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July 20, 2017

Ms. Debbie Taege
The Boeing Company
EHS Remediation Group
PO Box 3707 Mail Code 9U4-26
Seattle, WA 98124-2207

Re: Ecology Final Decision Under Informal Dispute Resolution Regarding the Upland Feasibility Study (FS) Report and Ecology Selected Remedies for the Boeing Everett Site.

Dear Ms. Taege:

Thank you and the Boeing Company's (Boeing) Team for attending several meetings with the Washington State Department of Ecology (Ecology) as requested by Boeing, under the informal dispute resolution terms of the RCRA Corrective Action Agreed Order (AO), No. DE 96HS-N274, Sections VII. 4 and 10. The purpose of the meetings was to discuss your disagreement with several of Ecology's preferred final Site remedy alternatives, as described in our August 18, 2016, FS Report response letter.

As stated in our August 2016 letter, and discussed in subsequent meetings, in those cases where Ecology did not agree with Boeing's preferred alternative (proposed in the draft upland FS Report), we either advocated:

a) the same basic remedial alternative that Boeing preferred, but added regulatory requirements in order to be compliant with the MTCA regulations; or,
b) selected a remedial alternative significantly different than Boeing's preferred action.

In both cases, our reasons for requiring a modified alternative, or choosing a different preferred alternative, were provided in the August 2016 letter. Boeing's response letter, dated September 19, 2016, however, took issue with a number of Ecology's preferred cleanup actions. It identified the points of disagreement between the two parties, and invoked informal dispute resolution under the AO.

During the ensuing informal dispute resolution period, Boeing submitted two Landau technical memoranda, dated November 2, 2016 and January 20, 2017. The memoranda provided support

for the company's positions regarding Ecology's preferred site remedies for the Powder Mill Gulch trichloroethylene (TCE) groundwater plume. Boeing additionally prepared and submitted its own written meeting summary notes,[1] based on the discussions held during informal dispute resolution meetings. Ecology has reviewed these documents, and we met with Boeing on five separate occasions (October 5, 2016, October 27, 2016, November 3, 2016, January 10, 2017 and March 22, 2017) and attended three telephone conference calls with Boeing staff (April 19, 2017, May 4, 2017 and June 8, 2017) over the past ten months to discuss the company's memoranda and explain Ecology's technical and regulatory rationale for our preferred Site remedies.

As we communicated during these meetings, Ecology does not agree with the conclusions drawn in the two Landau technical memoranda. Ecology's specific comments on the two memoranda are included in the Attachments A and B of this letter. In addition, our regulatory analysis of the Site remedial action alternatives in many cases differs from the analysis performed in the Draft Uplands FS Report.

Since Boeing invoked informal dispute resolution through its September 2016 letter, Boeing has been provided ample opportunity to voice the company's objections to Ecology's preferred site remedial alternatives. Ecology has seriously considered these objections. However, in some cases our professional/technical and regulatory opinions differ, and Ecology understands that Boeing may still disagree with aspects of Ecology's preferred cleanup action(s) for the Site. Where Ecology and Boeing continue to disagree, Ecology now believes the disagreements are based on conflicting perspectives, not a failure to effectively communicate each party's positions. Ecology therefore asks that Boeing respond to today's letter by:

a) Communicating in writing, within 10 calendar days of receipt of this letter, Boeing's willingness to prepare an upland draft cleanup action plan (dCAP). The dCAP would be prepared in accordance with Ecology's August 18, 2016 response letter, as modified by Attachments A and B of this letter; or,
b) If Boeing has disagreements with Ecology's positions, that Boeing invoke formal dispute resolution under the AO Section VII.10.B, as amended in 2006 and 2011.

If Boeing does not formally dispute Ecology's requirement that Boeing submit the upland dCAP, the dCAP will be due to Ecology 45 days after submitting your written response ((a) above). In the absence of a Boeing response, Ecology will assume Boeing is in agreement with Ecology's positions, formal dispute resolution will not be an option, and we will expect the dCAP within 55 calendar days following Boeing's receipt of today's letter.

[1] Ecology appreciates the written notes prepared by Boeing. Ecology did not provide input into these written notes prior to distribution and has found that there are regulatory errors within and other points that Ecology would have conveyed differently. As such, Ecology is using today's letter to respond to the most important points of disagreement or clarification to Ecology positions stated in those meeting notes.

Please contact me at (425) 649-7264 if you need any clarifications or have any questions regarding this letter.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste & Toxics Reduction Program

By certified mail: 9171 9690 0935 0136 8287 59

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Mike Palacios, Heather Griffin, Mark Sadler, Wendy McClure, City of Everett
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Attachment A: Ecology Decision Summary under Informal Dispute Resolution

1) Powder Mill Gulch (PMG) Trichloroethylene (TCE) Groundwater Contamination in Esperance Sand Aquifer: Preferred Remedies and Reasonable Restoration Timeframe, Application of Surface Water Criteria at the Point of Compliance and Remediation Levels

Alternative 1 was Boeing's initial preferred remedy[2]. Alternative 1 does not meet threshold criteria and does not meet reasonable restoration timeframe criteria as explained in Ecology's letter dated August 18, 2016. The rationale for this Ecology determination is unchanged after reviewing Boeing's September 2016 through March 2017 written communications[3].

Since the issuance of the November 15, 2016 Uplands FS Report, Boeing has proposed a new groundwater water remedial option[3] for Ecology to consider. The following discussion and analysis compares remedial alternative 4 (Ecology preferred) with alternative 2a (Boeing preferred). Ecology is identifying this new remedial option as Alternative 2a:

Alternative 2a: Source area only enhanced bioremediation and concurrent groundwater extraction operation with groundwater cleanup levels[4] met at a groundwater conditional point of compliance (CPOC) in groundwater prior to entering[5] Powder Mill Creek. Boeing proposed a 4 µg/L trichloroethylene (TCE) remediation level (RL) throughout the entire plume and another groundwater RL of 21 µg/L TCE throughout the plume when groundwater extractions wells near the creek are turned off, assuming declining groundwater TCE concentrations have become asymptotic[6]. Boeing now prefers alternative 2a over Ecology's preferred remedy, **Alternative 4.** Ecology has modified Alternative 2a in order for the alternative to meet threshold requirements under MTCA because, in unmodified form, it allows the TCE contaminated groundwater to enter Powder Mill Creek in excess of the groundwater cleanup levels and the newly adopted WQCs (based on the Boeing proposed 21 µg/L TCE groundwater RL). Therefore, alternative 2a is revised such that: (a) requirement is added for the operation of groundwater extraction wells along the creek until groundwater adjacent to and discharging to the creek meets groundwater cleanup levels[4]; and (b) all of the requirements for a conditional point of compliance (CPOC) under WAC 173-340-720(8)(c) and (d) are met[7]. From this point forward, any references in this letter to alternative 2a include all of the above mentioned modifications.

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[2] Boeing previously preferred remedial alternative in the Draft Uplands FS Report – Operation of the interim action groundwater pump and treat system with contingent ONLY enhanced groundwater bioremediation (EISB).
[3] Based on Landau technical memorandum dated November 2, 2016 and Boeing's email (and attachment) dated March 6, 2017.
[4] Groundwater cleanup levels based on the more stringent of the new water quality criteria (WQCs), MTCA Method B cleanup levels and other ARARs. For TCE, the WQCs are the most stringent ARAR for setting the groundwater cleanup level (0.3 µg/L).
[5] Sediment pore water within the groundwater/surface water transition zone.
[6] Boeing also proposes to evaluate shutting off the groundwater extraction wells near the creek if TCE decreasing groundwater TCE concentrations are asymptotic, even if groundwater TCE concentrations > 21 µg/L TCE.
[7] It appears that Boeing is seeking not just a CPOC, but an off-property CPOC. Additional regulatory requirements would need to be met depending on the setting of a CPOC (for example, for properties near, but not abutting, surface water the affected property owner between the source of contamination and the surface water body must agree in writing to the use of a CPOC).

Ecology previously explained its preferred remedy alternative 4 (and rationale) in its response letter dated August 18, 2016. Boeing's written responses and discussions during our meetings have not altered Ecology's preferred remedy for the Powder Mill Gulch TCE groundwater contamination.

Boeing has stated that Ecology has not adequately justified or explained its regulatory and technical positions/bases to support preferring alternative 4 and rejecting alternative 1[8]. We do not agree. We believe the parties have reached a point where Boeing understands, but does not agree with, Ecology's technical and regulatory positions. Boeing may disagree with Ecology's positions, but this does not mean that Ecology has not provided adequate explanation or justification.

