and copper may erode/leach from other weather-exposed architectural uses, e.g. flashing, decorative use, and fencing, and exposed treated lumber and wood finishes may erode or leach pollutants into stormwater. Ironically, fencing – e.g. galvanized chain-link fencing – used to fence off a fire lane (see above) makes the fire lane non PGIS, yet zinc leaching from the fencing could exceed the amount of zinc that might be generated by unrestricted but in frequent vehicular use on the pavement. It seems prudent to note that PGIS and PGPS are pollution-generating because they erode (wear) or leach chemicals of concern; i.e. the *erodible or leachable* and *PG_S* definitions should cross-refer each other. In summary, erodible or leachable materials should be considered umbrella terminology that includes as subcategories: – PGIS	

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				– PGPS Loose materials that can be responsible for discharge of pollutants, e.g. including but not limited to those materials already listed in the definition, *plus* synthetic sports fields and *applied* pesticides and fertilizers.	
Permit Appendix 1	2	3	***Maintenance –*** Repair and maintenance includes activities conducted on currently serviceable structures, facilities, and equipment that involves no expansion or use beyond that previously existing and results in no significant adverse hydrologic impact. It includes those usual activities taken to prevent a decline, lapse, or cessation in the use of structures and systems. Those usual activities may include replacement of dysfunctional facilities, including cases where environmental permits require replacing an existing structure with a different type structure, as long as the functioning characteristics of the original structure are not changed. One example is the replacement of a collapsed, fish blocking, round culvert with a new box culvert under the same span, or width, of roadway. See also Road Maintenance exemptions in Section 1 of this Appendix.	With the new emphasis on LID, the definition should be expanded beyond structures, facilities, and equipment, and should include maintenance of LID BMPs, e.g. but not limited to rain gardens, soil treatment layers, permeable pavement, and green roofs.	
Permit Appendix 1	2	4	***Permeable pavement*** – Pervious concrete, porous asphalt, permeable pavers or other forms of pervious or porous paving material intended to allow passage of water through the pavement section. It often includes an aggregate base that provides structural support and acts as a stormwater reservoir.	How will this be evaluated to see if it's still functional from a permeability point of view? How can one tell if/when the system (pavement and underlying media) is loaded with some pollutants to a degree that breakthrough occurs (need to define, since it's not really an absolute 'ok now, now not ok' situation) and maintenance is required? How will the system be maintained? Will underlying media need replacement at some point, and if so, when? How will spill control be achieved? Need to consider whether permeable asphalt may itself leach some pollutants (e.g. PAHs) when freshly poured, and as it ages.	At least, the definition should incorporate the word 'maintained', i.e.: ***Permeable Pavement*** - ~~Pervious~~ Maintained pervious concrete, porous asphalt, permeable pavers or other forms of pervious or porous paving material intended to allow passage of water through the pavement section. It often includes an aggregate base that provides structural support and acts as a stormwater reservoir. And it would be best to include a section detailing the maintenance issues noted above.
Permit Appendix 1	2	4	***Pesticide***	Not currently defined. Recommended including a definition, e.g.	Pesticide - Includes insecticide, nematodecide, rodenticide, fungicide, and herbicide including algaecide and moss-killer.
Permit Appendix 1	2	4 - 5	***Pollution-generating impervious surface (PGIS)*** – Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use; industrial activities (as further defined in the glossary of the Stormwater Management Manual for Western Washington (2012)); or storage of erodible	Need to cross reference to **Erodible and leachable materials** What is the potential of heavy metals and/or organic compounds to leach or erode from treated lumber (decking, fencing) or architectural metals, e.g. flashing, downspouts, decorative siding or other features, metal fencing, other roofing	Per Comments

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			or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall. Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating).	impregnated, e.g. with copper or zinc particles for moss control, or organic biocides for moss or rot control, or e.g. zinc strips added for moss control)? What about materials that aren't included in impervious surface area calculations, e.g. fencing and building siding and decorative elements that may contain erodible or leachable heavy metals or organic biocides? Currently says: " . . . Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating)." Need to be clear about the definition of "enamel coating". If this means true enamel, which is melted glass, it is likely to be fairly inert (although it could contain heavy metals if colored, leaching would be expected to be very slow); it is also very unlikely that conventional 'enamel' coated roofing is glass coated. The term 'enamel' is also used to describe some paints, and in this case likely refers to baked on 'powder coat'. While this will coat the underlying metal, whether the plastic itself contains leachable or erodible chemicals of concern, their potential to erode or leach at levels of concern, are questions that need to be addressed. More broadly, recent related reports from Ecology suggest that zinc is not the only chemical of concern from roof runoff See our comments on **Effective Impervious surface** (above), and **PGIS Definition: Roofing, SWMMWW Volume I, Sec, 2.3, Pages 2-6 – 2-8** (below) Consequently, Ecology should consider whether only uncoated metal roofing should be considered PGIS, or if additional roofing should be considered PGIS. Going one step further, Ecology should consider if for some land uses or proximity to some land uses and or industries, aerial deposition – either dry period buildup and storm wash-off, or precipitation-borne pollutants – may be high enough to be of concern and cause runoff to require treatment.	

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Permit Appendix 1	2	5	***Pollution-generating pervious surfaces (PGPS)*** – Any non-impervious surface subject to vehicular use, industrial activities (as further defined in the glossary of the Stormwater Management Manual for Western Washington (2012)); or storage of erodible or leachable materials, wastes, or chemicals, and that receive direct rainfall or run-on or blow-in of rainfall, use of pesticides and fertilizers, or loss of soil. Typical PGPS include permeable paved roads, driveways and parking lots, lawns, landscaped areas, golf courses, parks, cemeteries, and sports fields.	Recommend the following changes => Additional Comment: What about surfaces that are permeable at the surface – e.g. porous pavement and high-infiltration-rate sports field surfaces – but where the underlying soil has a low infiltration rate, requiring an underdrain system, which needs to be plumbed to a conventional facility; i.e. where the underlying soil is functionally impervious, at least when saturated. Is there not some point at which from a runoff modeling point of view the system is functionally PGIS rather than PGPS?	Pollution-generating pervious surfaces (PGPS) – Any non-impervious surface subject to vehicular use, industrial activities (as further defined in the glossary of the Stormwater Management Manual for Western Washington (2012)); or generation, use, or storage of erodible or leachable materials, wastes, or chemicals, ~~and~~ that receive direct rainfall or run-on or blow-in of rainfall~~,~~; or use of pesticides and/or fertilizers, or loss of soil. Typical PGPS include permeable paved roads, driveways and parking lots, lawns, landscaped areas, golf courses, parks, cemeteries, and sports fields.
Permit Appendix 1	2	6	*Vehicular Use* – . . .. . The following are not considered subject to regular vehicular use: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, fenced fire lanes, and infrequently used maintenance access roads.	On face value it makes sense to not consider these uses subject to regular vehicular use, but need to reconsider pollution-generating potential if fencing is made of or coated with an erodible or leachable metal, or contains erodible or leachable metal(s) or organic compound(s), e.g. galvanized chain link fencing or treated lumber fencing. Also need to define infrequently used..	See more detailed comments on the same subject in: Vol I, Sec. 2.3, Pg 2-10
Permit Appendix 1	Fig. 3.2	9	Figure 3.2 Flow Chart for Determining Requirements for New Development Decision Box:: Does the project convert ¾ acres or more of ~~native~~ vegetation to lawn or landscaped areas, or convert 2.5 acres or more of ~~native~~ vegetation to pasture?	What is the rationale behind deletion of the term 'native'? Is this to compensate for past damage that has not been remediated; e.g. if someone buys property that was previously logged and is now covered with broom – and that is being converted to a lawn or landscaped area? That makes some sense. What about with regard to the second example, what if a farmer is converting 2.5 or more acres of row crops to pasture. Should that trigger the minimum requirements?	Per Comments
Permit Appendix 1	4.5	23	Section 4.5. Minimum Requirement #5: On-site Stormwater Management Preface	Recommend the following text modification:	The Permittee must require On-site Stormwater Management BMPs in accordance with the following project thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff onsite to the ~~maximum~~ extent feasible without causing flooding, ~~or~~ erosion, landslide, or public health or safety impacts.
Permit Appendix 1	4.5	24	Mandatory List #1	**Comment RE: Other Hard Surfaces – and the overall list categories** Why is permeable pavement preferred over rain gardens? In fact, why is there a preferred order at all? If there is to be a preferred order, given concerns about permeable pavement	Per Comments

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				would not recommend it before rain gardens; the order should be reversed. Concerns about permeable pavement include lack of maintenance standards and especially maintenance methods for private individuals, challenges regarding assessment of performance (how can one tell when pollutant breakthrough is a concern?), insufficient knowledge of under-pavement treatment layer interaction with pollutants – with reason to suspect that it will not be equivalent to uncovered treatment layer media, and remediation cost when failure does occur. We recommend not requiring an order of preference; rather, to allow design flexibility, with consideration for maintainability. Suggest dividing the Mandatory List categories from two (Roofs, Other Hard Surfaces) to three (Roofs, Pavement, and Other Hard Surfaces). While it makes some sense to consider permeable pavement where feasible when paving, by breaking into three categories, the footnote ("This is not a requirement to pave these surfaces") can be eliminated for Other Hard Surfaces.	
Permit Appendix 1	4.5	25	Mandatory List #2 (only need to show line item 3 here, because the rest is applicable to the list as a whole) 3. Bioretention BMP's (See Chapter 7 of Volume V of the SMMWW) that have a minimum horizontally projected surface area below the overflow which is at least 5% of the of the total surface area draining to it. 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. (sic)	**Comment RE: Other Hard Surfaces – and the overall list categories** Same as comment for Mandatory List #1 above (except talking about bioretention here instead of rain gardens). **Comment RE: Other Hard Surfaces** Line item 3.) Why does this say "do not use this option unless the hard surface is categorized as pollution-generating. Why is it not OK to use this option with non-pollution-generating surface runoff? i.e., why impose the < 0.3 in/hr limitation at all for bioretention BMPs? A low infiltration rate means less credit should be given to the BMP for flow control, and that will affect neighborhood or regional FC facility sizing; but assuming a bioretention underdrain in these circumstances, water quality treatment should still be a benefit. Adjunct comment. All roofing and roof systems should be classified as pollution-generating (commentary elsewhere under Effective Impervious Area in Appendix 1, and under the definition of PGIS in Vol I).-	Per Comments

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Permit Appendix 1	4.6	26	Minimum Requirement #6: Runoff Treatment Treatment Thresholds	The order of presentation is confusing. It seems more straightforward to start with basic treatment requirements, and then indicate where more robust or additional treatment is required. The strategy of presenting treatment-type thresholds individually is confusing. It muddles the message that anywhere enhanced (in the broad sense of the term; i.e. oil control, phosphorus, and/or enhanced metals) treatment is required, basic treatment is also required. That phosphorus and/or enhanced metals treatment may also provide basic treatment does not mean basic treatment is not being provided nor that is not required. The solution is to state where basic treatment is required, then to state where additional or enhanced (broad sense again) treatment is required. A statement to the effect that per the SMMWW treatment facility menu(s), and depending on facility(ies) chosen, a treatment train may be required, or a single facility may provide multiple treatments.	Per Comments
Permit Appendix 1	4.6.1	26	Treatment-Type Thresholds, Oil Control b. An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil; c. An area of a commercial or industrial site subject to parking, storage or maintenance of 25 or more vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.);	RE: **b.** Needs to be edited to make it clear that the exemption for routinely delivered heating oil is only at the point of delivery for end use, not at commercial or industrial storage or transfer sites for heating oil. RE: **c.** The list of examples should include aircraft and aircraft servicing and towing equipment	Per Comments
Permit Appendix 1	4.6.1	27	Phosphorus Treatment	With respect to infiltration, the "within ¼-mile of a phosphorus sensitive lake (use a Phosphorus Treatment facility)" statement in the Basic Treatment section should be stated in the Phosphorus Treatment section.	Per Comments
Permit Appendix 1	4.6.1	27	Enhanced Treatment	Recommend changing the term from 'enhanced' to 'enhanced metals' treatment. The way 'enhanced' has been used in the past for stormwater treatment is specific to enhanced metals removal only. The word 'enhanced' should be freed as an adjective in its traditional broader sense, to describe any enhanced treatment, e.g. phosphorus, heavy metals, oil treatment, or for the future, e.g. but not limited to phthalate, phenol, PAH, and PPCPs. Recommend for the list of applicable sites; delete the word 'project', as it is at least redundant to the preceding narrative;	Per Comments

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				e.g. 'Industrial sites', not 'Industrial project sites. Further, as written, the list creates new concepts requiring definition; i.e. what exactly is a commercial or industrial project other than a development on a commercial or industrial site? However, that also begs the question of the definition of commercial and industrial sites. These should not be defined by zoning alone, as land uses are not always in concert with zoning. For example, areas zoned rural residential or even agricultural may have commercial businesses, e.g. furniture, boat, or lawnmower repair, cabinet making or boat making, pet kennels, general contractor or plumber or electrician shops and staging areas, etc. With respect to infiltration, the "within ¼ mile of a fish bearing stream, or a lake (use an Enhanced Treatment facility)" statement in the Basic Treatment section should be stated in the Enhanced Treatment section. Recommend adding Synthetic Sports Fields and Tracks to the list	
Permit Appendix 1	4.6.1	27	Basic Treatment	The bulleted order is confusing. It would be more straightforward to start with the most all-encompassing / general application; i.e. the third bullet: • "Project sites discharging directly (or indirectly through a municipal separate storm sewer system) to Basic Treatment Receiving Waters (Appendix I-C of the Stormwater Management Manual for Western Washington (2012))." should be the first bullet. 2) is confusing. If the project uses infiltration strictly for flow control, not for treatment, then it would seem that either treatment is required prior to infiltration; either by facility or soil treatment layer, or the runoff must be from non-pollution-generating surface (NPGS). If the runoff is NPGS, then why is there any need to consider sensitive lakes (phosphorus) or fish-bearing streams or lakes (metals)? Please clarify: does "and the discharge is within ¼ mile" mean "and the infiltration is within ¼ mile"?	Per Comments

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Permit Appendix 1	8.I.A	36	Bioretention BMP and Rain Gardens are considered infeasible (where) "Within 10 feet of small on-site sewage systems and greywater reuse systems"	Within 10 feet of the tank, leach lines, or either? Locating especially leach lines for older systems may range from expensive to infeasible. Many older septic systems do not have as-builts on file with municipalities. Getting an after-the-fact as-built drawing will be expensive at best, and may not be feasible as leach lines may be subject to damage by digging for location. Ground-penetrating radar may be costly. Does knowledge that e.g. a septic system exists, coupled with lack of knowledge of the leach field and/or tank footprint add a feasibility limitation?	Per Comment
Permit Appendix 1	8.I.A	36	Bioretention BMP and Rain Gardens are considered infeasible (where) "Within 10 feet of an underground storage tank."	May be expensive to locate. Possibility of damage by digging. Ground-penetrating radar may be costly. Does lack of knowledge of location and footprint add a feasibility limitation?	Per Comment
Permit Appendix 1	8.I.A	36	"The drainage area is less than 5,000 sq. ft. of pollution-generating impervious surface, or less than 10,000 sq. ft. of impervious surface; or less than ¾ acres of pervious surface, and the minimum vertical separation of 1 foot to the seasonal high water table, bedrock, or other impervious layer is not achieved."	How is a small project applicant to make determinations of distance to groundwater and bedrock or other impervious layer? This could be expensive. Does expense to a small project applicant constitute a feasibility limitation?	Per Comment
Permit Appendix 1	8.I.A	36	"Where the drainage area is more than any of the above amounts, and cannot reasonably be broken down into amounts smaller than those designated above, and the minimum vertical separation of 3 feet to seasonal high water table, bedrock, or other impervious layer is not achieved".	On one hand, same question as given in the previous comment, regarding cost and feasibility, especially near the cutoff point (greater than 5K/10K, but not by much). On the other hand, is this saying that an applicant can break up a large project into small zones and use the less protective vertical distances? This would not seem prudent from an environmental protection point of view.	Per Comment
Permit Appendix 1	8.I.A	37	"Where the field testing indicates potential bioretention/rain garden sites have a short term (a.k.a., initial) native soil saturated hydraulic conductivity less than 0.30 inches per hour. In these instances bioretention/rain gardens serving pollutant-generating surfaces can be built with an underdrain, preferably elevated within the underlying gravel layer, unless other feasibility restrictions apply."	We appreciate that K_{sat} has been changed from 0.15 to 0.3 in/hr; presumably to add a margin of safety for measurement uncertainty and possibly uncertainty that 0.15 itself would be sufficient. However, K_{sat} should not be based on 'initial native', as this implies uncompacted pre-development soil condition, whereas by definition rain gardens are going to be placed where native plants have been removed and grading with unavoidable compaction has occurred. K_{sat} should be measured in the post-development soil at the location and excavation depth where the bioretention/rain garden is going to be placed.	Per Comments
Permit Appendix	8.I.B	37 - 39	Permeable Pavements are considered infeasible (where)	For protection of groundwater quality, should add:	Per Comments