To summarize, Ecology's positions are provided below:

1) Ecology's preferred remedy is Alternative 4 - Enhanced In-Situ Bioremediation (EISB) in the Source Area, Downgradient and Off-Boeing Property locations and concurrent groundwater extraction to meet groundwater[4] and surface water cleanup levels at their respective standard points of compliance (SPOCs). Alternative 4 is the remedy that Ecology determined is permanent to the maximum extent practicable[9] and meets threshold and all other requirements for a final remedy under the MTCA regulations.

   Ecology's determination is that more EISB injections performed downgradient and off-Boeing property will result in a groundwater remedy that is "permanent to the maximum extent practicable."

   Boeings' March 6, 2017 email proposed (alternative 2a not modified by Ecology) implementing enhanced bioremediation at the TCE groundwater source area ONLY (on Boeing property), and concurrent operation of the interim action groundwater extraction system. However, Ecology continues to believe that its preferred remedy alternative 4 which requires concurrent treatment of the source area and downgradient and off-Boeing property TCE contaminated groundwater will result in the following:
   a) a shorter and reasonable restoration timeframe [WAC 173-340-360(2)(b)(ii) and (4)], and
   b) greater protectiveness, permanence and long-term effectiveness [WAC 173-340-360(3)(f)(i), (ii), (iv)]:
      a. less TCE groundwater discharged into the creek noting that groundwater extraction wells do not prevent all TCE groundwater from entering the creek as shown by consistent exceedances of the TCE water quality criteria in creek samples on and off-Boeing property,

[8] Boeing previously preferred remedial alternative 1 in the Draft Uplands FS Report – Operation of the interim action groundwater pump and treat system with contingent ONLY enhanced groundwater bioremediation (EISB).
[9] Alternative 4 is the most permanent remedy option and was the baseline remedial alternative that Ecology compares with all other less permanent remedial alternatives.

b. utilizes the destruction of contaminants rather than relying on downgradient dilution and dispersion, and
c. less uncertainty in the effectiveness of attaining groundwater cleanup levels in a reasonable timeframe due to more aggressive EISB downgradient treatment versus relying on dilution, dispersion, and discharge to the creek.

2) The Landau technical memorandum, dated November 2, 2016, was intended to update the Upland FS Report. It includes Ecology's requirement that the surface water cleanup levels using the new Water Quality Criteria as ARARs be used in establishing groundwater cleanup levels[4], AND that all interim action groundwater extraction wells be operated concurrently during any enhanced bioremediation.

This technical memorandum also proposed a groundwater conditional point of compliance (CPOC).[10] Boeing stated that a groundwater CPOC is justifiable because the estimated restoration timeframe for groundwater is 50 years or more under a groundwater standard point of compliance (SPOC) and it is not practicable to meet the cleanup levels quicker. For Ecology to approve a CPOC[11], it must be demonstrated under WAC 173-340-350 through 173-340-390 that it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame. It must also be demonstrated that all practicable methods of treatment are to be used in the site cleanup. Ecology believes fifty years is not an unreasonable groundwater restoration timeframe for this site's TCE groundwater plume, given the size and magnitude of the contamination. Therefore it will be practicable to meet the cleanup level throughout the site within a reasonable restoration time frame.

A groundwater standard point of compliance (SPOC) must be established at cleanup sites unless all conditions under WAC 173-340-720(8)(c) and (d) are met for a conditional point of compliance. Ecology does not believe these conditions are met. In our opinion, it is practicable to meet the cleanup level throughout the site within a reasonable restoration time frame 173-340-720(8)(c). For Boeing Everett, then, all contaminated groundwater at the Site must meet a single cleanup level at the SPOC (per WAC 173-340-720(8)(b)), and this cleanup level must be protective of surface water beneficial uses (per WAC 173-340-720(4)(b)(ii),[12] since contaminated groundwater discharges to Powder Mill Creek[13,14]).

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[10] Requires meeting the groundwater cleanup level (based on surface water cleanup levels (WQCs); 0.3 µg/L TCE) ONLY in groundwater in the groundwater/surface water transition zone prior to discharge into the creek AND meeting a remediation level of 4.0 µg/L TCE in the remaining body of contaminated groundwater. One condition for turning off the groundwater extractions wells is after attainment of a remediation level of 21 ppb TCE throughout the plume assuming TCE concentrations have reached declining asymptotic values.

[11] This requirement applies to a CPOC which will be set as close as practicable to the source, not to exceed the property boundary. If Boeing wishes to set the CPOC off-property, then additional requirements must be met. See WAC 173-340-720(8)(d)(i) and (ii).

[12]Concentrations established in accordance with the methods specified in WAC 173-340-730 for protecting surface water beneficial uses, unless it can be demonstrated that the hazardous sub-stances are not likely to reach surface water. This demonstration must be based on factors other than implementation of a cleanup action at the site.

[13] As stated in Ecology's August 19, 2016 response letter, one beneficial use for Powder Mill Creek is as a domestic water supply (Chapter 173-201A WAC).

[14] Based on Boeing written responses and verbal discussions at our meetings, it appears that Boeing has incorrectly interpreted this MTCA regulation to mean more than one cleanup level can be assigned to the contaminated groundwater using an SPOC.

Since Ecology does not agree that the requirements for a groundwater CPOC are adequately fulfilled, Ecology does not agree with or approve the discussions in the two Landau technical memoranda regarding groundwater compliance monitoring at the proposed CPOC.

3) Ecology has considered the possibility that our preferred remedy, alternative 4, may result in biofouling due to the presence of total organic carbon (TOC) and precipitating metals in the groundwater extraction wells and within the groundwater treatment system (that discharges to the creek under an NPDES permit). This possibility was raised and discussed in the January 20, 2017 Landau technical memorandum. With any groundwater pump and treat system, with or without concurrent enhanced bioremediation, Ecology believes that regular maintenance should be part of the system's operation and maintenance (O&M) procedures. O&M commonly includes tasks to clean out iron/manganese precipitates, biofilms, and calcium carbonate deposits, using various treatment and re-development techniques. Based on data collected from the existing TCE groundwater source remediation interim action, we believe that the following information suggests that extraction well and groundwater treatment fouling can be adequately mitigated during downgradient and off-Boeing property EISB injections (remedial alternative 4):
    a) The Landau 2017 technical memo[15] cites a reference (Suthersan, 1999) for concentrations of TOC and dissolved metals in groundwater leading to significant fouling and maintenance of groundwater treatment systems. But the Suthersan reference also states: *As a rule of thumb for iron and manganese concentrations of less than 5 mg/L, routine maintenance is sufficient.* The maximum groundwater concentrations of Fe(II) and Mn(II) within 75-160 feet of the interim action EISB source remediation are far below the 5 mg/L Fe(II) and Mn(II) rule-of-thumb threshold concentrations posited by Suthersan. In most cases, Fe(II) and Mn(II) groundwater concentrations are less than 1 mg/L or near site specific background levels outside the source treatment zone.

       It is expected that TOC concentrations will be elevated within the injection treatment zone. However, the existing data show that TOC concentrations decrease to background levels in a short distance from the injection zone. The maximum concentrations of TOC within 75-160 feet of the same interim action EISB work are also far below the 10 mg/L TOC threshold concentrations posited by Suthersan where exceedance results in operation problems that require periodic cleanup. Without elevated downgradient TOC, Fe(II), and Mn(II) groundwater concentrations, biofouling of near downgradient extraction wells and the groundwater treatment system is significantly reduced.

For example, Boeing proposed a groundwater cleanup level assigned to groundwater entering the creek based on the new WQCs AND another cleanup level assigned to the remaining contaminated groundwater plume.

[15] Ecology pointed out to Boeing that the Mn(II) concentrations cited in the technical memorandum were mistakenly presented three orders of magnitude higher than laboratory reporting results. For example, the maximum Mn(II) groundwater concentrations at EGW088 should be 2.9 ppm not 2,900 ppm. This significantly reduces the risk of Mn precipitation in groundwater extraction wells and within the groundwater treatment system and greatly weakens Boeing's argument in the tech memo.

b) Aeration effects created by extraction well pumping could increase biofouling if reduced (dissolved) metals such as iron and manganese are elevated in groundwater. The aeration effect can be minimized by a carefully designed and operated groundwater pumping system. The groundwater pumping system can, and should, be designed such that aquifer potentiometric surface or drawdown created by pumping will never fall below the top of the well screen or close to the submersible pump intake.

c) Existing data from the TCE groundwater source area interim action show that mobilized arsenic concentrations above groundwater cleanup levels, as well as altered groundwater redox conditions, have not migrated far from the treatment wells (160 feet). Based on groundwater geochemical parameters measured downgradient of the interim action TCE groundwater EISB zone, we believe that groundwater will become re-oxidized (under remedial alternative 4) in a relative short distance downgradient (less than 100-120 feet) away from the injection well.

d) Ecology has also considered Boeing's concern that stagnant vinyl chloride (VC) concentration conditions could possibly be created in groundwater due to incomplete TCE to ethane degradation under remedial alternative 4. Ecology believes that careful design of the bioremediation action, including stoichiometric dosing of carbon sources (similar to the interim action groundwater source area work in 2010), should minimize this potential. Bio-augmentation (introduction of additional microbes that more effectively and completely degrade TCE to non-chlorinated products), and implementation of downgradient and off-Boeing property EISB injections, should also be considered in the engineering design if Boeing continues to believe that dechlorination may stall once VC is generated. In any case, keeping the groundwater extraction wells operating near the creek is a good second line of defense to protect surface water and sediment quality, as required by Ecology.

   Note that Ecology's preferred groundwater remedy alternative 4, includes further optimization of the interim action groundwater recovery wells.

e) Boeings' cost estimates for alternative 4 appear to overemphasize the worst case scenario – i.e., requiring pretreatment of groundwater prior to entering the groundwater air stripper in order to prevent fouling and metals precipitation. First of all, the proposed downgradient and off-Boeing property EISB injections are only in the vicinity of three (3) downgradient interim action groundwater extraction wells. Of the total groundwater extracted from the 12 wells (approximately 200 gpm of contaminated groundwater), less than 30 gpm is likely to potentially have vinyl chloride, dissolved metals, and/or TOC from the near up-gradient EISB injections. Therefore, we should expect an eight to nine fold

dilution of any TOC, vinyl chloride, and dissolved metals concentrations before reaching the groundwater treatment system.

f) The January 20, 2017 Landau technical memo states that EISB injections should not be performed within at least 200 feet from downgradient extraction wells or creek discharge points. Given the discussion above and looking at the upland FS report's proposed locations for alternative 4's downgradient and off-Boeing property EISB injections, it appears that most of the creek and groundwater recovery wells are either located 200 feet or more from those EISB injection points, or could be moved a short distance to meet this criterion. Ecology notes that the 200-foot distance should be based on the greater groundwater flow path distance, not the shorter physical distance between the EISB injection locations and downgradient recovery wells and creek discharge points.

g) Lastly, Ecology believes that the reports of success or failure from other sites should be weighed against the existing data obtained from operating and monitoring the Boeing Everett TCE groundwater remediation interim action over the last seven years. No two cleanup site's conditions are the same in all respects. Site-specific conditions, including site geology and hydrogeology, aquifer geochemistry, aquifer potability, contaminant nature and extent, and contaminant fate and transport, will be the primary factors to impact selection, implementation, and success of remedial alternatives and technologies.

4) Regarding groundwater remediation levels (RLs)[16], Ecology has determined that a groundwater standard point of compliance (SPOC) applies to the entire TCE groundwater plume. Therefore, we do not approve use of Boeing's proposed groundwater remediation levels as concentrations to be used in lieu of meeting the groundwater cleanup levels.[4]

Furthermore,

a) One of Boeing's criterion is to shut off the interim action groundwater extraction wells near the creek when their proposed 21 µg/L TCE remediation level is met throughout the groundwater plume (assuming declining asymptotic groundwater concentrations). This is not approved, since it will result in additional TCE-contaminated groundwater, exceeding groundwater cleanup levels, surface water cleanup levels, and WQ criteria, entering Powder Mill Creek[17].

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[16] Under the groundwater standard point of compliance and as allowed under the MTCA regulations, Ecology anticipates that a groundwater RL would be established to determine when to move from enhanced bioremediation to MNA. However, that exact numeric groundwater RL cannot be determined now and will be based on review of site specific groundwater data indicating the effectiveness of the enhanced bioremediation and likelihood of MNA meeting MTCA requirements. However, an RL would not be considered the equivalent of meeting a CUL so that no further action is needed.

[17] Groundwater extraction wells will remain operational until Ecology determines that the TCE groundwater near and discharging to the creek meet the new water quality criteria (0.3 µg/L TCE for example).

To clarify, this site will have established (1) groundwater cleanup levels; and (2) surface water cleanup levels. Both must be met in their respective media. The groundwater remedy cannot cause a violation of the water quality standards (which is an ARAR). The Boeing proposed groundwater RL would result in violations of (a) groundwater cleanup levels based on a standard point of compliance; and (b) surface water cleanup levels at the discharge area and within the creek.

b) Ecology will evaluate site-specific EISB groundwater performance to determine when the TCE groundwater treatment may move from enhanced bioremediation to monitored natural attenuation (MNA). Ecology will base our determination on: (1) indications that enhanced bioremediation is no longer effective in degrading and reducing CVOC groundwater concentrations, AND (2) a conclusion that MNA meets MTCA regulatory requirements for a polishing step to attain groundwater cleanup levels[4] at the groundwater SPOC.

Boeing's updated FS analysis, contained in the two Landau technical memoranda, did not significantly change Ecology's regulatory and technical evaluation of the site's groundwater remedy alternatives. As a result, Ecology has not altered from our preferred alternative (4).[18] However, we agree that Boeing should perform phase 1 (pilot)[19] EISB injections north and south of Seaway Blvd. during the implementation of the cleanup action plan (CAP)/ Engineering Design Report (EDR). Ecology believes it is important to conduct the phase 1 (pilot) EISB injections in this timeframe because this leads to a more streamlined and expedient cleanup of the groundwater. The pilot study itself will be designed to provide data that can aid Boeing's redesign (if needed) of the locations and numbers of downgradient and off-Boeing property EISB injections.[20] This assumes that indications of remedial performance, related to the actions taken during phase 1, either suggest: a) a full-scale action consistent with Ecology's preferred remedy will be successful, or b) that a full-scale action will only be successful if downgradient and off Boeing property injections are performed with a reasonable degree of modification to system design.

As we have discussed, Ecology will review the information and Boeing conclusions included in the phase 1 results technical memo. If the memo proposes to reduce some -- or eliminate all -- EISB injections planned for the downgradient and off-Boeing property, Ecology will approve these changes to the cleanup action's design if we agree with the data interpretation and concur with the underlying rationale.

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[18] Refer to Attachment B which discusses the disproportionate cost analysis for alternative 4 (including additional system design elements to mitigate potential groundwater treatment system fouling).

[19] Discussed very generally during March 22, 2017 meeting.

[20] Ecology assumes that the following features are incorporated into alternative 4: TOC + metals gw pre-treatment facility and associated O&M, GET system replacement, biofouling equipment maintenance/replacement, and GW sampling for EISB parameters as stated in the November 2, 2016 Landau tech memo and optimized groundwater extraction (part of Ecology's preferred remedy). Ecology considers these to be reasonable system design elements.

Ecology also expects that the source area EISB injections will occur concurrent with the phase 1 (pilot) EISB injections since the latter will not impact the former and implementing source area EISB injections in this early timeframe leads to faster groundwater cleanup.

Therefore, the draft upland cleanup action plan will include Ecology's preferred alternative #4 and a groundwater standard point of compliance. It will also require the following:

1) EISB injections and monitoring -- AND concurrent operation of the interim action groundwater recovery wells -- to minimize the flux of TCE contaminated groundwater entering the creek now (objective of the ongoing MTCA interim action) and during the groundwater remediation.
2) Groundwater extraction wells near the creek remaining operational until Ecology determines that the TCE levels in groundwater nearest to the creek meet the groundwater cleanup levels[4].
3) Operation of the Interim action groundwater extraction wells along Seaway Blvd until Ecology determines that the groundwater remediation is equally effective in reducing the migration of contaminated groundwater off Boeing property.
4) Further optimization of the interim action groundwater pump and treat system to reduce TCE contaminated groundwater flux to the creek to the maximum extent practicable (IA objective).
5) Finalization of the locations for phase 1 (pilot) and source area EISB injections in the EDR. Ecology expects that source area EISB injections will not be affected by this phase 1 work and should be conducted concurrent with phase 1 (pilot) injections. Final design injections may be at slightly different locations than those proposed in the FS conceptual design.
6) Basing the locations of all subsequent phase 2 EISB injections on the phase 1 injection results. Locations of phase 3 and subsequent EISB injections, if necessary, shall be based on previous injection results. Again, final design injections may be at slightly different locations compared to proposals in the FS conceptual design.
7) Ecology assumes that the following features are incorporated into alternative 4: total organic carbon (TOC) and metals groundwater pre-treatment facility and associated operation and maintenance (O&M), groundwater extraction and treatment (GET) system replacement, biofouling equipment maintenance/replacement, and groundwater sampling for EISB parameters as stated in the November 2, 2016 Landau tech memo in addition to further optimized groundwater extraction (part of Ecology's preferred remedy). Ecology considers these to be reasonable system design elements for off Boeing property EISB injections.
8) Ecology and Boeing evaluation of EISB groundwater injection effectiveness to determine the timing for additional EISB injections. More injections may be required at new or repeat locations in order to facilitate attainment of groundwater cleanup levels at the SPOC. If Boeing or Ecology believes that additional EISB injections are not needed, that monitored natural attenuation (MNA) will achieve groundwater and surface water cleanup levels in a reasonable timeframe, and that the MNA action meets all necessary cleanup requirements under MTCA, Boeing or Ecology may propose to terminate EISB injection in favor of an MNA approach. If Ecology agrees, we may still require operation of the groundwater extraction wells in order to minimize TCE contaminated groundwater migration to the creek.