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1				Within a critical aquifer recharge area (CARA) or sole source aquifer area	
Permit Appendix 1	8.I.B	37	"In the drive aisles of parking lots as long as runoff is directed to pervious pavement parking spaces."	While this makes sense from a pavement wear point of view, a vehicle with a leak will deposit more in the parking stall during the time parked than in the short transit over the aisle area. Further, some vehicular leaks occur at a higher rate when the vehicle is stopped than when it is in motion, or occur primarily when the engine stops or the vehicle stops moving.	Per Comment
Permit Appendix 1	8.I.B	38	"Where the native soils below a road or parking lot do not meet the soil suitability criteria for providing treatment. Note: In these instances, the local government has the option of requiring a six-inch layer of media meeting the soil suitability criteria or the sand filter specification as a condition of construction."	It is not clear that the local government option is robust enough with regard to treatment, or what the media longevity will be. With respect to media depth, sand filter design calls for a media depth of 18 inches. Noting that these are used to treat concentrated flow, and that a linear sand filter to be used for less concentrated sheet flow requires a minimum 12 in depth, one might presume that if all that matters is the degree of flow concentration, then 6 inches might be OK for non-concentrated flow; i.e., if there the pavement only collects direct precipitation and not sheet flow runoff from adjacent area, or piped flow from a nearby area. However, the only difference between these different scenarios is the load per unit time. There is no reason to expect pollutant concentrations to differ. That said, we must consider minimum/optimal depth required for pollutant removal/treatment. 12 to 18 inches are required for imported stormwater; the same should be required for porous pavement, even without imported flow. We might assume that filter media under porous pavement will last longer before failure than in the other cases, because of lesser flow. However, we must also consider that a media filter buried under pavement will likely not behave the same as one exposed to air; at the very least, redox conditions are likely to differ. We should expect this to affect both chemical pollutant removal mechanisms and microbiological mechanisms. For example, diesel, motor oil, and PAHs may be broken down in an open-air sand filter, by aerobic bacteria and possibly some fungi. It is reasonable to expect some oxygen deficiency below porous pavement. We expect few or no anaerobic fungi; and any microbial anaerobic breakdown of oil and PAH, will be at a much lower rate than aerobic. We should also consider that while TSS clogging of the media may not be an issue (but clogging of the pavement may), the only way to replace the media if/when unacceptable pollutant	

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				breakthrough occurs, will be to tear up the pavement. This raises the question of how to evaluate when unacceptable breakthrough is occurring. We should also consider that with amended treatment soils (e.g. compost amended) in a bioretention system, as fibrous plant materials break down over time, they may be replenished by leaf litter, decay of plant roots, and if necessary, top dressing. These are not feasible with media under pavement. Last but not least, we must consider that soil amended with organic matter is likely to settle over time, which is not good for the bearing surface above. Last, if some pollutant removal credit is being assumed for the porous pavement itself, we must consider whether asphaltic concrete (AC) and Portland cement concrete (PCC) have the same pollutant removal profiles, or if, e.g. AC is better at trapping hydrocarbons and PCC is better at trapping metals. In either event, we must consider how TSS and other pollutants trapped in the pavement pores are to be cleaned out periodically by a landowner, the toxicity and fate of the removed material, and how to determine when the sub-pavement media needs replacing, noting that the only way to replace it is to tear up the pavement. This will be true whether the sub-pavement media is imported sand or native soil meeting soil treatment criteria. If we ignore our other concerns for the moment, and now assume an under-pavement media lifespan in the range of 20 to 50 years, we must still ask the question – are we protecting surface waters at the expense of creating acres to square miles of contaminated soils? And if we add the breakthrough question, are we protecting surface waters at the expense of groundwater quality? And if we go that route, we need to ask to what extent groundwater contamination may wind up in surface water streams.	
Permit Appendix 1	8.I.B	39	Competing Needs	Add:	Where the primary function or designated-use safety of the paved surface is impaired by use of a non-standard paving surface (e.g. a tennis court)
Overall				**Usability** The Manual structure is analogous to a text version of what in the multimedia and Web page worlds is referred to as a 'mashup'; i.e., rather than a complete work that stands on its	The Manual would be much easier to use if all volumes were

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				own, it refers to external documents, not just for evidentiary support by citation, but as extension of guidance (e.g. the *Low Impact Development Technical Guidance Manual for Puget Sound*, and as actual substitute language for part of the Manual; e.g. *NPDES Municipal Stormwater Permit Appendix 1*). Pointing to external documents creates several problems. One is that it makes the Manual cumbersome and difficult to follow when one has to retrieve external documents for complete reading, especially when internal and external language are interleaved as is the case with SWMMWW Chapter 2 and Appendix 1 of the permit. Another problem, which is related, is that these external documents may not be synchronized with the Manual, which leaves jurisdictions and private project Applicants at odds over which version of each external document is applicable. To use the Web analogy again, like visiting multiple sites, this makes it difficult for the user to always be up to date on the 'Terms and Conditions' of each connected 'web site' as it were. A related problem is that inconsistencies may exist between any combination of the Manual and these documents. As an example, those of us reviewing the SWMMWW just received notice on 01/27/2012 that the update draft 2012 *LID Technical Guidance Manual for Puget Sound* – which is clearly a key external document – is just now out for review. At the very least, as clearly integral to the SWMMWW, the Draft LID Manual should have been released concurrently with the Draft SWMMWW. Obtaining the Draft LID Manual at this late date makes it virtually impossible to review the SWMMWW and the LID Manual in concert as should be done, let alone not enough time to review the LID Manual on its own. While this is a Reviewability issue (see below), it is given as a case where lack of synchronization is a problem.	combined into one, and in addition to hard-copy, published in electronic version with hyperlinks between all table of contents, index entries, figures, tables, text references, and citations. As an added benefit, the process of combining into one manual should help decrease redundancy between what is now Vol. 1 and the other volumes. To the greatest extent possible, all referenced external documents should be included with the Manual as Appendixes, and cross-referenced and hyperlinked in the electronic (PDF) version. Suggested models to start with are WSDOT's Highway Runoff Manual (HRM) and generally, searchable Wiki web sites. As an equivalent (to the SWMMWW) manual, the WSDOT HRM is the more relevant example as a well cross-referenced work with links in the single downloadable PDF file, and is also available printed. In addition, the Manual should provide to the greatest extent possible, the intent and basis for each section and design.
Overall			"will be updated"	**Reviewability** We are unable to review the Manual fully, because portions are incomplete as of the current draft. There are at least three instances in Vol I and two in Vol II where notes appear stating, "will be updated". With regard to the Glossary, Ecology is asking for help; but with regard to the other sections, we cannot review language that is not presented.	Per Comments

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				In particular, relevant to the comment cell above: "This section will be updated to be complementary with . .. . the updated *Low Impact Development Technical Guidance Manual for Puget Sound*." As noted above, we have just received notice the updated version of the referenced manual is now available for review, but at this point there is not sufficient time to review that in the context of the SWMMWW in any meaningful way; and given the added emphasis on LID in this Permit and Manual, inability by the review deadline for the SWMMWW to adequately review what will constitute a substantial element of the SWMMWW puts us at disadvantage. Adding to the review convolution, the cover letter for the *LID Manual* says: " What is not included ... either does not need review (e.g. literature review matrices) or requires Ecology to complete their Permit and Stormwater Management Manual for Western Washington (SWMMWW) review." and "What is not included for your review: · Chapter 7 which is Ecology's design and flow control guidance. This is in Appendix III-C of the SWMMWW Volume 3. Once comments are received and Ecology updates that section we will include it in the LID Manual · Appendix 2 (Bioretention literature review), Appendix 6 (Compost specification) and Appendix 7 (Permeable pavement literature review)." Again, cross-review between documents when neither is complete severely limits our ability to provide complete review of either document. With regard to omission of review solicitation for compost specification or permeable pavement, we find these omissions to be problematic with respect to full public review.	
Overall				**Guidance for Meeting Permit Requirements vs. Encouragement to Go Above and Beyond**	Minimum requirements (used broadly – e.g. in this example basic treatment is indicated as the minimum requirement, but enhanced and/or phosphorus treatment is being encouraged)

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				Language encouraging action should be replaced with clear requirements. For example, the following is found in Vol V: "The requirements for use of Enhanced Treatment or Phosphorus Treatment represent facility selection based on pollutants of concern. Even if the site is not subject to those requirements, try to choose a facility that is more likely to do a better job removing the types of pollutants generated on the site". From experience, we can say with a high degree of certainty that if something is not required unequivocally, and implementation would cost more than the minimum requirements (using the term broadly here), few if any applicants will opt for the more protective more expensive option. In the example above, no private project Applicant will opt for or agree to enhanced or phosphorus treatment at added cost unless the site is subject to that requirement. Even municipal jurisdictions with the best of intentions are often forced to limit themselves to minimum requirements as a consequence of fiscal constraints. If Ecology feels that more site conditions should be subject to treatment above and beyond basic, Ecology should expand the list of conditions under which additional treatment is required. If Ecology wishes to keep 'encouraging' language, we recommend taking it out of the main body of text and putting it in margin or in-line 'information boxes'.	and that which may/could be more environmentally protective should be maintained as distinctly separate blocks of text, visually, e.g. margin or in-line call-out boxes. The fundamental part of the text that guides through permit compliance should not be broken up with 'wish list' text.
Overall				**Infiltration** Focus on restoring stream health through LID, with emphasis on infiltration is not balanced with equal concern with respect to groundwater quality protection. The Puget Sound Action Agenda, the NPDES Municipal Stormwater Permit, and the SWMMWW are all clearly focused on restoring stream health. However, we fear that in wholesale emphasis of stormwater infiltration, some crucial considerations are given short shrift, in particular with respect to protecting groundwater quality, and ironically, while recognizing the groundwater surface water connection from a hydrologic point	Please address these issues. Infiltration is only part of the solution, and has potential to create unintended consequences. It appears to us that more careful consideration needs to be given to mitigating potential deleterious effects from infiltrating stormwater. - Source Control should be considered first and foremost before Infiltration. - Dispersion should only be allowed for untreated stormwater from pollution-generating surfaces where the underlying soil is equivalent or better than the specification for a treatment liner. Dispersion of untreated stormwater from pollution-

[*] Assessment with liquid biosolids, not stormwater. Authors note that biosolids may affect geochemistry, which may affect infiltration rate. Nevertheless, the finding that bacteria move through macropores is something that must be considered with regard to stormwater infiltration.

[†] Review paper. The majority of these sites are land treatment sites; some solid waste, others liquid; although two studies found viruses at four groundwater recharge sites (chlorinated secondary or tertiary treated wastewater), at depths up to 5.5 to 9 m through overlying soil. A stormwater recharge basin yielded viruses at 9 m, but based on the species, propose the source may have been from nearby cesspools. Vertical migration distance would still be the same, with some added horizontal migration.

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				of view, largely overlooking the connection from a water quality point of view. Pre-developed conditions did not yield precipitation or runoff with the range of pollutants and magnitude of pollutant loads we have now. Emphasis should be on infiltrating only clean water. The SWMMWW does provide some guidance that is supposed to be for protection of groundwater; however it is inconsistent to a point of being dismissive in the case of full dispersion on native soils – even advanced gravel outwash – providing no rationale why some kind of treatment shouldn't be required prior to infiltration in that instance. If there were an infiltration facility in the same soil, either pre-treatment or a treatment liner would be required. Examination of Ecology's guidance where groundwater protection is indicated provides no evidentiary citations supporting e.g. minimum CEC, organic matter, infiltration rate, or depth to groundwater, or relationship between depth to groundwater and mounding potential. There does not appear to be a large abundance of research literature on the potential for stormwater to contaminate stormwater – *or not*. However, of the current literature, there is enough indicating that the potential for groundwater pollution is of concern, including evidence for some pollutants; that we believe it is crucial to consider source control as pre-requisite to infiltration. Further, increased emphasis on source control should decrease pollutant loading to surface waters, from that runoff which does not infiltrate, and this is no small matter. The intent of infiltration is to minimize runoff and minimize groundwater recharge, and through that to maintain and restore surface water baseflows. Minimizing runoff is often cited by Ecology and others for decreasing stream loading of pollutants, and groundwater recharge is often cited in temperature TMDLs as beneficial to 'maintaining cool baseflows'. However this presumes that infiltrated stormwater will reach streams, and this is not always a good assumption. In advanced gravel outwash soils, infiltrate may go to groundwater strata lower than local streams. Still, this would be beneficial in recharging those deeper layers which may be drawn upon by	generating surfaces should not be allowed on advanced gravel outwash. - Treatment liner criteria should be re-evaluated for adequacy. - Minimum separation from / distance to seasonal high groundwater should be re-evaluated for adequacy, with a conservative margin of safety and conservative factoring of mounding effects. - When re-evaluating soil criteria and depth to groundwater, Ecology should consider a far wider range of pollutants than currently addressed by the SWMMWW; including but not limited to (in addition to currently targeted pollutants), phthalates, phenols, pesticides, halogenated hydrocarbons, PAHs, bacteria, and viruses. - Ecology should conduct a literature search for the most complete information possible, with regard to the potential for groundwater contamination from stormwater, soil criteria and depth to groundwater, with the full range of pollutants in mind.

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				wells for drinking water and agriculture. When groundwater does reach streams, we must consider the potential for pollutants discharged to groundwater to reach surface receiving waters. There are some cases (the best example being Cu), where discharge to ground could easily meet the groundwater quality standard, but exceed the surface water quality standard. If the fate of infiltrate is drinking well water, then we must consider the risk of contaminating that resourced by infiltrating polluted stormwater. The presumption in the SMMWW is that if infiltration rate is limited, and flow is through specified 'treatment' soil profile, groundwater will be protected. However, the SWMMWW does not cite any scientific evidence to support that assertion. Clearly, presumptions are being made about soil layer treatment requirements for infiltration, but the literature suggests some of those assumptions may need re-evaluation: - Heavy metals, which are assumed to bind to soils and amended soils by sorption (generally), cation exchange, and chelation, may form colloids with dissolved organic matter, facilitating colloid-mediated infiltration of metals[1,2,3]. - Bacteria can move through vadose soil macropores at rates ~ 5 to 10 times faster than pore water migration rates, up to ~ 1 m/d (Unc* & Goss, 2003)[4], and bacterial indicators notwithstanding, pathogenic viruses considerably smaller than bacteria may infiltrate even where bacteria are trapped - Viruses considerably smaller than bacteria may infiltrate quite deeply through soil. Keswick and Gerba (1980)[5] note virus migration to depths ranging from 6 to 46 m and horizontal migration from 3 to 400 m†. - Pitt et al (1996[6], 1999[7]) indicate potential for groundwater contamination by a number of substances from stormwater infiltration; including pesticides, PAHs, pathogens, and some metals. - Hathorn et al. (1995)[8] recommend, "... serious consideration should be given to extending the minimum depth to groundwater from the existing value of 3 feet to 10 feet or	