9) A restrictive covenant and institutional controls to ensure that the extraction of groundwater contaminated with chlorinated volatile organic compounds (CVOCs) is not only prohibited for drinking water purposes but prohibited for any use, unless specifically approved by Ecology;
10) Continued efforts to inform the public about site contamination and prevent access to creek surface water and nearby creek bank TCE contaminated groundwater seeps throughout the cleanup process. This includes working with the City of Everett to provide additional signage near Powder Mill Creek access points on City property, warning the public to stay away from the creek (creek bank with groundwater seeps and water in the creek);
11) Notification to property owners that the indoor air quality in newly constructed buildings near and above the TCE groundwater plume may potentially be threatened by vapor intrusion. Boeing shall provide all available applicable soil gas and shallow groundwater VOC data to those property owners upon request.
12) Routine soil gas sampling from (soil gas) wells ESG001, ESG002, ESG003, and ESG004 (Bertch Capital Partners and Panattoni properties located over the TCE contaminated groundwater). The purpose of this sampling is to determine whether soil gas TCE levels pose a potentially future vapor intrusion threat during groundwater remediation. This is needed to meet the MTCA requirement for protection, performance, and confirmational monitoring under WAC 173-340-410. Ecology anticipates soil gas sampling twice in the first year, with reduction to annual sampling if soil gas and groundwater concentrations remain non-detect, show decreasing trends, or are consistently below screening levels.
13) Financial assurance for all near and long terms costs for cleanup actions required under RCRA and MTCA, including: maintenance of institutional controls and environmental covenants; ongoing O&M work; and long term repair costs until cleanup levels are met and shown be maintained at those levels.

Groundwater and surface water cleanup levels for the Esperance Sand Aquifer must be revised and incorporated in the dCAP to use a standard point of compliance (SPOC) and include groundwater and surface water cleanup standards that incorporate all appropriate ARARs: State and Federal Water Quality ARARs (Chapter 173-201A WAC, National Toxics Rule 40CFR131 and the 2016 updated National Recommend Water Quality Criteria – Human Health[21] criteria under Section 304(a) of the Clean Water Act); Federal Groundwater MCLs; and, as appropriate, MTCA Method B groundwater cleanup levels.

Groundwater and surface water CVOC cleanup levels in the dCAP should be revised as follows:

	Media	**Cleanup Level (µg/L)**	**ARAR Source**
Trichloroethylene (TCE)	Groundwater	0.30	Chapter 173-201A
	Surface Water	0.30	Chapter 173-201A

[21] WAC 173-340-730(1) states that the classification and the highest beneficial use of a surface water body, determined in accordance with chapter 173-201A WAC, shall be used to establish the reasonable maximum exposure for that water body. Surface water cleanup levels shall use this presumed exposure scenario. Under WAC 173-201A-600(1) and -602, Powder Mill Creek is protected for the following designated uses: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

cis-1,2-Dichloroethylene (cis-1,2 DCE)	Groundwater Surface Water	16 [MTCA B] 590	na EPA Eco
trans-1,2-Dichloroethylene (trans-1,2 DCE)	Groundwater Surface Water	100 100	MCL CWA304[22]
1,1-dichloroethylene (1,1 DCE)	Groundwater Surface Water	3.2 3.2	NTR[23] NTR
Vinyl chloride	Groundwater Surface Water	0.02 0.02	Chapter 173-201A Chapter 173-201A

2. a. SWMU171, Building 40-31, Former Bluestreak Vapor Degreaser: Preferred Remedies and Reasonable Restoration Timeframe

Based on additional information provided by Boeing's electronic mail dated November 2, 2016, Ecology has revised its preferred remedy for this SWMU. Ecology determined that the appropriate remedy is Alternative 1 – Maintain Containment and future Soil Vapor Extraction (Alternative 2) or other removal technology. [24]

The timeline for the start of the SVE or other approved Remedial Action has flexibility in order to accommodate Boeing's operations in the building. For the time period from the effective date of the Cleanup Action Plan (CAP) until implementation of the SVE or other approved Remedial Action, Boeing will retain a cap to provide short-term protection to human health and the environment. Details on the remedial action and the trigger for the start of the SVE or other approved Remedial Action are provided below.

As of the effective date of the CAP, Boeing will maintain a containment cap in the building, and collect routine sub-slab vapor (SSV) and indoor air (IA) monitoring on a semi-annual basis initially. Boeing will be required to maintain and monitor the cap to insure its continued effectiveness.

Once the factor necessary for the start of the SVE or other approved Remedial Action has been triggered, Boeing will provide Ecology with a draft workplan within 60 days. The draft workplan will detail the SVE or other approved Remedial Action which will include removal of a significant amount of subsurface contamination, thereby reducing the probability of future indoor air contamination and reducing the migration potential of contamination to the deep

[22] Federal National Recommended Water Quality Criteria for Human Health updated in 2015
[23] National Toxics Rule, 40CFR131 for organism consumption.
[24] Boeing re-visited the carpet shop at Building 40-31 to look more closely at the possibility of implementing SVE in this area. Based on the visit and consideration of new information, Boeing has determined that SVE cannot be implemented in this area in the near term without undue burden to facility operations.

potable aquifer. The design details and construction/testing/operation schedule shall be included in the work plan. Compliance monitoring will be conducted as further detailed in the CAP.

The factor necessary to trigger the start of the SVE or other approved Remedial Action is a change in operation(s) in the building which allows for implementation of the remedial action without an undue burden on Boeing's operation(s). Boeing shall notify Ecology in writing when this factor has been triggered. Ecology may also notify Boeing in writing if Ecology determines, after review of Boeing's operation(s), that the factor has been met. Ecology's decision may be subject to Dispute Resolution [Agreed Order DE96HS-N274, Section VII.4].

Regardless of whether the factor to trigger the start of the SVE or other approved Remedial Action is met, Boeing will be required to implement the remedial action immediately if Ecology determines the cap is no longer functioning as an adequate barrier to protect the building workers or if migration of contamination to the deeper aquifer is occurring or cannot be prevented without implementing the SVE or other approved remedial action.

Regardless of whether the factor to trigger the start of the SVE or other approved Remedial Action is met, Boeing shall implement the remedial action no later than 15 years from the effective date of the CAP. Boeing may a submit a written request for a time extension to Ecology no earlier than 18 months and no later than 1 year prior to the 15 year deadline. The request for a time extension will include the reasons why Boeing will not be able to perform the SVE or other approved Removal Action within the 15 year time frame. Ecology will provide up to a 5 year time extension for each such request provided Ecology agrees that factor for implementation of the SVE or other approved removal action is not met due to the continued undue burden on Boeing's operation(s).

Boeing shall provide a status summary report to Ecology annually, every January 31st, which will describe the review conducted by Boeing to determine if the factor to trigger the start of the SVE or other approved Remedial Action has been met. The status summary report will also identify any possible upcoming time intervals within the 15 year time frame for completing the Excavation and/or SVE Remedial Action. This summary report may be used by the parties to identify if a time extension will be necessary.

Ecology's preferred alternative also requires one deep well as close as possible to the downgradient edge of this SWMU. This is needed to verify that contamination from the SWMU will not migrate to the Esperance Sand Aquifer (as indicated by the vadose zone model, Appendix B of the FS report).

Perched groundwater has not been found in any of the borings drilled within this SWMU. However, soil cleanup levels must be calculated and established based on protection of the deep groundwater aquifer[4]. Soil contamination remaining after the completion of SVE soil system operation (or other remediation technology), but above soil cleanup levels, can still meet requirements for a final soil cleanup if WAC 173-340-740(6)(f) requirements are complied with.

2.b. SWMU 054, Building 40-51; SWMU 165, Former Fuel Farm; SWMU 093, Building 45-01[25]; SWMUs 067 and 071, Building 40-56; AND EV 48-1, Building 40-11: Preferred Remedies and Reasonable Restoration Timeframe

For these SWMUs, Ecology determined that the appropriate remedy is Alternative 1 – Maintain Containment and Alternative 2 - future excavation. Ecology explained its preferred remedies (and rationale) at these SWMUs in its response letter dated August 18, 2016, and summarizes that explanation below.

During the January 10th and March 22nd meetings, Boeing stated that it generally considers it beneficial to excavate remaining contamination if an opportunity arises that allows access without interfering with manufacturing operations. Ecology is pleased that Boeing is willing to perform this future excavation work.

The timeline for the start of the Excavation or other approved Remedial Action has flexibility in order to accommodate Boeing's operations in the building. For the time period from the effective date of the Cleanup Action Plan (CAP) until implementation of the Excavation or other approved Remedial Action, Boeing will retain a cap to provide short-term protection to human health and the environment. Details on the remedial action and the trigger for the start of the Excavation or other approved Remedial Action are provided below.

As of the effective date of the CAP, Boeing will maintain a containment cap in the building, and collect routine sub-slab vapor (SSV) and indoor air (IA) monitoring on a semi-annual basis initially, if required by Ecology. Boeing will be required to maintain and monitor the cap to insure its continued effectiveness.

Once the factor necessary for the start of the Excavation or other approved Remedial Action has been triggered, Boeing will provide Ecology with a draft workplan within 60 days. The draft workplan will detail the Excavation or other approved Remedial Action which will include removal of a significant amount of subsurface contamination, thereby reducing the probability of future indoor air contamination and reducing the migration potential of contamination to the deep potable aquifer. The design details and construction/testing/operation schedule shall be included in the work plan. Compliance monitoring will be conducted as further detailed in the CAP.

The factor necessary to trigger the start of the Excavation or other approved Remedial Action is a change in operation(s) in the building which allows for implementation of the remedial action without an undue burden on Boeing's operation(s). Boeing shall notify Ecology in writing when this factor has been triggered. Ecology may also notify Boeing in writing if Ecology determines, after review of Boeing's operation(s), that the factor has been met. Ecology's decision may be subject to Dispute Resolution [Section VII.10].

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[25] Future excavation was not evaluated as a remedial alternative for this SWMU in the Boeing Uplands FS report, however, near term excavation was evaluated as a near term alternative.

Regardless of whether the factor to trigger the start of the excavation or other approved Remedial Action is met, Boeing will be required to implement the remedial action immediately if Ecology determines the cap is no longer functioning as an adequate barrier to protect the building workers or if migration of contamination to the deeper aquifer is occurring or cannot be prevented without implementing the excavation or other approved remedial action.

Regardless of whether the factor to trigger the start of the Excavation or other approved Remedial Action is met, Boeing shall implement the remedial action no later than 15 years from the effective date of the CAP. Boeing may a submit a written request for a time extension to Ecology no earlier than 18 months and no later than 1 year prior to the 15 year deadline. The request for a time extension will include the reasons why Boeing will not be able to perform the Excavation or other approved Removal Action within the 15 year time frame. Ecology will provide up to a 5 year time extension for each such request provided Ecology agrees that factor for implementation of the excavation other approved removal action is not met due to the continued undue burden on Boeing's operation(s).

Boeing shall provide a status summary report to Ecology annually, every January 31st, which will describe the review conducted by Boeing to determine if the factor to trigger the start of the Excavation or other approved Remedial Action has been met. The status summary report will also identify any possible upcoming time intervals within the 15 year time frame for completing the Excavation or other approved Remedial Action. This summary report may be used by the parties to identify if a time extension will be necessary.

Routine sub-slab vapor (SSV) and indoor air monitoring is required during the period contaminated soils are contained[26] (SWMUs 054, 067/071) and during and following contaminated soil excavation. The duration and frequency of this monitoring program depends on the amount of soil contamination remaining after excavation and the variability and magnitude of SSV and IA contamination.

Ecology's preferred alternative also requires one deep well as close as possible to the downgradient edge of each SWMU. This is needed in order to verify that contamination from these SWMUs will not migrate to the Esperance Sand Aquifer (as indicated by the vadose zone model, Appendix B of the Upland FS report).

Perched groundwater has not been found in any of the borings drilled within this SWMU. However, soil cleanup levels must be calculated and established based on protection of the deep groundwater aquifer[4]. Soil contamination remaining after the future excavation (or other remediation technology), but above soil cleanup levels, can still meet requirements for a final soil cleanup if WAC 173-340-740(6)(f) requirements are complied with.

3. a. SWMU 055 and 168, Building 40-24, Utility Trenches and Sumps (indoors and outdoors) Preferred Remedies and Reasonable Restoration Timeframe

[26] SWMU 093 does not require routine sub-slab and indoor air sampling since Ecology was told that MEK is currently used in the main processes inside the building.

For these SWMUs, Ecology prefers Alternative 4[27]- Near Term Excavation, Dewatering and Periodic Removal of Perched Groundwater present in backfill within the 40-24 building indoor trenches.[28] We also require additional components to this remedy, as explained in our August 18, 2016 response letter. Boeing's written responses, and the discussions held during our meetings, have not altered Ecology's preferred remedies for these SWMUs. The following summarizes our position:

- Subsurface soil contamination above soil cleanup levels will be excavated in the future in accordance with the requirements in Section 2.a above. Indoor air and sub-slab vapor sampling is not required due to the low volatility of the Skydrol hydraulic fluid contaminant.
- The presence or absence of contaminated perched groundwater below the main utility trench inside the 40-24 building will be verified. Historically, discontinuous contaminated groundwater was present here. If present, removal (pumping) of the contaminated groundwater to the maximum extent possible is required to reduce the migration of contamination to the Esperance Sand Aquifer. This could be continuous or intermittent pumping depending on the amount of contaminated groundwater present. The objective of the groundwater pumping should be to remove at least 15-20 gallons of contaminated groundwater while operational as Boeing proposed in its March 6, 2017 email and attachment.
- The presence or absence of contaminated perched groundwater within the area around Vault E (EGW070), and within the south side of the main utility trench (EGW037), will be verified after decommissioning. Historically, discontinuous contaminated groundwater was present in these areas. If present, removal (pumping) of the contaminated groundwater to the maximum extent possible is required to reduce the migration of contamination to the Esperance Sand Aquifer. This could be continuous or intermittent pumping depending on the amount of contaminated groundwater present. The objective of the groundwater pumping should be to remove at least 15-20 gallons of contaminated groundwater while operational.

3.b. SWMUs Located in Buildings 40-22[29], 40-23[30], and 40-25[31] with Skydrol Hydraulic Fluid Contaminated Subsurface Soil: Preferred Remedies and Reasonable Restoration Timeframe

Boeing provided follow-up information on these additional SWMUs contaminated with Skydrol hydraulic fluid by electronic mail on October 17, 2016 (subsequent to the company's September 19, 2016 response letter). Higher concentrations of Skydrol hydraulic fluid soil contamination

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[27] Alternative 1(site monitoring) cannot be the most permanent remedy because it does not meet the threshold requirement for achieving groundwater cleanup levels. Furthermore, it over-relies on dilution and will not provide for a reasonable restoration timeframe (per WAC 173-340-360(2)(a), (b) and (e)).

[28] Such as in areas where historically discontinuous and contaminated perched groundwater was located near ESB1290 and the north sump areas.

[29] Slant #2 and #3.

[30] Static Test Pad

[31] Outdoor Vault

are found in the subsurface soils of these three buildings than at building 40-24 (SWMU 055/168). For these three new SWMUs, Ecology prefers Alternative 1 (under SWMU 055/168) and future excavation. No perched groundwater has been observed below these buildings thus far.

Ecology requires additional components to this remedy, consistent with those for SWMUs 055/168 (as explained in our August 18, 2016 letter).
In order to implement Ecology's preferred remedy for these additional Skydrol SWMUs, Boeing is required to conduct the following actions:

1) Install deep well(s) as close as possible to the downgradient edge of each building-specific SWMU in order to verify that contamination from the SWMU is not leaching into the Esperance Sand Aquifer.

2) Future excavation, conducted in accordance with the same language used for Building 40-24 (SWMU 055/168)

Sub-slab vapor and indoor air sampling is not required because the sub-surface contaminants have low volatility.

4.a SWMUs 086, 089 and 094 Building 40-56 – soil cleanup levels protective of groundwater cleanup levels established for the Esperance Sand Aquifer (protective of surface water cleanup levels)

As stated in our August 18, 2016 letter, Ecology's preferred remedy is Alternative 2: Soil Vapor Extraction, Groundwater Extraction, Institutional Controls and Monitoring. This remedy is the same as Boeing's preferred remedy, with the exception that Ecology added additional requirements in order to be compliant with the MTCA cleanup regulations.