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				more." Even if/where we consider soil treatment to be adequate to protect receiving waters, we must consider pollutant buildup over time. While some pollutants are biodegradable, others are not, e.g. halogenated hydrocarbons/organics and heavy metals. While the latter may in some cases be sequestered in soil, sequestration is temporary storage – it is not a permanent condition; and changing conditions can cause release. Assumed metal uptake by plants requires active management of periodic plant material removal, else the metals will recycle in place. Halogenated hydrocarbons may break down over very long periods of time, but in the meantime are bioaccumulative. In the process of infiltrating polluted stormwater, we are infiltrating what would otherwise go to a treatment facility with some expectation of pollutant removal out of pond from concentrated flows. These pollutants would then normally be periodically scraped and vault bottoms, or removed along with media filter cartridges; but with infiltration, they will be building up in soils and migrating to groundwater. Consider the use of a rain garden or bioretention facility in lieu of a filter cartridge system. SWMMWW Vol V, BMP T7.30 suggests 20 years for a rain garden to build up heavy metals to a point where the media needs to be replaced. The question is, who will be paying attention, and who will pay for disposal of soil and media replacement and replanting for tens or hundreds of thousands of rain gardens / bioretention systems? What about replacement of pervious pavement material and underlying media?	
Overall				**Hydraulic connectivity is assumed between groundwater and surface water, but the implications regarding water quality standards are not considered** If the fate of infiltrate is to travel laterally to a local stream, through groundwater strata or the vadose zone, then we must consider whether any or how much treatment occurs between the point of infiltration and the point of entry to the stream, and whether that level of treatment (if any) is sufficient to be protective of freshwater quality standards. For example, considering the copper or zinc content of stormwater; the criteria are not directly comparable, as the GWS is for total metal and the FWS is for dissolved. If for purposes of discussion we assume 50:50 partitioning between solid and dissolved, and 25 mg/L hardness for freshwater, the acute and chronic FW criteria are respectively 108 and 144-fold higher than the GWS	Increase emphasis on pollutant Source Control

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				for copper, and 71 and 77-fold higher for zinc. So while we are not likely given cause for concern from these two metals infiltrating from stormwater, even generally at untreated levels, if even an order of magnitude decrease in concentration is achieved before reaching a stream, that level could still be toxic to aquatic biota. And of course we must consider that which does not infiltrate, i.e. surface discharge in excess of that which can infiltrate. The LID assumptions do not consider that where underground utilities service homes, aggregate-filled utility trenches may well intercept some portion of infiltrated stormwater – particularly where vertical infiltration is impaired by underlying soil – and subsequently the infiltrate may wind up not recharging local streams; rather, may wind up flooding utility manholes and tunnels, at some expense to the homeowner who had to implement LID for naught, and expense to the Utilities to mitigate for facility flooding.	
Overall				**Recognition of a wider array of pollutants** The Manual should consider a wider range of pollutants than TSS, Cu, Zn, Total P, and oil. Other pollutants occurring in stormwater that should be considered include, but are not limited to, bacteria, PAHs, phthalates, phenols, pesticides, cyanide (e.g. road salt anti-caking agent[i], [ii],[1]), and sodium (of concern are the effects of sodium on treatment soils). There seems to be an unspoken and unsupported assumption that TSS removal will address many of these other pollutants. Consideration of these other pollutants should include: - Sources and source control - Treatment requirements and options for a wider range of pollutants - Alternatives and education	Per Comment

[1] Use in WA is noted as Prussian Blue (ferric ferrocyanide), 70 – 165 ppm; or Yellow Prussiate of Soda (YPS -- sodium ferrocyanide), 50 – 250 ppm [2]

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Overall				**LID Design and Maintenance Standards** On January 12, as stated by Ecology, "the Department of Ecology issued a Request for Proposals for a project to develop Low Impact Development (LID) standards, guidance, and training. The project is . . . is intended to help local governments and others prepare for long-term maintenance of LID best management practices." It seems premature then, to attempt review of LID requirements when it is clear that standards and guidance are not ready. We find the timing problematic. Given the heavy emphasis on implementing LID – by both the NPDES Permit and the Manual, this seems like an extreme case of putting the cart before the horse. For landscape-based treatment facilities using a soil layer – amended or not – for or as an adjunct to pollutant capture, e.g. bio-infiltration facilities, bio-filtration swales, and vegetated filter strips, long-term performance and media replacement cycle issues are addressed minimally or not at all in the current manual. An narrative example from an Ecology TAPE review of a WSDOT compost-amended bioswale[9]: "There is a need to address long-term performance and O&M"; i.e., how long before replacement of the compost? Unlike cartridges that are easily removed, the swales cannot be "changed out" readily". The same can be said for a soil layer as for a compost blanket, and for any landscape treatment facility or BMP, e.g. but not limited to vegetated filter strips and dispersion areas. The bio-infiltration section of Volume V says, "The design professional should calculate the pollutant loading capacity of the treatment soil to see if there is sufficient treatment soil volume for an acceptable design period", which implies some kind of maintenance; yet there is nothing in Table 4.5 (Maintenance Standards) for any facility, including bio-infiltration swales, regarding replacement of the treatment soil. The same consideration as that expressed above for operations and maintenance of facilities should also be applied to low impact development non-facility BMPs, e.g. rain gardens and	We strongly recommend that LID requirements not be required until design and maintenance standards , and a credible view of replacement cycle and related costs have been established.

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				dispersion areas.	
Overall				**Unintended Consequences of use of LID Media** The manual should address cases where some treatment facilities may release some pollutants. · For any treatment facility using compost as treatment media, citing the BER* in Howie (2011)[9]: "Question: Is there any concern that the treatment technology materials could unintentionally contribute pollutants (e.g., nutrients, toxicity, and high pH) to stormwater?" "#1 - Yes there is. The report clearly showed that nutrients, both N and P, were released from the compost-amended swale. Although it is probably beyond the scope of the study, a more long-term analysis of these releases would be interesting in order to determine if there is a time where this treatment technique no longer releases N and P but instead treats it. . . . If there is export of phosphorus from this technology, there may be limitations on where you can install the technology". "#2 - Yes. The compost releases relatively high concentrations of P. This is known in the literature and can be problematic if this technology is employed near nutrient sensitive waters. In addition, N is leached from the compost." The point is that the manual should consider the issue of unintended pollutant release for all approved facilities, not just for those now requiring TAPE review, and a full range of potential leachable pollutants should be evaluated. The literature contains several studies indicating pollutant release from compost mix media. See our comments RE: Glossary: definition of Compost	Need to evaluate unintended pollutant release from facilities and BMPs using soil and amended soil media, before wholesale placement of these BMPs. Need to consider nutrient release as a potential limiting factor with regard to LID BMPs using compost: as part of feasibility analysis in basins with sensitive lakes and/or nutrient TMDLs targeting phosphorus. Need to evaluate longevity to unacceptable pollutant breakthrough and soil / amended soil / engineered soil replacement cycle, before wholesale placement of these BMPs.
Overall	All & Glossary			**Ecology should revisit cation exchange capacity (CEC) analytical method**, and re-evaluate whether method 9081 is suitable. Cornell (2007)[10] suggests that the stock method may	See comments on Cation Exchange in Glossary comment.

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				overestimate CEC when analyzing acidic soils. EPA 9081 itself says at the outset: "The method of cation-exchange capacity by summation (Chapman, 1965, p. 900; see Paragraph 10.1) should be employed for distinctly acid soils." A likely scenario is that Applicants will simply send soil samples to the lab and ask for method 9081, without pointing out to the lab that western WA precipitation is acidic, and soils are often acidic. It would seem prudent to make it clear that the method should be by summation, not the sodium acetate protocol of 9081.	Ref. to -Cornell (2007a)[39], and Cornell (2007b)[40]
Overall				**There appears to be some inconsistency in soil treatment layers, and little to no evidence-based support for the criteria**. · For facilities in general, a "low permeability treatment liner is defined as "A two-foot thick layer of soil with a minimum organic content of 5% AND a minimum cation exchange capacity (CEC) of 5 milliequivalents/100 grams can be used as a treatment layer beneath a water quality or detention facility". There is no citation, and there is no suggestion here regarding calculation of acceptable design period, after which the treatment layer should be replaced. · For bio-infiltration swales, the figures given are nominal 18 inches depth, 5 meq/100 cation exchange capacity, and 1% organic matter, a maximum infiltration rate of 2.4 inches per hour is applicable for 18 in depth. The manual cites Stan Miller, Criteria for Assessing the Trace Element Removal Capacity of Biofiltration Systems, Spokane County, June 2000; but no other publication information is provided, and this document is not readily found by title and author. This section in the manual advises "The design professional should calculate the pollutant loading capacity of the treatment soil to see if there is sufficient treatment soil volume for an acceptable design period". There is no discussion as to why 1% organic content is the minimum acceptable here, while 5% is considered necessary for a two-foot thick low-permeability liner. This section also says, "Other combinations of treatment soil thickness, CEC, and organic content design factors can be considered if it is demonstrated that the soil and vegetation will provide a target pollutant loading capacity and performance level acceptable to the local jurisdiction." · Hinman (2009)[11] says, "To provide adequate soil contact and provide an equivalent media for enhanced treatment	

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				and protection of groundwater quality, Department of Ecology will now accept the following bioretention soil mix guidelines: a CEC ≥ 5 meq/100 grams of dry soil; 8-10 percent organic matter content; 2-5 percent fines; a maximum of 12 inches per hour initial (measured) infiltration rate; and a minimum soil depth of 18 inches with the above qualities (O'Brien, 2008)". While this is not a treatment layer per se, the quote above cites groundwater protection, and SWMMWW Volume V says, "Bio-infiltration swales have been used in Spokane County for many years to treat urban stormwater *and recharge the ground water*". That last statement may be the case, but in the absence of any further discussion or evidence, we do not know if the infiltrated water has caused any degradation in groundwater quality, or even if not, whether pollutants are migrating slowly and could cause groundwater degradation in the future. The manual should provide explanatory notes with respect to different soil treatment requirements, and robust methodology for independent calculation of necessary depth, organic matter, CEC requirements and redox conditions for treatment soils, in relation to infiltration rates and depending removal of pollutants including but not limited to metals, nutrients, and other pollutants that could contaminate groundwater in addition to surface water concerns. Maintenance, assessment, and replacement considerations should be included. Citations for the bases for these criteria should be provided.	
I & V				Ecology should consider whether the seasonal temperature-dependence of the viscosity of water in should be a factor in assumptions about LID and facility infiltration.	
I & V				The Manual should address the fact that even successful removal of indicator bacteria may not reduce pathogenic potential proportionally, when considering the pathogenic potential of viruses.	
I & V				The manual should consider other downstream impairments, e.g. high bacteria and low dissolved oxygen, and indicate which facilities are likely to exacerbate the downstream problems and which are likely to be helpful or at least have no net effect.	

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I & V				Basic-only water bodies should not be based solely on flow volume of the receiving water. There should also be consideration of relative proportion of discharge volume, and for cumulative effect of loadings from multiple outfalls. The same list should not apply for flow control and water quality consideration. No discharge should not be exempt from enhanced treatment where TMDLs or any other local, state, or federal cleanup actions are in effect.	
I & V				**The SWMMWW and the LID Manual should both consider what happens to trapped pollutants when a facility or BMP is exposed to salt in runoff from winter deicing, and effects on soils and metals entrained in soils** (Bäckström et al., 2004[12], Granato et al., 1995[13], Howard and Sova, 1993[14], Nelson et al., 2009[15], Norrström, 2005[16], Oberts et al., 2000[17]); mechanisms include cation exchange, metal-chloride complex formation, increasing solubility of metals, and colloid mobilization/dispersion; pH change has also been noted. First flush toxicity has been shown to increase. Oberts et al. (ibid) notes that the picture is complicated because" Sodium easily exchanges with Ca and Mg in soils, destroying soil structure and mobilizing organic matter", with can then increase mobilization of metals complexed to organic matter, while complexation may decrease bioavailability to fish, although likely no decrease for benthos feeding off sediment; and un-protective from a drinking water point of view. These studies all relate to heavy metals and soils. We must also consider enhanced metal-treatment facilities that are not based on soils, and the implications of salting on them.	Please address this issue in the Manual
I & V				**Recommend changing the term from 'enhanced' to 'enhanced metals' treatment**. The way 'enhanced' has been used in the past for stormwater treatment is specific to enhanced metals removal only. **The word 'enhanced' should be freed as an adjective in its traditional broader sense**, to describe any enhanced treatment, e.g. phosphorus, heavy metals, oil treatment, or for the future, e.g. but not limited to phthalate, phenol, pesticides, PAHs, PDBEs and pharmaceuticals and personal care products.	Make change wherever the term 'enhanced' is used
I	1.1	1-1	The objective of this manual is to provide guidance on the measures necessary to control the quantity and quality of stormwater produced by new development and redevelopment	The opening leaves some uncertainty as to whether the Manual a guidance document or a regulatory document with enforceable requirements. The term guidance is clear.	

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			such that they comply with water quality standards and contribute to the protection of beneficial uses of the receiving waters. . . . . This manual establishes minimum requirements for development and redevelopment projects of all sizes and provides guidance concerning how to prepare and implement stormwater site plans.	Establishment of minimum requirements sounds regulatory.	. . . . This manual reiterates minimum requirements established by the NPDES Municipal Stormwater Permit for development and redevelopment projects of all sizes and provides guidance concerning how to prepare and implement stormwater site plans.
I	1.4	1-4	"How to Use this Manual" *is followed by* "This manual has applications for a variety of users" *which is then followed by some examples and scenarios*.	Questionable usefulness for this section as-is	Recommend use of ideally a flowchart or at least a table for clarity, so the reader knows where to go next. Graphical roadmaps are easier to follow than narratives for decision trees.
I	1.5.2	1-5	Source control BMPs prevent pollution, or other adverse effects of stormwater, from occurring.	Source control BMPs do not always prevent pollution; they may prevent or limit the amount of pollution that gets into stormwater. From a syntAppendix point of view, pollution is not an adverse effect that occurs; it is the cause of adverse effects. Same argument regarding "other adverse effects" – which we assume means hydraulic or hydrologic effects.	Source control BMPs limit or prevent pollutants from getting into stormwater, and/or limit or prevent adverse hydraulic or hydrologic effects from occurring.
I	1.5.3	1-5	Treatment BMPs include facilities that remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, and soil adsorption.	The replacement language is more complete	Treatment BMPs include facilities that remove pollutants by simple gravity settling of particulate pollutants, centrifugal separation (vortex, cyclonic), filtration, engineered media adsorption, biological uptake, and natural or engineered soil adsorption.
I	1.5.4	1-5	Flow control BMPs typically control the rate, frequency, and flow duration of stormwater surface runoff.	The replacement language is more complete	Flow control BMPs typically control stormwater flow volume, peak flow, frequency of discharge, and flow duration.
I	1.5.4	1-5	Construction of an infiltration facility is the preferred option but is feasible only where more porous soils are available.		Construction of an infiltration facility is the preferred option but is feasible only where more porous soils are available, and treatment is provided before infiltration, or soil type and depth are deemed adequate and suitable for treatment (pretreatment is always required).

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I	1.5.4	1-6	Why has the language been changed from: In regard to wetlands, it is necessary to not alter the natural hydroperiod. To: In regard to wetlands, the goal is to not alter the natural hydroperiod. (?)	This seems less protective than the original language; it seems to allow some 'wiggle' room that is likely to result in some wetland degradation. Subsequent text indicates, it is "very difficult to predict and track water surface elevation changes". Understanding this point, but trying to maintain more protective language we recommend =>	In regard to wetlands, maintaining natural hydroperiod is crucial for survival of the wetland and its natural delineation.
I	1.5.5	1-6 & 1-7		**On-site Stormwater Management BMPs** Recommend that the following BMP be added to the list: . . . that post-development soils be amended with high quality compost, and de-compacted by ripping, disking, and roto-tilling following application of the compost layer. This should be the preferred LID BMP in lieu of requiring others.	Anywhere that land is cleared or soil is disturbed during development, those soils shall be compost amended and de-compacted by ripping, disking, and rototilling following application of the compost layer. Need to define compost characteristics and depth, and specifics of tillage requirements. See our comments RE: definition of Compost in Vol 1 Glossary.
I	1.6.4	1-11--1-17		Addition of the *Puget Sound Action Agenda* is understandable. What is confusing is wholesale deletion of *Stormwater Comprehensive Programs*. Are these elements no longer desired? It seems to us that these directives are still in effect – so why are they deleted?	
I	1.6.5	1-17	**Phase I - NPDES and State Waste Discharge Stormwater Permits for Municipalities** RE: "These Phase I municipal stormwater permittees must refer to Appendix 1 of their permit rather than relying on Chapter 2 of Volume I to find the minimum requirements, thresholds, and definitions that their jurisdiction either must implement, or must adopt equivalent measures as determined by Ecology."	The word "must" seems out of place in what Ecology states is a strictly technical *guidance* manual. Second (our above statement notwithstanding), it is quite convoluted to say 'don't use a specific part of this manual, use a Permit Appendix instead. The new Minimum Requirements should be incorporated into the Manual as an identifiable section applicable to permittees, and Chapter 2 applicable presumably to everyone else. As also mentioned in an earlier comment, this direction could be a decision branch in a flow chart earlier on (with a subset of the flowchart repeated here). Last, please verify that all of the deleted text just prior to section 1.6.6 is no longer applicable. The latter half of the deleted text does look dated; but the first ~ half looks like it may still be applicable.	