Boeing's written responses and discussions during our meetings have not altered Ecology's preferred remedies for SWMUs 086, 089 and 094. Ecology explained its preferred remedies (and rationale) for these SWMUs in its August letter; the following summarizes our position:

- Ecology has determined that a groundwater standard point of compliance applies to the Powder Mill Gulch TCE groundwater plume (Esperance Sand Aquifer). Based on this determination, cleanup levels for contaminated soils above the Esperance Sand Aquifer are based on being protective of the groundwater cleanup levels assigned to the Esperance Sand Aquifer. Since this contaminated aquifer discharges to the Powder Mill Creek, the Method B groundwater cleanup levels must be at least as protective as the surface water cleanup levels.

- As Ecology mentioned during our previous meetings, after operation of the SVE system to remove as much volatile organic contamination from the sub-surface soils as practical, it is possible that soil contamination will still exceed soil cleanup levels protective of the

groundwater cleanup levels assigned to the Esperance Sand Aquifer. In this case, soil contamination remaining after SVE completion that is above soil cleanup levels can still meet requirements for a final soil cleanup if WAC 173-340-740(6)(f) requirements are complied with.

- Boeing has stated that we should expect faster biodegradation of the toluene, ethylbenzene and xylene subsurface contamination (compared with CVOC degradation rates). This would reduce the potential for contaminant migration to the underlying deep potable aquifer. While this is possible, post-SVE subsurface soil sampling will be required to determine if and how quickly such biodegradation occurs. Ecology cannot establish less protective soil cleanup levels based on this uncertain hypothesis regarding faster VOC degradation.

- Ecology's preferred alternative also requires one additional deep well as close as possible to the downgradient edge of this SWMU group in order to verify that contamination from this SWMU will not migrate to the Esperance Sand Aquifer in the future (as indicated by the vadose zone model, Appendix B of the FS report).

4.b SWMU151, Building 40-51; SWMU97, Building 40-11; SWMU98, Building 40-53; SWMUs 169, 170 and Paint Crib, Building 40-02; Footing Excavation, Building 40-32; SWMU 68, Former South Fire Pit: Soil Cleanup Levels Protection of Deeper Aquifer Cleanup Levels

With the exception of SWMU151, perched groundwater[32] has not been found in any of the borings drilled within these SWMUs. However, soil cleanup levels must be calculated and established based on protection of the deep groundwater aquifer[4]. Soil contamination remaining [33]above soil cleanup levels can still meet requirements for a final soil cleanup if WAC 173-340-740(6)(f) requirements are complied with.

5. Vapor Intrusion Monitoring

a. Upland SWMUs

Boeing's written responses and discussions during our meetings have not altered Ecology's requirement for concurrent and routine indoor air and sub-slab vapor (SSV) [or soil gas (SG)] sampling at several upland SWMUs[34] where containment and monitoring of sub-surface soil contamination is Ecology's preferred remedy.

We explained our rationale for this routine sampling in our August 18, 2016 letter and during subsequent meetings. Boeing has agreed to collect routine indoor air samples, but does not agree that routine SSV and/or SG samples need to also be collected. The following summarizes our position on this issue:

- SSV and SG sampling is not conducted at any regulatory-based point of compliance.

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[32] SWMU 151 has discontinuous contaminated perched groundwater.
[33] For SWMU 97, the soil cleanup levels apply after soil excavation conducted in the short term.
[34]SWMUs 090, 054, 112, 086/089/094, 067/071, 170, 169, Former Paint Crib, 098, 171, Building 40-32 Footing Excavation.

However, this subsurface information is necessary in order to help Ecology:

- Verify the source of any volatile contaminants detected in indoor air samples (i.e., does the detection originate from the subsurface, or is it more likely due to an indoor source).
- Better establish the frequency of future indoor air monitoring (e.g., indoor air monitoring can be performed less frequently if soil gas concentrations are low, or are demonstrably decreasing).

- If SSV/SG results are stable or decreasing, Ecology has stated it is willing to reduce routine SSV/SG sampling frequencies after the first annual winter and summer sampling event to annual sampling.

b. Powder Mill Gulch, Esperance Sand TCE plume

Boeing's written responses and discussions during our meetings have not altered Ecology's requirement for routine soil gas monitoring on the Panattoni and Bertch properties (ESG001 through ESG004). Ecology explained its rationale for this routine sampling during previous meetings. The following summarizes our position on this issue:

- Four SG monitoring wells are already installed and were sampled in January 2014. This was the only time they were sampled. Ecology requires additional soil gas data from these four SG wells in order to verify there are no increases in TCE or degradation product levels prior to or during groundwater remediation.
- We do NOT consider this routine SG monitoring to be an additional investigation, as Boeing has claimed. Instead, it is necessary for *protection* monitoring to verify that future indoor air concentrations in the nearby Panattoni warehouse buildings stay below acceptable cleanup levels. It is also needed during *performance* monitoring to verify that groundwater cleanup action is also reducing soil gas concentrations in the sub-surface vadose zone, a remedial action objective. During *confirmational* monitoring, the sampling results will be used to verify that soil gas concentrations after the groundwater remediation is shut off continue to be protective of Panattoni warehouse indoor air quality.
- As Ecology has stated during our meetings, we are willing to reduce routine sampling frequencies after the first annual winter/summer sampling event if: SSV/SG results are below screening levels; SSV/SG concentrations are demonstrably stable or decreasing; and/or, co-located groundwater volatile contaminant concentrations are stable or decreasing.

6. **Deep Well Installation and Routine Groundwater Monitoring**

Boeing's written responses and discussions during our meetings have not altered Ecology's requirement for deep groundwater monitoring well installation and routine groundwater monitoring downgradient of specific SWMUs. Ecology explained its rationale for this routine sampling in Ecology's August letter and in subsequent meetings. The following summarizes our position:

- Consistent with Ecology's August 18, 2016 response letter, downgradient deep groundwater monitoring well installation and routine groundwater monitoring is required at these SWMUs[35]:

[35] Ecology stated during the March 22, 2017 meeting that it no longer requires a downgradient deep groundwater monitoring well at SWMU083 due to smaller amounts of TPH-D contamination in shallow soils.

i. SWMU 054, Building 40-51;
ii. UST EV-48-1, Building 40-11;
iii. SWMUs 086/089/094, Building 40-56[36]
iv. SWMU 067/071[36]
v. SWMU 055/168, Building 40-24
vi. SWMU 098, Building 40-53;
vii. SWMU 171, Building 40-31
viii. Footing Excavation Area, Building 45-32
ix. SWMU 165, Fuel Farm;
x. SWMU 093, Building 45-01;
xi. Building 40-22;
xii. Building 40-23;
xiii. Building 40-25

- Boeing should make best efforts to locate the downgradient deep groundwater monitoring wells as close as possible to (but not within) the soil contamination. However, if installing the groundwater monitoring well(s) inside the building is disruptive to the current manufacturing processes, Boeing may propose to locate the groundwater monitoring wells as close as possible to the outdoor downgradient building wall. We mentioned this option during our November 3, 2016 meeting, and proposed locations for such outdoor-located downgradient deep wells.
- Ecology does not agree that the vadose zone infiltration model (SESOIL) results can be used to justify omitting a routine monitoring requirement for the downgradient Esperance Sand aquifer deep wells. As we stated during our recent meetings, routine groundwater monitoring of this type is a requirement under WAC 173-340-740(6)(f)(v). Groundwater monitoring is commonly needed to 'verify' the results of any vadose zone soil modeling[37] result.

- Many of the SWMU areas listed above are located outdoors and have documented perched[38] groundwater contamination near and below the contaminated soils. The FS

[36] EGW040 does not adequately serve as a downgradient deep groundwater monitoring well. Ecology requires an additional deep groundwater monitoring well on the east side of building 40-56, if it cannot be located inside the building. This additional monitoring well will serve to monitor these five SWMUs. Similarly, SWMUs 169 and 170 have two deep downgradient groundwater monitoring wells which Ecology has determined satisfy the deep downgradient groundwater monitoring well requirement.

[37] Ecology also notes that the vadose soil model SESOIL, used by Boeing to prepare the FS report, is frequently a tool used in solid waste landfill designs. Even though solid waste landfills may be designed with low permeability liners and caps, groundwater monitoring is still a permit requirement.