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I	1.6.6	1.18 & 1-19	**1.6.6 Phase II - NPDES and State Waste Discharge Stormwater Permits for Municipalities**	Even though King County is not affected by Phase II requirements, the same comments as we've provided above for section 1.65, with respect to awkwardness of substitution of a Permit Appendix for Manual Chapter 2 would seem to be equally applicable here. As above, the Minimum Requirements for Phase II jurisdictions should be incorporated into the Manual – again with a flowchart to assist in who does what.	
I	1.6.15	1-25	Examples of UIC wells are drywells, <u>infiltration trenches with perforated pipe</u>, catch basins, stormchambers, and similar devices that discharge to the ground.	How does an infiltration trench without a perforated pipe differ from one with perforated pipe?	Examples of UIC wells are drywells, infiltration trenches ~~with perforated pipe~~, catch basins, stormchambers, and similar devices that discharge to the ground.
I	1.6.15	1-25	**Underground Injection Control Authorizations**	**(UIC)** We strongly encourage Ecology to revisit the appropriateness of allowing UIC for stormwater infiltration, even with pre-treatment. - Need to revisit surfaces currently classified as non-pollution generating, and consequently whether runoff from these surfaces may be infiltrated without treatment (especially see our comments on roofing systems as PGIS). - Need to evaluate a wider range of chemicals than those for which groundwater criteria currently exist, and/or for which no treatment is specified by the Manual; e.g. but not limited to phthalates, phenols, pharmaceuticals, pesticides, personal care products, PCBs, PBDEs, and perfluorinated compounds. - Halogenated organics are inherently highly resistant to degradation, and many are bioaccumulative and persistent. - Need to consider that mechanisms for organic pollutant treatment (as opposed to solely sequestration by sorption to particulate matter) are biological, and; - Redox conditions in a UIC facility are likely to differ than those in e.g. an open infiltration pond facility; conditions are likely to be hypoxic to anoxic. Under hypoxic/anoxic conditions likely at the bottom of a UIC facility, breakdown mechanisms for organic pollutant are limited; in particular photo-oxidation and aerobic microbial breakdown. - Phytoremediation by plants is not feasible because light	

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				required for photosynthesis is precluded. - With close-to-surface BMPs, e.g. swales, filter strips, and rain gardens, contaminated media can be easily replaced. What is the replacement strategy for UIC facilities that have become contaminated, or clogged, limiting infiltration? - Need to consider that if UIC infiltrate travels laterally to a surface water body, then surface water quality standards are of concern in addition to groundwater quality standards. A clear case of this is the criteria for copper and zinc, which are vastly higher for groundwater than for surface water. In this case, while enhanced (metals) treatment may not normally be required for discharge to ground, ground discharge to a surface water body might dictate that enhanced (metals) treatment be required for injection/infiltration.	
I	1.7.2	1-26 & 1-27	**Hydrologic Changes**	Figure numbering is awkward; numbering coincides closely but not exactly with relevant sections; e.g. Section 1.7.2 contains Figures 1.7.1 and 1.7.2.	Recommend changing Figure numbering to match the section in which the figure resides. In the example here, Section 1.7.2 would contain Figures 1.7.2.1 and 1.7.2.2.
I	1.7.3	1-27 & 1-28	**Water Quality Changes**	Same comment as above, but as it pertains to Table numbering. It is awkward to find Table 1.7.1 in Section 1.7.3.	Recommend changing Table numbering to match the section in which the table resides. In the example here, Section 1.7.3 would contain Table 1.7.3.1
I	1.7.4	1-29	**Biological Changes**	Is "Figure 1.3 from May et al (1997)" a typo? This appears to refer to Figure 1.7.3 on the following page.	Expect 1.3 is a typo. Please see comments immediately preceding with regard to recommended correction – and for all subsequent Tables and Figures.
I	1.7.4	1-30		Why is Figure 1.7.3 in section 1.7.4? Re-title Figure 1.7.4?	See immediately preceding comments. Rename e.g. 1.7.4.1
I	2.1	2-1	Municipalities covered under the Phase I or II NPDES Municipal Stormwater Permits should use Appendix 1 of those permits rather than the bold font statements of this chapter for determining their compliance requirements.	Interleaving Permit requirements with Manual guidance is awkward at best, and confuses the distinction between requirements and guidance, and increases difficulty complying with the permit. The audience is not just the municipalities reviewing the Manual. There is considerable risk that many readers - e.g. development permit applicants - will miss this directive, and will not know to substitute Permit Appendix 1 for the bold font statements.	Recommend: where Appendix I is applicable in Chapter 2, integrate that language into Chapter 2. Recognizing that this may be awkward, as Appendix 1 of the Phase I and Phase II permits may differ: At each section or statement where anyone in a Phase I or Phase II jurisdiction is supposed to substitute Appendix 1 of the relevant permit, that should be noted immediately preceding the section or statement. Could be achieved by in-line or margin call-out boxes, or localized mini-flow-charts. In this case, both Phase I and Phase II permits should be included with the Manual as Appendixes, and in the PDF version

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					of the manual, hyperlinks should take the reader to the appropriate section of the relevant permit.
I	2.3	2-5	**Effective Impervious Surface** . . .Impervious surfaces are considered ineffective if .... 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion," . . . 2) residential roof runoff is infiltrated in accordance with Downspout Infiltration Systems in Volume III . . .	Effective impervious should be defined differently for hydraulics and water quality consideration. The definition of ineffective as-stated makes sense from a hydraulics point of view if the local LID infiltrative intent is achieved in the long term; and that if should be a stated caveat. Full dispersion should only be allowed where soils do not meet treatment layer criteria. Roof runoff should not be considered non-polluting as stated more fully under commentary on the definition of PGIS in this same section (2.3) . The allowance for driveways as ineffective surfaces is questionable, as they are subject pollution from vehicles with leaks, and from spills during vehicle maintenance.	Requesting that Ecology re-write the definition to incorporate these considerations.
I	2.3	2-5	Erodible or leachable materials – Wastes, or chemicals that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.		Erodible or leachable materials – Wastes, or chemicals that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, unprocessed and processing compost, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.
I	2.3	2-6	**LID** **LID BMPs** **LID Principles**	Pre-developed conditions did not yield precipitation or runoff with the range of pollutants and magnitude of pollutant loads we have now. All definition and discussion regarding LID should emphasize source control as a crucial part of mimicking pre-development conditions.	Include Source Control in these definitions
I	2.3	2-6	**Maintenance**	The definition of Maintenance should include assessment to ensure ongoing proper operation, removal of built up pollutants (i.e. sediments) and replacement of failed or failing treatment media.	Amend per comment
I	2.3	2-7 & 2-8	Pollution-generating impervious surface (PGIS) - Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use; industrial activities (as further defined in the glossary); or storage of erodible or leachable materials, wastes, or chemicals, and which receive	**PGIS Definition: Roofing** There is a substantial body of literature indicating potential for a wide variety of roofing materials to leach, weather, and convey a wide array of pollutants at levels of concern for both surface water and groundwater. Recent related reports from Ecology	All roofing should be designated PGIS Change the terminology from roofs/roofing to 'roof systems including gutters and downspouts

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			direct rainfall or the run-on or blow-in of rainfall. Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating).	indicate that zinc is not the only chemical of concern from roof runoff (Roberts et al, 2011[18], Norton et al, 2011[19]). Weight of evidence from these and other readily available research literature – some of which is likely referenced by Ecology (*ibid*), demonstrates that roofing besides zinc, copper, and lead (which are of obvious concern) have been found to release pollutants at levels of concern: (Amman et al, 2003[20], Bucheli et al, 1998a[21], Bucheli et al., 1998b[22], Chang et al., 2004[23], Clark et al., 2008a[24], Clark et al., 2008b[25], DeBusk, 2009[26], Dietz, 2009[27], Mason et al., 1999[28], Nicholson et al., 2010[29], Schueler, 1994[30], Van Metre and Mahler, 2003[31], Vialle, 2011a[32], Vialle, 2011b[33], Zobrist, 2000[34]). Pollution-generating roofing materials include but are not limited to wood shingle, plywood with tar paper, built-up, rock and tar, composition asphalt shingle, concrete tile, ceramic, polyester, and terra cotta. Pollutants of concern at levels commensurate to or even exceeding levels found in 'typical' PGIS stormwater, but discharging from roofing, include but are not limited to heavy metals, PAHs, organic pesticides, organic halogens, phthalates, and nutrients. In any given situation, some proportion of each pollutant present is intrinsic, and some may be extrinsic. Intrinsic sources of these substances from roofing include but are not limited to heavy metals from bare metal in roofing or as 'moss strips', possibly as a leachable catalyst for e.g. EPDM membrane roofing, or entrained in granular, powder, or metal salt form as moss killer or for rot resistance; and organic chemicals used for moss killer, rot resistance, other pesticides/herbicides, and/or possibly fire retardants. Ironically, 'green roof' substructure is likely to be treated with leachable toxic materials for rot-resistance, intentions notwithstanding, owners may apply fertilizer and/or pesticides to green roofs, and even the soil layer itself may leach some additional pollutant; so while green roofs are expected to provide some hydraulic benefit, there may be unintended consequence of additional pollutants in the discharge. The Manual allows that metal roofs "coated with an inert, non-leachable material (e.g., baked-on enamel coating) are non-pollution generating, but without clear guidance on what constitutes 'inert', the coating itself may leach harmful substances. e.g. in the case of "baked on enamel", this is likely to actually be a baked on 'powder coat' plastic coating, which may contain heavy metals for pigment and/or e.g. UV	

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				stabilization, and may leach e.g. phthalates or other plastic components. Whatever its own pollution-generation potential,' roofing may also convey pollutants from dry deposition or via precipitation. Extrinsic pollutants include but are not limited to heavy metals, PAHs, pesticides, halogenated organic compounds, nutrients, bacteria, soot, and TSS. Which pollutants are most prevalent is likely to be somewhat land-use dependent, but there will be some overlap and as always – variability. Further, an obvious source of heavy metals in the Pacific Northwest is the use of moss killer applied to roofs by homeowners and contractors. Last but not least, gutters and downspouts must be considered part of the roofing system, and their pollution-generating potential factored in. Drainage materials of concern include zinc/galvanized, copper, and plastics which may contain heavy metals and/or leach e.g. phthalates. There is a well-documented case of deck-drainage downspouts on the SR-520 bridge causing high zinc leachate levels in the discharge, while bridge runoff itself was relatively low in zinc concentration. There is no reason not to suspect that the same could occur with zinc and copper roof gutters and drains. Plastic materials may not get a free ride either; heavy metals are used for color and stabilization of some plastics, and may leach out. Further, some plastic compounds may leach, e.g. phthalates and bisphenol A.	
I	2.3	2-7 & 2-8		**PGIS Definition: Other Building Materials** Beyond roofing, other building materials should be evaluated as PGIS. These include but are not limited to: · Structural and decorative use of leachable or erodible metals for e.g. siding, flashing, and trim: e.g. copper, brass, bronze, zinc, and lead; · Exterior paints and stains which may leach, erode, or otherwise release toxic substances by weathering or direct contact with rainwater. Substances of concern include but are not limited to heavy metals (pigments and stabilizers), algaecides, and nanomaterials. · Treated lumber exposed to weather	

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				· Fencing, e.g. galvanized chain-link fencing While the literature is much more sparse than that for roofing, other building materials besides roofing have been documented as having potential to leach toxic pollutants into stormwater. [35], [36]. Consideration will need to be applied where leachable or erodible PGIS surfaces are vertical (i.e. walls, fences). Treatable area is inherently based on area. While roofing presents an obvious footprint, how to deal with contributions from vertical surfaces, which may still contribute to the pollution footprint of a building, by leaching, eroding, or weathering.	
I	2.3	2-8	**Pollution-generating pervious surfaces (PGPS)** – Any non-impervious surface subject to vehicular use, industrial activities (as further defined in the glossary); or storage of erodible or leachable materials, wastes, or chemicals, and that receive direct rainfall or run-on or blow-in of rainfall, use of pesticides and fertilizers or loss of soil. Typical PGPS include permeable paved roads, driveways, and parking lots; lawns, landscaped areas, golf courses, parks, cemeteries, and sports fields.	"Any non-impervious surface subject to vehicular use" means that by definition permeable pavement is pollution generating. We do not disagree, with regard to persistent potential and to episodic risk (spills). Arguments may be made about full infiltration, but as that is highly unlikely except over advanced outwash (where risk becomes more of an issue). Besides vehicular use, pervious pavement is subject to pesticide applications –both drift and direct (how will a homeowner manage moss growth in pervious pavement?); and is subject to some fertilizer input as lawn up to the edge of pavement may be fertilized.	A cautionary note, to be considered and related back to the Permit with regard to potential unintended consequences of promoting pervious pavement – especially promotion ahead of other BMPs.
I	2.3	2-8	**Project site** - That portion of a property, properties, or right of way subject to land disturbing activities, new impervious surfaces, or replaced impervious surfaces.	Interpretation is somewhat confusing, especially when juxtaposed to the definition of Site	Recommend changing the term to **Site Project Area**, or simply **Project area**, with no change in definition.
I	2.3	2-9	**Receiving waters -** Bodies of water or surface water systems to which surface runoff is discharged via a point source of stormwater or via sheet flow. Ground water to which surface runoff is directed by infiltration.	A good place to note hydraulic connectivity between ground water and surface water; with the consequence that one may meet a particular groundwater quality standard yet that could cause a surface water quality impairment. Examples include phosphorus, for which there is no groundwater quality standard, e.g. discharging through groundwater into a sensitive lake; and for zinc and even more so for copper, for which the groundwater quality standard (even accounting for total vs. dissolved) is much higher than the surface water quality standard.	**Receiving waters -** Bodies of water or surface water systems to which surface runoff is discharged via a point source of stormwater or via sheet flow. Ground water to which surface runoff is directed by infiltration. When considering water quality criteria, hydraulic connectivity between groundwater and surface water must be considered.
I	2.3	2-9	**Site** – The area defined by the legal boundaries of a parcel or parcels of land that is (are) subject to new development or redevelopment. For road projects, the length of the project site	Recommend adoption of King County definition, as more detailed.	**Site (a.k.a. development site)** means a single parcel, or two or more contiguous parcels that are under common ownership or documented legal control, used as a single parcel for purposes of applying for authority from ~~King County~~a jurisdiction to carry

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			and the right-of-way boundaries define the site.		out a development/project proposal. For projects located primarily within dedicated rights-of-way, site includes the entire width of right-of-way within the total length of right-of-way subject to improvements proposed by the project.
I	2.3	2-10	**Vehicular Use** (and not) definitions	Fenced fire lanes and 'infrequently used maintenance roads' are exempted; i.e., not considered subject to vehicular use.	With regard to the 'fenced' condition, it seems prudent to specify that the fencing itself must not be made of erodible or leachable material, e.g. galvanized chain link fencing, or pressure-treated wood fencing, either with potential to leach toxic pollutants onto the rarely used roadway. With regard to 'infrequently used' maintenance roads, some definition of 'rarely used' should be provided. Does this mean once per year? quarterly? monthly? weekly? How many vehicle trips per 'infrequent' period? Does the kind of vehicular traffic have any bearing on the subject?
I	2.4	2-11	**Figure 2.4.1** (without evaluating suitability of this Figure number (see prior comments in that regard): central box: Does the project convert ¾ acres or more of ~~native~~ vegetation to lawn or landscaped areas, or convert 2.5 acres or more of ~~native~~ vegetation to pasture?	What is the rationale behind deletion of the term 'native'? Is this to compensate for past damage that has not been remediated; e.g. if someone buys property that was previously logged and is now covered with broom – and that is being converted to a lawn or landscaped area? That makes some sense. What about with regard to the second example, what if a farmer is converting 2.5 or more acres of row crops to pasture. Should that trigger the minimum requirements?	Please clarify per comments
I	2.4.1	2-12	Narrative text identical to and/or expansion on flow chart on prior page	Same comments	Please clarify per comments
I	2.5.2	2-20 & 2-21	**Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)** **Element 4: Install Sediment Controls**	Need to insert language specifying that no TESC materials shall be used that have not been themselves been proven to not leach or otherwise discharge pollutants themselves (see Wu et al., 2010)[37]. Manufacturer's assertions including MSDS sheets are not sufficient in and of themselves. Ecology needs to evaluate TESC products with a program similar to TAPE, or at the very least to evaluate the basis for manufacturer's claims for validity[*].	Recommend language insertion per comments
I	2.5.2	2-21 & 2-22	**Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)** **Element 5: Stabilize Soils**	Need to insert language specifying that no soil stabilization materials shall be used that have not been themselves been proven to not leach or otherwise discharge pollutants themselves (see Wu et al., 2010)[37]. Manufacturer's assertions including MSDS sheets are not sufficient in and of themselves.	Recommend language insertion per comments

[*] We have seen a case where a MSDS indicates a sample collection methodology was used for a toxicity test, with methodology not appropriate for the test.