[38] In addition, based on the observation of year around perched groundwater at many outdoor SWMUs, Ecology assumes that rainwater infiltration into the contaminated soils is occurring now. It is not clear if rainwater is infiltrating through the cover directly above the SWMU or if rainwater (or leaking water lines) is infiltrating at a distance from the SWMU and flowing under the SWMU. The Vadose Zone Modeling report states that contamination will reach the Esperance Sand aquifer from the SWMU if water is allowed to infiltrate into the contaminated vadose zone soils. Ecology comments on the vadose zone modeling report indicated that contaminated perched groundwater was not accounted for in the modeling results and the most uncertainty in the modeling results lies in the accuracy in the amount of time before vadose zone contamination from either perched groundwater or subsurface soils reaches the Esperance Sand Aquifer.

report's leaching models show that contamination will reach the Esperance Sand aquifer where infiltration of rainwater occurs above or near these outdoor SWMUs[39].

- The contaminated soils may be left in place for decades. Therefore, it is reasonable for Ecology to require the downgradient deep groundwater monitoring wells in the Esperance Sand aquifer as a condition for approving on-site contaminated soil containment as part of the preferred remedy.

- Ecology believes it is reasonable to require downgradient deep groundwater monitoring wells for the SWMUs located inside buildings even if perched groundwater has not been (currently) observed in select borings. Again, the containment remedy for the contaminated soils may need to be maintained for decades (assuming no new unacceptable exposure pathways). The uncertainties associated with the containment remedy, which are also the basis for Ecology's requirements for these Esperance Sand aquifer downgradient groundwater monitoring wells, include possible higher than measured subsurface soil contamination concentrations; vertical vapor migration, future rainwater infiltration to these contaminated soils, and future water releases from nearby utilities and stormwater lines/drains.

- Ecology stated during several of our meetings that Boeing may consider combining some SWMUs for monitoring by using same downgradient deep monitoring well(s). Ecology has accounted for this option.

- Quarterly routine groundwater sampling should be performed for the first 2 years. Boeing may then request a reduction to semi-annual routine monitoring if the quarterly groundwater data indicate that contaminants have not been detected above the reporting limit (RL). Any semi-annual groundwater monitoring well that detects groundwater contamination when previously not detected will immediately move to routine quarterly sampling. Semi-annual groundwater monitoring will target the wet and dry seasons of a year. Annual groundwater monitoring is not adequate for these SWMUs; it does not cover a complete hydrologic cycle and therefore may be is too infrequent to be able to quickly identify groundwater contamination from a SWMU where contaminated soil is left in place.

7. **Contingency Remedial Action Evaluation**
Ecology will not require a remedial action contingency section in the uplands CAP. Instead, upon Ecology determination of remedy failure at any SWMU, Ecology will modify the cleanup order, CAP and EDR to require Boeing to implement an alternative remedial action that will meet MTCA cleanup requirement including attaining cleanup levels in a reasonable timeframe. Public comment will be required when modifying the cleanup order.

[39] Ecology cannot assume (as the FS report does) that outdoor SWMUs do not have any rainwater infiltration.

8. **Restrictive Environmental Covenants (RECs) for PMG**
Boeing's written responses and discussions during our meetings have not altered Ecology's requirement for meeting all of the applicable requirements under WAC 173-340-440, including WAC 172-340-440(8)(c). Ecology explained its rationale in our August 2016 letter, and during several subsequent meetings. Boeing has recently agreed to this requirement. The following summarizes our position:

   - As required under MTCA, Boeing must make a good faith effort to request restrictive environmental covenants (RECs) for the Panattoni, Seaway West, and City of Everett (Lot 9) properties from their respective owners. The TCE groundwater plume is located below all three properties.

   - City of Everett ordinances are not adequate in lieu of RECs to prohibit the withdrawal of contaminated groundwater for any use.

   - It is true that during our five-year review Ecology could (and probably will) evaluate whether City of Everett ordinances appear to adequately prevent the withdrawal of contaminated groundwater. However, as noted above, we do not believe that the ordinance, by itself, is sufficiently protective over the long term. Nor do we want to wait for as long as five years to find out that withdrawals have been occurring despite the ordinance.

   - Notification to property owners that the indoor air quality in newly constructed buildings near and above the TCE groundwater plume may potentially be threatened by vapor intrusion. Boeing shall provide all available applicable soil gas and shallow groundwater VOC data to those property owners upon request.

9. **Revising the FS**
Since August 2016, Boeing's written submittals and the discussions the two parties have held, have not altered Ecology's decision that the upland FS report should not be revised. Instead, we should move forward and begin preparing the draft cleanup action plan. Ecology explained its rationale in our August 2016 letter, and during several subsequent meetings. The following summarizes our position:

   - A first draft of the upland CAP should now be prepared. It should be consistent with the preferred cleanup action alternatives Ecology has described above.

   - Ecology plans to prepare a public comment summary fact sheet that describes and explains both Ecology's and Boeing's preferred remedial actions. We believe this is the best way for Ecology and Boeing to "*have an understanding of the FS*", as stated in Boeing's March 6, 2017 electronic mail.

   - The Draft Uplands FS report, along with Ecology's response letters, are available for public review. They provide adequate detail for members of the public who would

like more information on the remedy selection process.

- Ecology is not requesting and Boeing is not required to submit a revised upland FS report. The information referred to in the second and third bullets above adequately serves to provide the public with both a brief summary and a more fully detailed overview of the FS.

  Boeing may believe there is value in preparing a revised FS report that incorporates modifications agreed to by both parties since the document was submitted. But any revised upland FS report is also likely to include new points of disagreement that were not in the draft report. These new disagreements will then be the subject of additional comment (dispute) resolution, further delaying preparation of the dCAP. Furthermore, Ecology has limited resources. We cannot justify the commitment of site manager and support resources to another FS report review without the expectation that there will be, as a result, significant benefit to the cleanup. That is not our expectation at this site, and for these reasons we do not intend to review further revisions of the FS report.

10. **Compliance Monitoring**
Boeing and Ecology already agreed to discuss routine sampling requirements AFTER the upland site wide final remedies are determined by Ecology, and Boeing agrees to include all of them in the dCAP and EDR. Until Ecology begins review of the EDR, it expects this discussion to be conceptual and not define specific locations and number of monitoring locations or monitoring frequencies.

Attachment B: Ecology Analysis of New Remedial Action Options for Powder Mill Gulch:

Alternative 4 requires more remedial actions compared to alternative 2a:

1. Enhanced in-situ bioremediation (ESIB) injections at the downgradient and off-Boeing property in addition to the source area.
2. Groundwater standard point of compliance (SPOC) and groundwater cleanup levels[4] met throughout the groundwater.
3. Groundwater treatment performance based remediation levels for an Ecology decision that enhanced bioremediation is no longer effective and monitored natural attenuation may proceed in accordance with the MTCA.
4. Groundwater extraction wells operating along the creek until groundwater near to and discharging into the creek meets surface water cleanup levels.

Ecology has already eliminated Boeing's previously preferred alternative 1[40] (operation of the

[40] Boeing asked that Ecology provide a defensible basis to support this rationale to eliminate alternative 1. Ecology provided its defensible basis in its August 18, 2016 response letter, Attachments A and B and during subsequent meetings. Furthermore, groundwater pump and treat systems alone are known to fail to meet very low groundwater cleanup levels and this is stated in the

groundwater extraction wells and ONLY contingent enhanced bioremediation) from remedy consideration when compared to Ecology' preferred alternative 4. Ecology's determination that alternative 1 did not meet MTCA threshold and other requirements was previously discussed in its August 18, 2016 response letter and subsequent meetings. Those discussion points will not be reiterated in this letter.

The discussion below summarizes the MTCA regulatory analysis for Ecology's determination that alternative 4 meets all MTCA threshold and other regulatory requirements (WAC 173-340-360(2)(a)) and is permanent to the maximum extent practicable (WAC 173-340-360(2)(b)) and therefore preferred over alternative 2a.

A. Threshold Requirements: requirements that all alternatives must comply with, if selected, described in WAC 173-340-360(2)(a).

A.1. Protect Human Health and the Environment (WAC 173-340-360(2)(a)(i):
Conclusions: Both alternatives 4 and 2a should adequately protect human health and the environment as long as: a) institutional controls are effective; b) contaminated groundwater is not withdrawn for drinking water or other purposes, currently or in the future; and c) walkers on the trail within Powder Mill Gulch obey the signage and stay away from the creek and TCE contaminated groundwater seeps, prior to attainment of groundwater and surface water cleanup levels.

A.2 Comply with cleanup standards (see WAC 173-340-700 through 173-340-760):
Conclusions: Alternatives 4 and 2a[41] comply with this threshold requirement.

A.3 Comply with applicable state and federal laws (see WAC 173-340-710):
Conclusions: Remedial alternatives 4 and 2a[41] comply with this threshold requirement.