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				Ecology needs to evaluate TESC products with a program similar to TAPE, or at the very least to evaluate the basis for manufacturer's claims for validity*.	
I	2.5.5	2-34	**Minimum Requirement #5: On-site Stormwater Management** Projects shall employ On-site Stormwater Management BMPs in accordance with the following projects thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding or erosion impacts.	Incomplete statement	**Minimum Requirement #5: On-site Stormwater Management** Projects shall employ On-site Stormwater Management BMPs in accordance with the following projects thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding, ~~or~~ erosion impacts, or groundwater pollution.
I	2.5.5	2-34 & 2-35	**Mandatory List #1** **BMP selection in the order listed**	There is no reasonable rationale for the preferential order of the list – especially with regard to cost, likelihood of failed installation, and maintainability of pervious pavement. We recommend that the following BMP be added to the list: . . . that post-development soils be amended with high quality compost, and de-compacted by ripping, disking, and roto-tilling following application of the compost layer. This should be the preferred LID BMP in lieu of requiring others. We further recommend that if a preferential list is maintained, that this added compost and de-compacting BMP be placed at the top of the list, and pervious pavement be placed at the bottom.	Recommend changes to accommodate these comments
I	2.5.5	2-34 & 2-35	**Mandatory List #1** **Roofs**	Section (list numbers 1-4) needs to be re-evaluated in the context of roof systems (roofs, gutters, and drainpipes) designated as PGIS, per commentary re: definition of PGIS (above)	Section needs amendment accordingly
I	2.5.5	2-36 & 2-37	**Mandatory List #2** **BMP selection in the order listed**	There is no reasonable rationale for the preferential order of the list – especially with regard to cost, likelihood of failed installation, and maintainability of pervious pavement. We recommend that the following BMP be added to the list: . . . that post-development soils be amended with high quality compost, and de-compacted by ripping, disking, and roto-tilling following application of the compost layer. This should be the preferred LID BMP in lieu of requiring others. We further recommend that if a preferential list is maintained,	Recommend changes to accommodate these comments

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				that this added compost and de-compacting BMP be placed at the top of the list, and pervious pavement be placed at the bottom.	
I	2.5.5	2-36 & 2-37	**Mandatory List #2** **Roofs**	Section (list numbers 1-4) needs to be re-evaluated in the context of roof systems (roofs, gutters, and drainpipes) designated as PGIS, per commentary re: definition of PGIS (above)	Section needs amendment accordingly
I	3.1.1	3-2	**Step 1 – Collect and Analyze Information on Existing Conditions** This section will be updated to be complementary with Site Assessment procedures described in the updated **Low Impact Development Technical Guidance Manual for Puget Sound.**	Unable to review as update by Ecology is pending	
I	3.1.2	3-4	**Step 2 – Prepare Preliminary Development Layout** This section will be updated to be complementary with Site Assessment procedures described in the updated **Low Impact Development Technical Guidance Manual for Puget Sound.**	Unable to review as update by Ecology is pending	
I	4.2	4-4	**4.2 BMP and Facility Selection Process** **Step V: Select Treatment Facilities** Ecology proposes to eliminate the existing text from Step V, and replace it with a reference to Volume V, Chapter 2. We are interested in comments concerning any perceived drawbacks with this approach. Note that the text that appeared here will continue to be in Chapter 2 of Volume V. That text is being updated.	While cautioning against the functional equivalent of computer programming 'spaghetti code', we encourage decreasing redundancy and increasing clarity in the SWMMWW. If that can be achieved by the functional equivalence of programming subroutines – with clear direction back to the main program, that could be a good thing. This should be done in the context – as we have already commented – of combining the individual volumes of the SWMMWW into a single volume, with the electronic PDF version being full hypertext cross linked. This case under discussion is a good example. Ideally the Manual would ultimately be electronic and form-based, similar to tax -preparation software, with walk-through questionnaires as that software has. As complicated as stormwater management has gotten, it's still not likely as complicated as the tax code.	Consider comments in draft Manual re-write organization
I	Glossary	8	**Cation Exchange Capacity (CEC)** The amount of exchangeable cations that a soil can adsorb at	As commonly used in stormwater documents, CEC seems to be intended to be the amount of exchangeable cations other than hydrogen ions that a soil can adsorb. Since total CEC includes	The amount of exchangeable cations that a soil can adsorb. Units are milli-equivalents per 100 g of soil, typically abbreviated simply as meq. Soil found to have a CEC of 5 meq

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			pH 7.0.	hydrogen ions, CEC of other cations depends on pH of the laboratory test method, and likewise soil CEC is pH-dependent[38], and may be quite different than that measured in the laboratory. While not stated here, the test method given elsewhere in the manual, unless read very carefully by an applicant, will result in a neutral to alkaline test, resulting in an overestimation of field CEC, because Western Washington precipitation and soils tend to be acidic (USGS says precipitation is ~ pH 5.3). See Cornell (2007a)[39], and Cornell (2007b)[40].	at pH 7 will have CEC < 5 meq when pH < 7. One must be mindful that sorption is not permanent; that the E in CEC indicates that the cations are exchangeable, and that sorbed heavy metal cations may be displaced, e.g. by protons in low pH soil and salt cations from pavement salting. See Cornell (2007a)[39], and Cornell (2007b)[40].
I	Glossary	10	**Compost** Organic residue or a mixture of organic residues and soil, that has undergone biological decomposition until it has become relatively stable humus. Reference note: The Department of Ecology Interim Guidelines for Compost Quality (1994) defines compost as "the product of composting; it has undergone an initial, rapid stage of decomposition and is in the process of humification (curing)." Compost used should meet specifications for grade A or AA compost in Ecology publication 94-038.	Following directions, a web search for Ecology Publication 94-038 yields this web page: http://www.ecy.wa.gov/biblio/94038.html, which says: This document is no longer available. Please visit our compost web site at: http://www.ecy.wa.gov/programs/swfa/compost/ Following that link gets to an Ecology HTTP 404 Error: "Sorry, Page Not Found".	We recommend that Ecology conduct a thorough literature search on content of compost and compost-soil mixture leachate. Studies are needed that measure not only leachate pollutant concentrations, but also the solid media concentrations of the same substances. Ecology should identify data gaps, and fund any studies needed to fill those gaps.
				Compost for Use for Stormwater Treatment Media The only compost standard in Washington is currently WAC 173-350-220. We are not questioning use of that standard for compost used for general landscaping. However, we are concerned about the standard with respect to compost use for stormwater treatment BMP media. The compost quality criteria* are very limited in the list of risk parameters – nine heavy metals, pH, bacteria, and sharps. The absence of standards for any other pollutants in compost means there is a large information gap with respect to risk from other pollutants when using compost. We note that WA MTCA standards for unrestricted use (Table 749-2) is more conservative for several of the metals. According to Mikula et al. (2007)[41],"... it has been shown in past filter work that the media can be a source of pollutants either due to the release of previously-trapped compounds or of compounds contained in the media itself. It has been well-documented that small concentration gradients between the	

* WAC 173-530-220 Tables A and B
† Cu and Zn criteria are calculated at hardness = 25 mg/L

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				media and the pollutants in the water results in weak removals, and that when media concentrations of a pollutant are greater than those in the passing water, negative removals occur"; and Gharabaghi et al. (2007)[42] found 12% net export of copper in a compost sock biofiltration experimental field box, (median influent Cu 13.4ug/L, n=3). Bugbee et al.[43] found that both copper and zinc in leachate from planting media exceeded WA state surface water chronic criteria. Exceedance occurred at 0% compost, and increased as % compost increased. Manganese in leachate exceeded the EPA human health level at 60% compost and above[†]. Copper and zinc levels in the compost were 202 and 296 mg/kg respectively, compared the WAC 173-350 limits of 750 and 1400 mg/kg respectively. Kirchoff et al.[44] did a column leachate test simulating over a year worth of precipitation, applied to biosolids mixed with wood chips, sand, and clay. They found copper leachate at or above 120 ug/L at 1.5 months of simulated precipitations, and at or above 10 ug/L at 9 months. The acute and chronic water quality criteria are 4.6 and 3.5 ug/L. Zinc was at or above 700 ug/L at 1.5 months, and at or above 180 ug/L at 9 to 12 months. The acute and water quality criteria are 35.4 and 32.3 respectively. Total zinc in untreated stormwater is typically 168, 236, or 629 ug/L respectively in commercial, traffic, and industrial runoff[45]. [(*)] In order to find that compost that even marginally meets WAC 173-530-220 heavy metals criteria is as effective at removal of those same metals from stormwater as is compost containing much lower heavy metal pre-loading requires testing that to the best of our knowledge has not been done. It seems a reasonable presumption that considering compost-media filtration, with e.g. a cartridge filter system, eventually the cartridge will become loaded, and that at the very least it makes sense to start with a filter with as little pollutant pre-loading as possible. There is also the question of eventual breakdown of compost organic matter. That may be resolved in e.g. rain gardens and surface biofiltration facilities; but it seems inadvisable to consider compost as a permanent media component e.g. as an amendment under pervious pavement. In the end, no matter where applied, we have the question how long the media will last before requiring replacement because loading has rendered it ineffective, and/or the media has broken down. Studies	

[*] Data in these reports were not described as dissolved, so for purposes of comparison to the state WQS, US EPA's metal translator from total to dissolved (0.960) was used here. Exceedances would not be as large with a smaller ratio, but even at 0.5, there would be some exceedances. 25 mg/L hardness is assumed for calculating chronic and acute state WQ criteria.

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				assessing these issues experimentally are scarce, and as interest and research on these systems is relatively new, any estimates must by necessity be modeled based on very time-limited data. Ecology has suggested a 20-year lifespan (SWMMWW Vol V, BMP T7.30); we provide comments with respect to that in our review of Vol V.	
I	Glossary	16	Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces on residential development sites are considered ineffective if: 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion" as described in Chapter 5 of Volume V; 2) residential roof runoff is infiltrated in accordance with Downspout Infiltration Systems in Volume III; or 3) approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated .	See prior comments Re: Roofing and roofing systems should be considered PGIS, and therefore not included in this back-door definition of ineffective.	Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces on residential development sites are considered ineffective if: 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion" as described in Chapter 5 of Volume V; 2) ~~residential roof runoff is infiltrated in accordance with Downspout Infiltration Systems in Volume III; or 3)~~ approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated~~.~~, and the soil has been found to meet required soil treatment layer criteria.
II	All	All		Ecology should evaluate the potential for erosion and sediment control materials to leach toxic materials, as suggested by Wu et al. (2010)[46]. Further, we have noted that manufacturer's assurance of no leachate toxicity can be based on inappropriate sample collection methodology, e.g. extremely high flow rate through material, with very short contact time, biasing the sample to unrealistically dilute with respect to leachate. We have also noted only acute testing may be applied and question why chronic should not also be required. We recommend that Ecology establish a program similar to TAPE to evaluate the potential toxicity of erosion and sediment control materials.	
II	BMP C-101	4-4	Paint root ends with asphalt based paint.	This is only needed if the roots will be exposed for a long time. If cut and then covered over, not needed.	II
II	Table 4.1.8	4-25	Wood-based mulch…hog fuel.	The source of hog fuel is not closely monitored. If, as happens, it is contaminated with seeds and the rooting bits of plants, then weeds start popping up and cause problems later on. Also, some do not like the appearance of hog fuel, so aesthetics should be considered if it is used in residential construction, though it can be mixed in with loose soil to improve the appearance. **WoodStraw** should be added to the discussion of wood-based mulches. It is a clean, manufactured wood product that is more	

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				stable on slopes than hog fuel.	
II	BMP C-122	4.26	Synthetic nests and blankets can be used to permanently stabilize channels….	Actually, synthetic blankets entangle maintenance crew equipment and should be avoided. Natural fiber blankets are much more useful and add to the soil composition as they deteriorate. Avoid all synthetics for permanent use.	
III	1.1	1-1	BMPs for preventing pollution of stormwater runoff and for treating contaminated runoff are presented in Volumes W and V, respectively.	"W" designation does not appear to be correct.	
III	2.2.3	2-12	If the post development flow duration values exceed any of the predevelopment flow levels between 8% and 50% of the 2-year predevelopment peak flow values, then the LID performance standard not been met.	Note that there are no allowable, temporary excursions for this part of the curve, unlike those allowed for ½ of the 2 to the 50 year portion of the curve. Is this realistic?	
III	3.2.1	3-26 & 3-27	Planting Requirements Exposed earth on the pond bottom and interior side slopes should be sodded or seeded with an appropriate seed mixture. All remaining areas of the tract should be planted with grass or be landscaped and mulched with a 4-inch cover of hog fuel or shredded wood mulch. Shredded wood mulch is made from shredded tree trimmings, usually from trees cleared on site. The mulch should be free of garbage and weeds and should not contain excessive resin, tannin, or other material detrimental to plant growth.	For wood mulch produced on-site, by shredding local tree trimmings obtained from land clearing for the pond: How is one to determine that the wood does not contain excessive resin, tannin, or other materials detrimental to plant growth – and should be added – not detrimental to aquatic life; i.e., there should also be concern about potential leachate to receiving waters through the MS4. 'Excessive' needs to be defined in this context. Is there a list of trees whose wood does or does not contain substances at harmful levels re: plant growth or leachate to receiving waters through the MS4? The Manual should prominently note this caveat: If commercially produced mulch is imported from off-site: "When wood recovered from construction and demolition (C&D) debris is used as mulch, it sometimes contains chromated copper arsenate (CCA)-treated wood. The presence of CCA-treated wood may cause some potential environmental problems as a result of the chromium, copper, and arsenic present."[47]	Please address how to determine that the wood does not contain excessive resin, tannin, or other materials, and note potential detriment to receiving waters as well as immediate locale plant growth. Add cautionary mulch source language per comment. If quote is used, include citation as given in Comment cell.

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				The reader should be advised to be sure the mulch is certified (does WA have a mulch certification program) to be free of anything besides natural wood with no history of chemical treatment.	
III	3.3.2	3-65	Pretreatment facilities that have the capability for removal of soluble pollutants particularly •petroleum-related pollutants and bacteria are advisable if Site Suitability Criterion SSC-6 is not met at the infiltration facility.	"Advisable" is fuzzy language here. Is this a requirement or suggestion only?	
III	3.3.4	3-68	In addition, the overflow/bypass must meet the LID performance standard if it is the option chosen to meet Minimum Requirement #5, or if it is required of the project.	I suggest clarifying that the "pond and/or overflow bypass system" must meet the LID performance standard if it is the option chosen to meet MR#5 or required for the project.	
III	3.3.4	3-70	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.	Note that no details are given re: facility testing to determine that the facility performs as designed. Most are built with a given long term perc rate so that won't be tested. Is this to be a full scale test? Minimum 48 hours drawdown time is mentioned elsewhere. Provide more clarification/details here. Note that on page 3-79, the text says that verification testing of the completed facility is "strongly encouraged"—is it a requirement or not?. SSC-9 uses "recommended".	
III	Figure3.26	3-71		"Soul gradation" should be "Soil gradation"	
III	3.3.5	3-72	Subsurface explorations (test holes or test pits) 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.	Need definition of saturation zone.	

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III	3.3.6	3-79	Verification testing of the completed facility is strongly encouraged. (See Site Suitability Criterion # 7-Verification Testing)	Text under Construct the facility & Conduct Performance Testing page 3-70 seems to require testing. Please clarify if it is encouraged or required and be consistent.	
III	3.3.6	3-87	The SHC infiltration-rate obtained from the PIT test shall-be-considered to be a short-term rate.	Spell out or define /abbreviate as SHC earlier in relevant text.	
III	3.3.7	3-94	Verification testing of the completed full-scale infiltration facility is recommended to confirm that the design infiltration parameters are adequate.	Called out as a “must” earlier. #7, page 3-70	
III	Figure 3.297	3-97		An arrow is missing to proceed from box starting with “Perform computer design infiltration”	
III		3-103	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 in accordance with section 3.3.8.	“Recommended “or “advised “elsewhere in text. Need to be consistent	
III	3.4.2	3-115	After developing a preliminary development layout in consideration of the procedures outlined in Chapter 3 of Volume 1 and XX of the LID Manual for the Puget Sound Basin	Is “XX” a placeholder?	
III	3.4.2	3-115	On a single, smaller commercial property, one bioretention facility will likely be appropriate.	Is “smaller” a judgment call or is there a quantifiable threshold or definition?	
III	3.4.2	3-115	In that case, a small-scale pilot infiltration test should be performed at the proposed bioretention location.	Provide language here linking to appropriate section that describes requirements/guidelines for small scale PITs.	

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III	3.4.2	3-115	Unless seasonal high groundwater elevations across the site have already been determined, upon conclusion of the testing, infiltration sites can be overexcavated 3 feet to see any restrictive layers or groundwater	The language here needs clarifying. It is not clear if "can be overexcavated" is a requirement or suggestion.	
III	3.4.2	3-116	On commercial property, permeable pavement should be the first choice for parking lots and walkways, unless infeasible	Why should this be the first choice over bioretention??Why not give the designer the choice? It would lead to more effective designs based upon all the site parameters	
III	3.4.2	3-116	On residential developments, permeable pavements should be the first choice for subdivision roads and walks, and for private walks and driveways on residential lots.	Why should this be the first choice over bioretention??Why not give the designer the choice? It would lead to more effective designs based upon all the site parameters	
III	3.4.2	3-116	On residential developments, permeable pavements should be the first choice for subdivision roads and walks, and for private walks and driveways on residential lots. Small	"unless infeasible" should be added to be consistent with text above for commercial properties.	
III	3.4.2	3-116	Small-scale Pilot Infiltration Tests (PIT) should be performed every 150 feet of roadway; and at every proposed lot.	1 test per lot—does it matter what the lot size is?	
III	3.4.2	3-116	However, if the site subsurface characterization, including soil borings across the development site, have consistent characteristics and depth to the to seasonal high groundwater conditions the number of test locations may be reduced.	To a number recommended by a geotechnical professional??? Please clarify if the designer or geotechnical professional should make this determination.	
III	3.4.2	3-116	Unless seasonal high groundwater elevations across the site have already been determined, upon conclusion of the testing, infiltration sites can be overexcavated 3 feet to see any restrictive layers or groundwater. Observations through a wet season can identify a seasonal groundwater restriction.	Ponderous language, "can be, can identify…" not clear if this a suggestion or requirement. Additionally, I thought it was a requirement ("are necessary") to observe gw elevation Dec1 through April 1	
III	Appendix III-B			There are several instances where updates to the WWHM are referenced as pending. It is therefore difficult to review functionality and corresponding guidance in SMMWW at this time.	
III	Appendix III-B	B-8	Until such time as WWHM2 is upgraded to directly model porous pavementsAWRM3, the LID credit guidance in Appendix C should be followed. It will direct you to enter a certain	I don't understand this. If the porous pavement can be directly modeled with a limiting infiltration rate (either the pavement or soil), why would lack of undefined "significant" base course for	

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			percentage of the pervious pavement area into the landscaped area category rather than the street/sidewalk/parking lot category. Even after the WWHM update, those methods are appropriate to use where the pervious pavement does not have a significant depth of base course for storage.	storage push to the simplified approach of just modeling as landscaped/impervious mix?	
III	Appendix III-B	B-13	If the post-development flow duration values exceed any of the predevelopment flow levels between 8% and 50% of the 2-year predevelopment peak flow values, then the LID performance standard not been met.	I'm curious as to why no minor performance variances are allowed similar to the MR#7 standard	
III	Appendix III-C	C-3	Should a correction factor for site variability be considered in Setting the design infiltration rate?	Require a geotechnical engineer professional to recommend the rate.	
III	Appendix III-C	C-7	Full Dispersion for the Entire Development Site (fulfills treatment and flow control requirements)	This comment applies generally to using full dispersion where infiltration is occurring into native soils—there is no protection for groundwater resources (water quality) ensconced in requirements except for where engineered soils are proposed for the location of infiltration/dispersion. Especially problematic in outwash/hi perc rate areas and groundwater protection areas that would require an infiltration facility to meet strict water quality standards.	
III	Appendix III-C	C-15	Table X.X Flow Control Credits for Retained Trees.	Earlier section above this one cites Table 4.8 Rather than "X.X".	
III	Appendix III-C	C-17	Flow Control Credits for Newly Planted Trees.: Equation for calculating credit.	Equation given for calculating credit is unclear-implies trees credits are percentages rather than 20 or 50 SF per tree then divided by 100. The division by 100 is already included in the calculation.	
III	7.9.4.1	C-24	If the drainage area does not exceed any of the above area limits, use 2 as the infiltration reduction correction factor.	Given that the bioretention is sized for a specific tributary area, it seems loading rates will be similar regardless of whether described thresholds are crossed. Given uncertainties re: long	

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				term performance and maintenance, it would be more protective to use either the larger reduction factor or base the correction factor on long term performance data (if available) or consequence/risk if a system fails e.g. overflow concern.	
III	Appendix III-C	C-19	Mulches should be ofshredded or chipped hardwood or softwood and should not exceed XX inches thick.	The Manual should prominently note this caveat: "When wood recovered from construction and demolition (C&D) debris is used as mulch, it sometimes contains chromated copper arsenate (CCA)-treated wood. The presence of CCA-treated wood may cause some potential environmental problems as a result of the chromium, copper, and arsenic present."[47] The reader should be advised to be sure the mulch is certified (does WA have a mulch certification program) to be free of anything besides natural wood with no history of chemical treatment. ..... What does Ecology propose for the XX inches thick, and what is the rationale?	Add language per comment. If quote is used, include citation as given in Comment cell.
III	Appendix III-C	C-18	The compost to aggregate ratio should be 60:40. —The mix should have a CEC > 5 meq/100 grams of dry soil; 8 – 10 percent organic matter content by dry weight; 2 – 5 percent fines; a minimum depth of 18 inches; a minimum longterm infiltration rate of 1 inch per hour (estimated by applying a correction factor of 2 or 4 – depending upon size of drainage area – to the initial rate), and a maximum initial rate of 12 inches per hour.	Please provide by citation in the Manual, supporting evidence that the CEC, % OM, % fines, minimum depth, and long term infiltration rate are protective. Please define protective in terms of expected initial and long-term (e.g after 10 – 20 years) pollutant removal rates, and the basis for those expectations. What is the basis for CEC > 5 meq? CEC is defined in Vol 1 as measured at pH 7, yet Western WA precipitation and soils are typically acidic. For media that has been tested and found to have CEC = 5 at pH7 in the laboratory, what is the functional CEC for e.g. heavy metals in the range of e.g. 5 < pH < 6 in the field? We understand this may be moot in the sense that given 8 – 10 % OM, we would expect CEC to be considerably higher than 5 in any even. Two questions remain regarding CEC: level is 'needed, and what is the appropriate test method. We have commented in more depth on test method in our comments on Vol 1, under Glossary: Compost. Please see out comments Re: Compost, in Vol 1, Glossary Please provide, by citation in the Manual, supporting evidence	Please address comments per requests for recommendations and more information.

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				regarding infiltration rate range and applicability of correction factor, with respect to optimal contact time for miniimal pollutant removal.	
III	Appendix III-C	C-18	and meeting the contaminant standards of Grade A Compost.	Please see out comments Re: Compost, in Vol 1, Glossary	Same as comment
III	Appendix III-C	C-17	The organic content for "pre-approved" amendment rates can be met only using compost that meets the definition of "composted materials" in WAC 173-350-220.	Please see out comments Re: Compost, in Vol 1, Glossary.	
I	2.5.3	2-32	Structural source control BMPs should be identified in the stormwater site plan and should be shown on site plans submitted for local government review.	Structural source control BMPs need to be shown on actual building plans, not just site plans, and be approved by the reviewing agency.	Structural source control BMPs should be identified in the stormwater site plan and should be shown on all applicable plans submitted for local government review and approval.
IV	2.1	2-3	Do not connect floor drains in potential pollutant source areas to storm drains, surface water, or to the ground.	This belongs in the mandatory, not recommended section. There should be no interior floor drains connected to storm drain systems, regardless of where they are inside. This is important from an IDDE perspective.	Do not connect interior floor drains to storm drains, surface water, or to the ground. Plug existing floor drains that are connected to storm drains, surface waters or to the ground or convert them to sumps.
IV	2.1	2-4	Construct impervious areas that are compatible with the materials handled. Portland cement concrete, asphalt, or equivalent material may be considered.	Unclear sentence	Construct impervious areas such that they are compatible with the materials handled. Portland cement concrete, asphalt, or equivalent material may be considered.
IV	2.1	2-6	Determine whether there is/are unpermitted non-stormwater discharges to storm drains or receiving waters, such as process wastewater and vehicle/equipment washwater, and either eliminate or obtain a permit for such a discharge.	The illicit connection must be addressed along with the discharge.	Determine whether there is/are unpermitted non-stormwater discharges and/or connections to storm drains or receiving waters, such as process wastewater and vehicle/equipment washwater, and either eliminate them or obtain a permit for such a discharge.
IV	2.2	2-8	**Description of Pollutant Sources:** Sources of pollutants for shipbuilding, repair, and maintenance of boats at boatyards, shipyards, ports, and marinas include pressure washing, surface preparation, paint removal, sanding, painting, engine maintenance and repairs, and material handling and storage, if conducted outdoors.	The word “Vessels” is inclusive and eliminates the distinction between boats and ships.	**Description of Pollutant Sources:** Sources of pollutants for shipbuilding, repair, and maintenance of vessels at boatyards, shipyards, ports, and marinas include pressure washing, surface preparation, paint removal, sanding, painting, engine maintenance and repairs, and material handling and storage, if conducted outdoors.

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IV	2.2	2-9	Immediately clean up any spillage on dock, boat, or ship deck areas and dispose of the wastes properly.	"Dock" is the term for the area of water next to a pier or wharf.	Immediately clean up any spillage onboard and on any adjacent work surfaces.
IV	2.2	2-12	BMPs for Commercial Composting	The terms "Compost" and "Composting" are used interchangeably in this section and not always correctly. Compost is the product – composting is either a verb or adverb.	Correct the entire BMP for consistency in terminology.
IV	2.2	2-18	Sprinkle or wet down soil or dust with water as long as it does not result in a wastewater discharge.	"Wastewater discharge" is an unnecessary term when runoff is really what is meant.	Sprinkle or wet down soil or dust with water as long as it does not result in runoff.
IV	2.2	2-18	Ecology prohibits the use of motor oil for dust control is prohibited. Take care should be taken when using lignin derivatives and other high BOD chemicals in excavations or areas easily accessible to surface water or ground water.	Poor sentence structure.	Ecology prohibits the use of motor oil for dust control is prohibited. Take care when using lignin derivatives and other high BOD chemicals to prevent them from entering surface ground waters.
IV	2.2	2-27	**Description of Pollutant Sources:** Illicit connections are unpermitted sanitary or process wastewater discharges to a storm drain or to a surface water, rather than to a sanitary sewer, industrial process wastewater, or other appropriate treatment. They can also include swimming pool water, filter backwash, cleaning solutions/washwaters, cooling water, etc. Experience has shown that illicit connections are common, particularly in older buildings.	Disposal should be added after treatment. King County has not found illicit connections to be common.	**Description of Pollutant Sources:** Illicit connections are unpermitted sanitary or process wastewater discharges to a storm drain or surface waters, rather than to a sanitary sewer, industrial process wastewater, or other appropriate treatment and disposal. They can also include swimming pool water, filter backwash, cleaning solutions/washwaters, cooling water, etc.
IV	2.2	2-28	Lawn and vegetation management can include control of objectionable weeds, insects, mold, bacteria, and other pests with chemical pesticides.	By default, all pesticides are chemicals.	Lawn and vegetation management can include control of objectionable weeds, insects, mold, bacteria, and other pests with pesticides.
IV	2.2	2-28	Develop and implement an Integrated Pest Management Plan (IPM) and use pesticides only as a last resort.	Poor sentence structure.	Develop and implement an Integrated Pest Management Plan (IPM) that specifies use of pesticides only as a last resort.

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IV	2.2	2-29	Develop and implement an IPM (See section on IPM at end of BMP) and use pesticides only as a last resort.	Poor sentence structure	Develop and implement an IPM (See section on IPM at end of BMP) that specifies use of pesticides only as a last resort.
IV	2.2	2-36	Curbs are not installed at large loading areas frequently are not curbed along the shoreline. As a result, stormwater passes directly off the paved surface into surface water.	Poor sentence structure	Waterfront loading areas frequently are not curbed along the shoreline and as a result, stormwater passes directly off the paved surface into surface water.
IV	2.2	2-37	The volume of the spill containment sump should be a minimum of 50 gallons with an adequate grit sedimentation volume.	Better word choice	The volume of the spill containment sump should be a minimum of 50 gallons with an adequate grit sedimentation capacity.
IV	2.2	2-36	Inspect for leaks all incoming vehicles, parts, and equipment stored temporarily outside.	Poor sentence structure. Temporarily is too subjective.	Inspect all incoming vehicles, parts, and equipment for leaks that will stored outside.
IV	2.2	2-36	Do not connect maintenance and repair shop floor drains to storm drains or to surface water. To allow for snowmelt during the winter, install a drainage trench with a sump for particulate collection. Use the drainage trench only for draining the snowmelt only and not for discharging any vehicular or shop pollutants.	Add additional language about drains and sumps. Split the BMP into two separate bullets.	Do not connect any floor drains to storm drains or to surface water. Plug any existing floor drains or convert them to sumps. To allow for snowmelt during the winter, install a drainage trench with a sump for particulate collection. Use the drainage trench only for draining the snowmelt only and not for discharging any vehicular or shop pollutants.
IV	2.2	2-41	Consider storing damaged vehicles inside a building or other covered containment, until successful removal of all liquids. Remove liquids from vehicles retired for scrap.	Stronger wording.	Store damaged vehicles inside a building or under cover, until all liquids have been removed. Remove all liquids from vehicles designated for scrap.
IV	2.2	2-46	Maintain stormwater treatment facilities according to the O & M procedures presented in Section 4.6 of Volume V in addition to the following BMPs:	O & M is never spelled out.	Maintain stormwater treatment facilities according to the Operations and Maintenance (O & M) procedures presented in Section 4.6 of Volume V in addition to the following BMPs:
IV	2.2	2-47	Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catchbasin.	All the debris needs to be removed, and one doesn't clean woody debris.	Remove all debris in a catch basin as frequently as needed to ensure proper operation of the catchbasin.

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IV	2.2	2-47	Post warning signs; "Dump No Waste - Drains to Ground Water," "Streams," "Lakes," or emboss on or adjacent to all storm drain inlets *where practical*.	These aren't warning signs.	Post messages to the effect of: "Dump No Waste - Drains to (waterbody)", "Only Rain Down the Drain" on or adjacent to, all storm drain inlets *where practical*.
IV	2.2	2-52	**BMPs for Painting/Finishing/Coating of Vehicles/Boats/ Buildings/ Equipment** **Description of Pollutant Sources:** Surface preparation and the application of paints, finishes, and/or coatings to vehicles, boats, buildings, and/or equipment outdoors can be sources of pollutants. Potential pollutants include organic compounds, oils and greases, heavy metals	Vessels, not boats	**BMPs for Painting/Finishing/Coating of Vehicles/Vessels/ Buildings/ Equipment** **Description of Pollutant Sources:** Surface preparation and the application of paints, finishes, and/or coatings to vehicles, vessels, buildings, and/or equipment outdoors can be sources of pollutants. Potential pollutants include organic compounds, oils and greases, heavy metals
IV	2.2	2-54	**Description of Pollutant Sources:** Public and commercial parking lots such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and parking lot driveways, can be sources of toxic hydrocarbons and other organic compounds, oils and greases, metals, and suspended solids.		**Description of Pollutant Sources:** Public and commercial parking lots such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and parking lot driveways, can be sources of toxic hydrocarbons and other organic compounds, including oils and greases, metals, and suspended solids.
IV	2.2	2-56	**BMPs for Recyclers and Scrap Yards**	There are no BMP's listed here at all, only a reference to the Vehicle Recycling Guide. Many recyclers don't recycle vehicles, so either there should be BMPs listed or the heading should be changed to only apply to vehicle recyclers and vehicle scrap yards.	
IV	2.2	2-58	**BMPs for Soil Erosion and Sediment Control at Industrial Sites**	This seems oddly brief for such an important issue. There should be more specific BMPs e.g. wheel washes.	
IV	2.2	2-61	The BMPs specified below apply to container(s) located outside a building used for temporary storage of accumulated food wastes, vegetable or animal grease, used oil, liquid feedstock, or cleaning chemicals, or Dangerous Wastes (liquid or solid) <u>unless the business is permitted by Ecology to store the wastes (Appendix IV-D R.4).</u>	This sentence doesn't make sense –unless what? Is the cited appendix correct. Missing trash compactors and dumpsters.	**Clarify what is meant by this statement and if the citation is correct. Add dumpsters and trash compactors to the list of pollutant sources.**
IV	2.2	2-61	**Pollutant Control Approach:** Store containers in impervious containment under a roof or other appropriate cover, or in a building. When collection trucks directly pick up roll-containers, place a filet can be placed on both sides of the curb to facilitate moving the dumpster. For storage areas on-site for less than 30	Confusing section. Business owner is not going to be able to instruct the waste hauler how to pick up containers.	**Pollutant Control Approach:** Store containers in containment under a roof or other appropriate cover, or inside. For waste materials stored on-site for less than 30 days, consider using a portable temporary secondary system like that shown in Figure

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			days, consider using a portable temporary secondary system like that shown in Figure 2.8 in lieu of a permanent system as described above.		2.8 in lieu of a permanent system as described above.
IV	2.2	2-62	Businesses accumulating Dangerous Wastes that do not contain free liquids need only to store these wastes in a sloped designated area with the containers elevated or otherwise protected from storm water run-on.	Slope is unnecessary.	Businesses accumulating Dangerous Wastes that do not contain free liquids, need only to store these wastes in a designated area with the containers elevated or otherwise protected from storm water run-on.
IV	2.2	2-62	Cover dumpsters, or keep them under cover such as a lean-to, to prevent the entry of stormwater. Replace or repair leaking garbage dumpsters. Drain dumpsters and/or dumpster pads to sanitary sewer. Keep dumpster lids closed. Install waterproof liners.	Trash compactors need to be included in this BMP.	Keep dumpsters closed at all times, or keep them under cover such as a lean-to, to prevent the entry of stormwater. Replace or repair leaking garbage dumpsters and trash compactors. Install waterproof liners. Drain dumpsters and trash compactors and/or pads to sanitary sewer or to a sump for collection and disposal.
IV	2.2	2-65	**Description of Pollutant Sources:** Aboveground tanks containing liquids (excluding uncontaminated water) may be equipped with a valved drain, vent, pump, and bottom hose connection. Heat above ground tanks with steam heat exchangers equipped with steam traps.	Since when are above ground tanks supposed to be heated? Either remove or re-write.	**Description of Pollutant Sources:** Aboveground tanks containing liquids (excluding uncontaminated water) may be equipped with a drain valve, vent, pump, and bottom hose connection.
IV	2.2	2-66	Use simple pH measurements with litmus or pH paper can be used for areas subject to acid or alkaline contamination.	Poor wording	For areas subject to acid or alkaline contamination, test the pH of the runoff using pH strips or a pH meter.
IV	2.2	2-67	Contact of outside bulk materials with stormwater can cause leachate, and erosion of the stored materials. Contaminants include TSS, BOD, organics, and dissolved salts (sodium, calcium, and magnesium chloride, etc).	Poor wording.	Stormwater coming into contact with materials stored outside can become contaminiated and cause erosion of bulk materials. Contaminants include TSS, BOD, organics, and dissolved salts (sodium, calcium, and magnesium chloride, etc).
IV	2.2	2-72	**Description of Pollutant Sources:** The commercial cleaning of vehicles, aircraft, vessels, and transportation, restaurant cooking, carpet cleaning, and industrial equipment, and large buildings with low- or high- pressure water or steam. This includes frequent “charity” car washes at gas stations and commercial parking lots. The cleaning can include hand washing, scrubbing, sanding, etc. Washwater from cleaning activities can contain oil and grease, suspended solids, heavy metals, soluble organics, soaps, and detergents that can	Ambiguous wording. Charity carwashes aren’t limited to gas stations and commercial parking lots.	**Description of Pollutant Sources:** The cleaning of vehicles, aircraft, vessels; and transportation, restaurant cooking, and industrial equipment; carpet cleaning; and building exteriors. This includes “charity” car washes. Cleaning methods can include hand washing, scrubbing, sanding, pressure washing, steam cleaning, etc. Washwater from cleaning activities can contain oil and grease, suspended solids, heavy metals, soluble organics, soaps, and detergents that contaminate stormwater.

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			contaminate stormwater.		
IV	2.2	2-72	The Industrial Stormwater General Permit prohibits the discharge of process wastewater (e.g., vehicle washing wastewater) to ground water or surface water, without pre-treatment. Stormwater that commingles with process wastewater is considered process wastewater.	This is not consistent with our policy of allowing infiltration of wash water.	
IV	2.2	2-72	At a commercial washing facility in which the washing occurs in an enclosure and drains to the sanitary sewer, or In a building constructed specifically for washing of vehicles and equipment, which drains to a sanitary sewer.	Many places recycle the washwater and some collect and haul for offsite disposal.	At a facility or building where the washwater is collected for recycling or disposal to the sanitary sewer.
IV	2.2	2-74	Because operators can use soluble/emulsifiable detergents can be used in the wash medium, it is important to make careful consideration of the selection of soaps and detergents and treatment BMPs. Oil/water separators are ineffective in removing emulsified or water soluble detergents.	Poor wording	Oil/water separators are ineffective in removing oil when soaps and detergents unless they are specifically designed to do so.
IV	2.2	?	Missing BMP	We see a need for Potable Water Line Flushing and Tank Maintenance BMPs either as separate BMPs or as a single multi-section BMP. Low and high volume flushing have some commonality and some separate considerations.	We are including with this review, a PDF attachment titled: Potable Line Flushing BMP for Vol IV or equivalent section.pdf. Provided as an example, this is a draft for our own SPPM update, and is subject to change.
IV	Appendix IV-G			All evenly numbered pages in Appendix IV-G are labeled as F-, while odd numbered pages are labeled with G-.	Change F to G.
IV	Appendix IV-G	G-5	Whether or not a soil is a clean soil depends primarily upon the level of contaminants and, to a lesser degree, on the background level of contaminants at a particular location and the exposure potential to humans or other living organisms.	Discussion on clean soils is misleading. The *Contamination in Street Waste Solids* section correctly references the definition of clean soils from the Solid Waste Handling Standards (WAC 173-350-100) as "soils…which are not dangerous wastes, [or] contaminated soils…" and, therefore, clean soils are those soils that do not designate as dangerous waste and do not meet the definition of contaminated soils. "Contaminated soils" is also defined in regulation (WAC 173-350-100) as "soils removed during the cleanup of a hazardous waste site, or a dangerous waste facility closure, corrective actions or other clean-up activities and which contain harmful substances but are not designated dangerous waste." Street	Solid waste discussion should focus on the existing definition of clean soils in WAC 173-350-100. Is this soil "dangerous waste"? If no, is this soil "contaminated soil"? If no, then it is clean and should have a full range of reuse options.

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				waste does not ordinarily classify as dangerous waste and typically is not generated during a hazardous waste cleanup, dangerous waste facility closure or corrective actions. In addition, Ecology has communicated that routine collection of street waste (e.g., cleaning catch basins and sweeping streets) is not considered a clean-up activity. Ecology acknowledges that "street waste does not ordinarily classify as dangerous waste" and therefore, street waste is not ordinarily contaminated soil or dangerous waste, meaning street waste typically meets the definition of clean soils. However, the discussion following the definition of clean soils is contradictory to the regulatory definitions laid out in WAC 173-350. Appendix IV-G states "Whether or not a soil is a clean soil depends primarily upon the level of contaminants and, to a lesser degree, on the background level of contaminants at a particular location and the exposure potential to humans or other living organisms." As outlined above, whether or not soil is "clean soil" depends solely on whether or not it is dangerous waste or contaminated soil. Therefore, the guidance to "evaluate both the soil and potential land application sites to determine if a soil is a clean soil" is inappropriate. Generators must evaluate whether street wastes designate as dangerous waste or meet the definition of contaminated soils to determine if their waste is clean soil.	
IV	Appendix IV-G	G-5 & F-6	Local health districts have historically used the Model Toxics Control Act Cleanup Regulation (MTCA) Method A residential soil cleanup levels to approximate "clean" and to make decisions on land application proposals. … Using the new MTCA terrestrial ecological evaluation procedures, allowable TPH levels for land application could range from 200 – 460, depending on site characteristics and intended land use.	Appendix IV-G states that many local health districts have used MTCA to adopt TPH thresholds for determining whether a soil is a clean soil (which is inappropriate, per the comment above). The criteria values cited in Appendix IV-G are 200 and 460 mg/kg. The guidance acknowledges that MTCA "is not intended to be directly applied to setting contaminant concentration levels for land application proposals" but that MTCA could provide a useful framework for evaluating appropriate reuse options. Why then, does the guidance only cite those MTCA criteria that are the most stringent without including the Method A level for the heavy oil fraction of TPH, the most common fraction found in street waste, which, in Table 740-1 (Method A Soil Clean-up Levels for Unrestricted Land Uses) at page 233 of MTCA is set at 2,000 mg/kg. If MTCA can provide a useful framework for determining reuse options, then Ecology's guidance should support and encourage the consideration of all relevant TPH criteria contained within MTCA, not just the most stringent.	Ecology's guidance should support and encourage the consideration of all potentially relevant TPH criteria contained within MTCA, not just the most stringent-- include the 2000 mg/kg limit for heavy oil found in Table 740-1 (Method A Soil Clean-up Levels for Unrestricted Land Uses) at page 233 of MTCA.

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IV	Appendix IV-G	F-6	Where the laboratory results report no 'fingerprint' or chromatographic match to known petroleum hydrocarbons, the soils should not be considered to be petroleum contaminated soils.	"Petroleum contaminated soils," sounds like a regulatory term of art. If it is, a regulatory definition of the term, if one exists, should be included. As outlined above, street wastes do not typically meet the definition of "contaminated soils". Therefore, if "petroleum contaminated soils" is not a regulatory term of art, it should be avoided.	Include or reference regulatory definition of "petroleum contaminated soils". If there is none, amend the sentence: Where the laboratory results report no 'fingerprint' or chromatographic match to known petroleum hydrocarbons, the soils should not be considered to be petroleum contaminated.	
IV	Appendix IV-G	F-6 & G-7	**Table G.1 & Table G.3**	Studies cited in Table G.1 and G.3 are between 12 and 19 years old. Many, if not all, of the agencies listed in the table have continued to conduct street waste characterization sampling. The guidance document should use the latest and best data available to reflect improvements in laboratory analytical procedures. It also is not clear whether the data summarized in Table G.1 reflects street wastes that have undergone any level of processing or treatment that could affect contaminant concentrations. TPH, as well as other contaminant, levels may be significantly different in raw street waste vs. street waste that has been processed or treated to prepare it for reuse.	Update tables to include more recent data and clarify whether the street wastes studied were raw or processed.	
IV	Appendix IV-G	F-6 & G-7	**Table G.1, G.2, & Table G.3**	There are insufficient references for the cited studies. Ideally, not only would the studies be referenced to the point where they could be readily found, the manual should link to them to facilitate research and understanding. Also, the tables contain acronyms and abbreviations that are undefined.	Provide complete references for all citations as well as links to the source material. Be sure to define all acronyms and abbreviations in the document, even those in tables.	
IV	Appendix IV-G	F-8	The collector of street waste should evaluate it both for its classification potential as dangerous waste and to not meet end users [sic] requirements.	The edits to this sentence unfortunately removed a parallel construction that made the sentence work. It should be restored or an equivalent used.	The collector of street waste should evaluate it both for its potential to be classified as dangerous waste and to not meet end user's requirements. OR The collector of street waste should evaluate it for its potential classification as dangerous waste and for its conformity with the end user's requirements.	JF/JK
IV	Appendix IV-G	G-5 & G-11	There are no specific references in the Solid Waste Handling Standards to facilities managing street waste solids although these facilities typically fit under the section dealing with Piles Used for Storage and Treatment (Section 320). Compost street sweepings that consist primarily of leaves, pine	The guidance document refers to street waste treatment and storage facilities as classified under the piles section of WAC 173-350, which triggers the need for a solid waste handling permit, thereby possibly alerting generators that a permit is likely needed. However, on page G-11, Ecology recommends composting organic-rich street wastes without mentioning the	Clarify permitting ramifications to generators for both handling street waste and for composting it.	

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			needles and branches, and grass cuttings from mowing grassy swales. Remove litter and other foreign material prior to composting or the composting facility must provide for such removal as part of the process. Dispose of the screened trash is [sic] solid waste at an appropriate solid waste handling facility.	permitting implications this may have on street waste generators. Composting is regulated under its own section of the Solid Waste Handling Standards and entities undertaking composting activities may need to obtain a composting permit in addition to or in place of their piles permit.	
IV	Appendix IV-G	F-12	The first paragraph on page F-12 discusses ditching material that may or may not be contaminated. The guidance advises that contaminated ditching material "must be stored, tested, and handled in the same manner as other street waste solids. It is the generator's responsibility to visually inspect and otherwise determine whether the materials may be contaminated."	By saying contaminated ditching material must be handled the same as other street waste, it implies that other street waste is contaminated soil. As outlined in earlier comments, street waste typically meets the definition of clean soils.	Revise language to clearly acknowledge that street waste typically meets the definition of clean soils.
IV	Appendix IV-G	F-12	List of reuse options for street wastes.	The fill options are too limiting--only in recreational settings and commercial and industrial areas. The fill options should be expanded to any setting provided the street waste used does not contain contaminants at levels that would be harmful to human health or the environment.	
V	1.4	1-3	**Infiltration**. 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.	We question the ability of natural soils to filter, adsorb, and/or biologically decompose all stormwater pollutants and levels in perpetuity.	Infiltration. Infiltration refers to direction of stormwater to naturally occurring soils. Depending on pollutant type and load, and soil type, pre-treatment is often required prior to infiltration. This may be achieved by a treatment facility prior to infiltration, or a soil treatment layer. Thethe use of the filtration, adsorption, and biological decomposition properties of naturally-occurring soils to remove pollutants as stormwater soaks into the ground is likely to require periodic removal and replacement of the top infiltrative soil layer. .
V				Please note that not all citations in the main body of text appear in the reference section. e.g. in section BMP T7.30, Prince George's County, 2002; Tackett (2004); and U.S. Army Environmental Center and Fort Lewis, 2003), are cited, but none show up in the Reference section.	Please review all of Volume V to be sure that all citations are represented in the Reference section.
V				Need to add facilities / BMPs designated for treating bacteria; e.g. wet ponds have been shown to be more generally effective at decreasing bacteria populations than have wet ponds.	

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V	BMP T7.30	7-9	Depth-to-hydraulic restriction layer: separation to a hydraulic restriction layer (rock, highly compacted soil layer or water table) is an important design consideration for infiltration and flow control performance. Contamination of groundwater is an important factor when infiltrating stormwater; however, when determining depth to the water table the primary concern in the SWMMWW is infiltration capacity (as influenced by ground water mounding) and associated flow control performance. When properly designed and constructed the BSM will provide very good water quality treatment before infiltrated stormwater reaches the subgrade and then groundwater. The following are recommended minimum separations to groundwater:	We disagree with this statement. Groundwater contamination potential should be considered of equal importance to infiltration capacity.	Depth-to-hydraulic restriction layer: separation to a hydraulic restriction layer (rock, highly compacted soil layer or water table) is a~~n important~~ crucial design consideration for infiltration and flow control performance. ~~Contamination of groundwater is an important factor when infiltrating stormwater; however, w~~When determining depth to the water table ~~the primary concern in the SWMMWW is~~both maintaining groundwater quality and hydraulic infiltration capacity (as influenced by ground water mounding) and associated flow control performance are of equal imporance. When properly designed and constructed the BSM will provide very good water quality treatment before infiltrated stormwater reaches the subgrade and then groundwater. The following are recommended minimum separations to groundwater:
V	BMP T7.30	7-9	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 5,000 square feet of pollution-generating impervious surface; and less than 10,000 square feet of impervious surface; and less than ¾ acres of lawn. Recommended separation distances for bioretention areas with small contributing areas are less than the new Department of Ecology (Ecology) recommendation of 3 feet for two reasons: (1) bioretention soil mixes provide effective pollutant capture; and (2) hydrologic loading and potential for groundwater mounding is reduced when managing flows from smaller contributing areas in relation to bioretention area.	We are concerned that depth to groundwater may be insufficient. As commented for Vol. 1, we believe a full literature search on this subject is warranted (please see that full commentary). Pending that, we do not believe it is appropriate to allow a minimum separation of 1 foot – if for no other reason, then at least because this provides virtually no margin of safety – and no less than 3 feet should be used. For larger contributing areas depth should be greater; i.e., no less than 10 feet, per Hathorn et al. (1995)[8].	A minimum separation of ~~1 foot~~3 feet 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 5,000 square feet of pollution-generating impervious surface; and less than 10,000 square feet of impervious surface; and less than ¾ acres of lawn. Recommended separation distances for bioretention areas with small contributing areas are less than the new Department of Ecology (Ecology) recommendation of ~~3~~ 10 feet for two reasons: (1) bioretention soil mixes provide effective pollutant capture; and (2) hydrologic loading and potential for groundwater mounding is reduced when managing flows from smaller contributing areas in relation to bioretention area.
V	BMP T7.30	7-9 & 7-10	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: 5,000 square feet of pollution-generating impervious surface; or 10,000 square feet of impervious surface; or ¾ acres of lawn and landscape.	For larger contributing areas depth should be greater; i.e., no less than 10 feet, to provide a margin of safety, and per Hathorn et al. (1995)[8].	A minimum separation of ~~3~~ 10 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: 5,000 square feet of pollution-generating impervious surface; or 10,000 square feet of impervious surface; or ¾ acres of lawn and landscape.
V	BMP T7.30	7-10	Expected pollutant loading: Bioretention can provide very good water quality treatment for heavy pollutant loads associated with industrial or commercial sites. In these settings an impermeable liner between the BSM and the subgrade and an under-drain may be required due to soil and groundwater contamination concerns.	What is the basis for stating that bioretention can provide "very good water quality treatment for heavy pollutant loads associated with industrial or commercial sites"? Aside from that, this is a case where more guidance or requirement is needed than "may be required". What information is to be processed and what criteria used to make this determination? We agree that potential for soil and	Expected pollutant loading: Bioretention can provide very good water quality treatment for heavy pollutant loads associated with industrial or commercial sites. However, ~~In~~ in these settings an impermeable liner between the BSM and the subgrade and an under-drain ~~may be~~is required due to soil and groundwater contamination concerns.

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				groundwater contamination is a serious concern. In the absence of specific risk criteria, and in the absence of criteria for media replacement cycle – as would (or should) be required for facility approval under TAPE, an impermeable liner and underdrain should simply be required for commercial and industrial sites. Exceptions might be considered under development/engineering review, for certain uses; e.g. a portion of a school site might be found to be very low risk even though the entire site is commercial. However, a permit allowing no liner/underdrain would need to be conditioned such that if the business, land-use discharging to that BMP, process were to change, the owner would be required to notify the local jurisdiction, and might be subject to requiring retrofit if it is determined that the new discharge poses more risk. However, this could clearly be problematic in terms of downstream facility capacity not originally planned for. If allowed, conditions would have to be entered into the public record attached to the property title, so that information would be transferred upon change of ownership.	
V	BMP T7.30	7-14	Compost	Please see our comments on Volume 1, with regard to Compost.	Please see our comments on Volume 1, with regard to Compost
V	BMP T7.30	7-14	A minimum depth of 24 inches should be selected for improved phosphorus and nitrogen (TKN) removal where under-drains are used.	While we are all for increased depth for added treatment media, what is the basis for claiming improved phosphorus removal? The literature suggests that compost and compost amended media is often a net phosphorus source. Not passing judgment one way or the other on the TKN statement – would need to do more research to address that We have seen suggestions of design where infiltration is low and depth is added with the underdrain positioned to encourage an anaerobic zone to encourage denitrification. Nitrogen speciation is complex as it is dependent on a number of highly variable environmental factors.	A minimum depth of 24 inches should be selected for improved ~~phosphorus and~~total nitrogen (TKN) removal where under-drains are used..
V	BMP T7.30	7-16	Under-drain pipe: Under-drains should be slotted, thick-walled plastic pipe. The slot opening should be smaller than the smallest aggregate gradation for the gravel filter bed (see under-drain filter bed	"thick-walled" is a qualitative description. The second bullet following specifies schedule 40 pipe. Subjectively, we would consider schedule 80 to be thick-walled, which would mean SCH 40 is not. If Ecology thinks SCH 40 is sufficient, just use the spec,	Under-drain pipe: Under-drains should be: • Minimum pipe diameter: 4 inches (pipe diameter will depend

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			below) to prevent migration of material into the drain. This configuration allows for pressurized water cleaning and root cutting if necessary (personal communication, Tracy Tackett, 2004). Under-drain pipe recommendation: • Minimum pipe diameter: 4 inches (pipe diameter will depend on hydraulic capacity required, 4 to 8 inches is common). • Slotted subsurface drain PVC per ASTM D1785 SCH 40.	not an adjective. Additionally, the initial narrative simply says 'plastic pipe', but the second bullet specifies PVC. Considering this and the prior comment, this section seems unnecessarily internally redundant. Suggest condensing.	on hydraulic capacity required, 4 to 8 inches is common). • Slotted PVC per ASTM D1785 SCH 40. • ~~slotted, thick-walled plastic pipe.~~ The slot opening should be smaller than the smallest aggregate gradation for the gravel filter bed (see under-drain filter bed below) to prevent migration of material into the drain. This configuration allows for pressurized water cleaning and root cutting if necessary (personal communication, Tracy Tackett, 2004). ~~Under-drain pipe recommendation:~~ ~~• Minimum pipe diameter: 4 inches (pipe diameter will depend on hydraulic capacity required, 4 to 8 inches is common).~~ ~~• Slotted subsurface drain PVC per ASTM D1785 SCH 40.~~ • Slots should be cut perpendicular to the long axis of the pipe and be 0.04 to 0.069 inches by 1 inch long and be spaced 0.25 inches apart (spaced longitudinally). Slots should be arranged in four rows spaced on 45-degree centers and cover ½ of the circumference of the pipe. See Filter Materials section for aggregate gradation appropriate for this slot size. • Under-drains should be sloped at a minimum of 0.5 percent unless otherwise specified by an engineer (Low Impact Development Center, 2004).
V	BMP T7.30	7-19	**Mulch Layer**	Please see our comments on Vol III with regard to Mulch Please see our comments on Volume 1, with regard to Compost	Please see our comments on Vol III with regard to Mulch Please see our comments on Volume 1, with regard to Compost
V	BMP T7.30	7-20	If machinery must operate in the bioretention cell for excavation, use light weight, low ground-contact pressure equipment	Needs a more complete definition	Please define "light weight" and "low ground-contact pressure". e.g. at least provide a maximum allowable pounds per square foot of contact area value.
V	BMP T7.30	7-23	Soil: Soil mixes for bioretention facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioretention systems. Replacing mulch in bioretention facilities where heavy metal deposition is likely provides an additional level of protection for prolonged	The terms 'soil mix' and 'mulch' seem to be getting mixed up here. There is no reason to suspect that the mix overall will not become contaminated beyond use over time; i.e., more than just a top mulch layer will need replacement. This guidance is not helpful absent criteria for 'acceptable' pollutant levels or a required testing cycle. Local and other	Soil: Soil mixes for bioretention facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioretention systems, but this will vary according to pollutant load. Replacing ~~mulch~~ media in bioretention facilities where heavy metal deposition is likely

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			performance. If in question, have soil analyzed for fertility and pollutant levels.	research indicating positive % removal notwithstanding, some literature indicates some potential for unused/new compost and compost amended media to discharge some heavy metals in excess of influent concentrations, and/ or in excess of state water quality standards. Please see our Vol. 1 comments regarding compost. Arguments are made by some that relatively high levels (e.g. maximum levels in WAC 173-350-220) are acceptable because 'compost binds metals'. Noting that we are talking about a mix, so those values will be diluted by the mix ratio; at best compost is highly variable, so given the same media metals levels, one soil mix may retain those and do a better job of filtering metals from stormwater than another batch. Depending on compost/mix composition and metals content at any given time, any given mix may provide net metal % removal from stormwater with concentration(s) at the higher end of the 'typical' stormwater range, yet effluent concentration may exceed influent concentration if influent concentration is low. See Mikula et al., 2007[41].	provides ~~an additional level of~~will be necessary for protection for prolonged performance. ~~If in question, have soil~~ Soil will need to be analyzed for ~~fertility and~~ pollutant levels every X years, and may be tested for fertility as needed if plants appear stressed for nutrients.~~.~~ **Comment:** Assessment involving both literature search and likely requiring additional research is needed to come up with more definitive and protective guidance, especially given variability in compost physical and chemical characteristics, and site pollutant loading variability.
V	BMP T7.30	7-24	Large bioretention cells (bioretention facilities receiving water from several lots or 1/4 acre or more of pavement or other impervious surface): Multiple small or one large-scale PIT. If using the small-scale test, measurements should be taken at several locations within the area of interest. After completing the infiltration test, excavate the test site at least 3 feet if variable soil conditions or seasonal high water tables are suspected. Observe whether water is infiltrating vertically or only spreading horizontally because of ground water or a restrictive soil layer. Use 1 as an infiltration correction factor when entering this initial rate into the runoff model.	Is it reasonable to make infiltration decisions based on suspicion? Shouldn't soil be at least probed qualitatively if not actually sampled to assess variability, and shouldn't holes be dug to find out if there is a seasonal high water table? Related to that, shouldn't methods for assessing infiltration specify that testing be done during the wet season under saturated conditions? Upon observing whether the water is infiltrating vertically or spreading horizontally because of ground water or a restrictive soil layer, what is one to do with that information? Shouldn't one observation vs. the other result in different infiltration correction factors for the input model?	Note Comments
V	BMP T7.40	7-26	**Compost-amended Vegetated Filter Strips (CAVFS)**	Please see our comments on Volume 1, with regard to Compost To which we point out that according to a report on CAVFS performance, while there was net removal of dissolved copper; total copper was found at statistically significantly higher level in runoff from the un-composted control compared to a composted test strip. The author stated, "The source of the higher total copper concentrations . . . has not been definitely identified; however, it is possible that the compost used in the construction of the filter strips may have contained some trace	Note Comments

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				amounts of copper that is now leaching into runoff at the ground surface." (Herrera, 2007)[48] A subsequent small study was done analyzing compost that had been saved from the project – although not securely.*	
V	BMP T7.40	7-28	Maintenance Compost, as with sand filters or other filter mediums, can become plugged with fines and sediment, which may require removal and replacement. Including vegetation with compost helps prevent the medium from becoming plugged with sediment by breaking up the sediment and creating root pathways for stormwater to penetrate into the compost. It is expected that soil amendments will have a removal and replacement cycle; however, this time frame has not yet been established.	Ecology needs to address the replacement cycle question	Note Comment
V	All Figs	All		Many of the Figures appear to be copies of bitmap scans from other drawings. Clarity would be improved by replacement with fresh drawings done in a vector graphics program.	Note Comment
V	Fig. 8.3	8-6	Figure 8.3 (cont) Sand Filter with Level Spreader: Section A-A, Trench, and Section B-B	It is somewhat confusing to have the Sand Filter drawings precede design text. It is awkward to have all the sand filer drawings along with flow splitter drawings all together in one block instead of contained within text sections specific to each unique facility type. As drawn, Section B-B makes it appear the spill control device will be ineffective.	Recommend moving drawings after text. Recommend separating drawings so text for each sand filter type is followed by relevant drawings for that facility type only. Re-draw section B-B to indicate spill control component elevations that look like they will work.
V	Fig. 8.7	8-12	Figure 8.7 – Linear Sand Filter	The Linear Sand Filter appears to be designed to fit in narrow areas, e.g. along roadways and parking lots. If the sand filter is fed by sheet flow through the grating, pollutant load will be spread evenly across the sand filter. Influent through the inlet pipe in Plan View (A-A) or the optional pipe shown Section View (B-B) will present more localized pollutant loading, likely resulting in early sediment buildup in the fore-chamber near the pipe inlet. Section 8.4 (pg 8-13) text says, "Pretreatment is necessary to reduce velocities to the sand filter and remove debris, floatables, large particulate matter, and	Recommend only sheet flow into a linear sand filter Recommend not allowing pipe inlets Recommend a minimum sand media depth of 18 inches

* We believe the results did not contradict the initial suspicion, but we don't have access to that report at this time to confirm that.

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				oils". Yet in a linear application, pretreatment is likely not an option. So we must assume that the fore-chamber is supposed to act as a presettling vault as well as a flow spreader. This observation is in part because the chamber is larger than it needs to be as a flow spreader alone. In this case, we note the short travel distance from the putative pre-settling chamber is too short for good particle settling if inlet flow is concentrated. For sheet flow this is not a problem, but we question the pipe and 'optional' pipe. Perhaps of even more importance, we question why if 18 inch sand depth is required for other sand filter designs – and we agree 18 inches should be the minimum – why the linear sand filter is allowed a minimum depth of 12 inches?	
V	8.5	8-15	An overflow should be included in the design of the basic and large sand filter basin or vault. The overflow height should be at the maximum hydraulic head of the pond above the sand bed. On-line filters shall have overflows (primary, secondary, and emergency) in accordance with the design criteria for detention ponds ( ). For off-line filters, the overflow, and the underdrain structure must both be designed to pass the 2-year peak inflow rate, as determined using 15-minute time steps in an approved continuous runoff model.	What goes in the open parentheses ( ) ?	See Comment
V	BMP T8.40	8-36	BMP T8.40 – Media Filter Drain (previously referred to as the Ecology Embankment)	Maintenance does not indicate the replacement cycle for the pollutant-trapping media	Include media replacement cycle
V	4.6	4-46	Maintenance Standards for Drainage Facilities No. 15 – Stormfilter™ (leaf compost filter)	StormFilter (TM) is stricken throughout Vol. V, except it appears here under maintenance. We question why StormFilter has been removed as allowable for Basic treatment, although we do not challenge disallowance for dissolved metals removal, as we have not seen data supporting TAPE requirements.	Include in the Manual reason StormFilter (ZPG) was removed from the list of allowed Basic treatment facilities, or add it back to the list. If still no longer allowed, it would be helpful to include a notice with the No. 15 Table for Maintenance – that the table is retained for maintaining StormFilter systems that were installed in the past.
V	4.6	All	Maintenance Standards for Drainage Facilities	Compartmentalization of Maintenance Standards for Drainage Facilities into one block is an example of part of the fragmentation in the Manual. Rather than being able to find out everything one needs to know about a facility, one has to jump around to blocks of drawings and the maintenance	It would be more reader friendly to have each facility type to have a section of its own, with narrative description, principles / basis, any site placement considerations, design drawings, design formulas, and maintenance requirements.

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				section.	

V			Section not specified, as section numbers are assigned to specific treatment facility types.	Given that bacteria TMDLs are very common, there is perceived need for either stormwater treatment facilities that are designated specifically for reducing bacteria or for guidance on which facilities and BMPs are more effective than others in removing bacteria from stormwater.
				
				At the very least, we can offer that the literature suggests that while some wet ponds have been shown to decrease bacteria, some ponds show net gain. Treatment wetlands on the other hand seem to be generally more effective than wet ponds. For some literature on these and some other BMPs/facilities and caveats, see e.g. Bavor et al., 2001[49], Davies et al., 2000[50], Bomo et al., 2004[51],Fox, 2011[52], Garbrecht et al., 2009[53], Hathaway et al., 2009[54], Maïga et al., 2009[55], Struck et al., 2007[56], Struck et al., 2008[57], Unc and Goss, 2003[4], Vacca et al., 2005[58], Vega, 2003[59].
					Ecology should do a thorough literature search, and if it can be done, provide an effectiveness ranking for at least some existing BMPs/facilities.
					
					At the same time, we must be mindful that:
					
					- Fecal coliform is looking not so good as an indicator of:
					
					  - Pathogenic potential
					
					  - Human / human-controllable fecal source ID
					
					Ecology should be clear in any guidance that successful decrease of any indicator species is not proof of commensurate decrease in pathogenic potential, as unrelated pathogens not being monitored may survive or pass filtration, e.g. especially viruses.
					
					Ecology's research should also encompass
					
					- Identification of better indicator species
					
					- Decreasing pathogenic potential overall through treatment
					
					- Decreasing pathogenic potential by source control. In the end, this seems likely to always be the primary and most crucial tool in our toolbox.

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