A.4 Provide for compliance monitoring (see WAC 173-340-410 and 173-340-720 through 173-340-760):

Conclusions: Remedial alternatives 4 and 2a[41] meet Ecology requirements for compliance monitoring.

B. Other Requirements: When selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall also meet the following requirements:

B.1 Provide for a Reasonable Restoration Timeframe, WAC 173-340-360(2)(b)(ii) and (4)

To determine whether a cleanup action provides for a reasonable restoration time frame, the following factors must be considered:

Draft Uplands FS report Table 6-11. Boeing understands Ecology's statements, but does not agree. However, because Boeing does not agree with Ecology's statements does not mean that Ecology has not provided a defensible basis for its determination.
[41] As modified by Ecology per Attachment A, Section 1, Page 1.

(i) potential risks posed by the site to human health and the environment;
(ii) practicability of achieving a shorter restoration time frame;
(iii) current uses of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
(iv) potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
(v) availability of alternative water supplies;
(vi) likely effectiveness and reliability of institutional controls;
(vii) ability to control and monitor migration of hazardous substances from the site;
(viii) toxicity of the hazardous substances at the site; and
(ix) natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

Conclusions: Remedial alternatives 4 and 2a are based on different groundwater points of compliance. Alternative 4 requires a groundwater SPOC. Boeing estimates that remedial alternative 4 will require approximately 47 years to complete (range between 37 and 56 years). Ecology believes this is a reasonable timeframe given the magnitude and size of the TCE groundwater plume both on and off Boeing property. Alternative 2a uses a CPOC[42]. Alternative 2a is expected to require approximately 61 years to complete, given the similar EISB treatment, groundwater extraction requirements and monitoring requirements under alternative 2 (Source EISB only and groundwater cleanup levels[43] at an SPOC described in the Landau technical memo dated November 2, 2016). Alternative 2a proposes only to implement enhanced bioremediation in the source area and thus relies on less certain dispersion and dilution mechanisms (versus destructive technologies) in TCE groundwater plume downgradient and off-Boeing properties. Thus, Ecology believes this results in more uncertainty in the restoration timeframe and slower reductions in TCE groundwater concentrations for alternative 2a compared to alternative 4.

There is value in hastening groundwater cleanup (reducing restoration timeframe). The Esperance Sand Aquifer is a potential drinking water source, and faster attainment of groundwater and surface water cleanup levels means that unrestricted access to the off Boeing property creek and creek banks can be realized sooner than later.[44] Furthermore, given the high toxicity and carcinogenicity of TCE, if it is technically practicable to achieve groundwater and surface water (creek) restoration timeframes shorter than what alternative 2a can achieve, this is what we should do [WAC 173-340-360(4)(b)(ii) and (viii)]. Enhanced biodegradation is a well-established technology for in-situ treatment of TCE contaminated groundwater and a more

[42] Meeting the WQ criteria (0.3 µg/L TCE) ONLY in groundwater in the transition zone prior to discharge into the creek AND meeting a remediation level of 4.0 µg/L TCE in the remaining body of contaminated groundwater.
[43] Groundwater cleanup levels based on the more stringent of the new water quality criteria (WQCs), MTCA Method B cleanup levels and other ARARs. For TCE, the WQCs are the most stringent ARAR for setting the groundwater cleanup level (0.3 µg/L).
[44] Groundwater seeps with elevated TCE contamination are present on some of the creek banks. The TCE concentrations in these seeps are consistent with elevated groundwater TCE concentrations that are higher than surface water TCE concentrations.

reliable remediation alternative for the downgradient and off-Boeing property plume, given the elevated contaminant concentrations, compared to dilution and dispersion.

B.2 Consider public concerns (see WAC 173-340-360(2)(b)(iii):

Conclusions: Compliance with this requirement is generally best measured after the draft Cleanup Action Plan (CAP) has been provided to the public for comment. Therefore, Ecology can only anticipate public sentiment during the formal FS public comment period, regarding the type of cleanup action that would be preferred, especially regarding groundwater SPOCs versus CPOCs.

As stated earlier in this letter, even if Ecology believed the MTCA requirements for a groundwater CPOC were met, the MTCA regulations for an off-property CPOC for property near, but not abutting, surface water require that all off-Boeing property owners (City of Everett, Panattoni, Bertch Properties) above the contaminated groundwater to agree in writing that a groundwater CPOC is acceptable [WAC 173-340-720(8)(d)(ii)]. Much of the site's groundwater and surface water TCE contamination above WQCs is located off Boeing property and it is unclear whether the three downgradient property owners and Boulevard Bluffs Neighborhood Coalition (BBNC) would agree to a conditional point of compliance as proposed by Boeing under alternative 2a, since this would lead to less aggressive groundwater cleanup and longer and more uncertain restoration timeframes, compared to a groundwater standard point of compliance under Ecology's preferred remedy alternative 4.

Ecology is also concerned that the three downgradient property owners and BBNC will view alternative 2a as implementing more aggressive groundwater treatment (enhanced bioremediation) on Boeing property ONLY, while essentially no action beyond continued implementation of the interim action groundwater extraction wells on the three downgradient properties.

As a result, Ecology would expect that the three downgradient property owners and BBNC would prefer alternative 4, the more aggressive EISB groundwater treatment in the source area, downgradient, and off-Boeing properties, resulting in a shorter restoration timeframe, less liability due to a shorter restoration timeframe, less uncertainty[45] in groundwater treatment intended to protect the creek (including groundwater seeps along the creek bank), and minimizing potential vapor intrusion threat for future buildings constructed over the TCE contaminated groundwater.

[45] The alternative 2a groundwater CPOC requires treatment and attainment of groundwater cleanup levels nearest the creek only. All remaining contaminated groundwater would have to meet a 4 µg/L TCE remediation level. However maintaining this localized zone of treated groundwater near the creek protective of surface water cleanup levels is expected to be difficult to maintain and confirm at all locations adjacent to the creek. Furthermore, alternative 2a relies on dilution and dispersion to remediate groundwater on off-Boeing properties. In addition, alternative 2a has similar uncertainties in meeting the surface water CUL at the surface water POC. The surface CUL would need to be met at all points where the hazardous substances are released to surface water (e.g., the seeps) – and this would apply all along the creek. There is no mixing zone for hazardous substances released as a result of groundwater flows.

B.3 Use permanent solutions to the maximum extent practicable WAC 173-340-360(2)(b)(i):

WAC 173-340-360(3) provides the regulations for 'determining whether a cleanup action uses permanent solutions to the maximum extent practicable.' Besides using permanent solutions to the maximum extent practicable, the preferred cleanup action **must**:

- Protect human health and the environment
- Comply with cleanup standards.
- Comply with ARARs
- Provide for compliance monitoring
- Provide for a reasonable restoration timeframe
- Consider public concerns
- Not primarily rely on ICs where it is technically possible to implement a more permanent cleanup action

As discussed above, the disproportionate cost analysis (DCA) is only applied to those cleanup alternatives capable of meeting the **minimum requirements for a cleanup action.** If these minimum requirements are not met, the "alternative" cannot be selected as the site's cleanup action. Alternative 1 does not meet threshold and other requirements under WAC 173-340-360(2)(a) and (b), therefore, cannot be selected as a final remedy and the DCA analysis does not include alternative 1.

To decide whether a cleanup action uses permanent solutions to the maximum extent practicable, a DCA is performed. This analysis requires ranking the alternatives from most to least permanent. If the incremental costs of an alternative over that of a less permanent, lower cost alternative exceed the incremental benefits, the added costs are "disproportionate." The preferred alternative, then, is the most permanent action whose costs are not disproportionate to cheaper, less permanent actions.

The objectives of WAC 173-340-360 are to essentially determine which alternatives are the most permanent, how much each alternative is likely to cost, and - through use of the DCA criteria - what benefits are associated with each alternative.

Ecology evaluated and weighed the DCA criteria, resulting in an overall conclusion that, alternative 4 is "permanent to the maximum extent practicable" [46] and as a result also indicates that is practicable to meet the cleanup level throughout the site within a reasonable restoration time frame. Below we explain how we arrived at our own conclusions per criterion.

Protectiveness (360(3)(f)(i)): This criterion is intended to compare each remedial alternative's *time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks*

[46] WAC 173-340-360(3)(e)(ii)(C) states that: *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action.*

resulting from implementing the alternative, and improvement of the overall environmental quality.

Ecology believes that remedial alternative 4 is more protective of human health and the environment than alternative 2a. More aggressive treatment of the source, downgradient and off-Boeing property TCE groundwater plume will result in less reliance on dilution and dispersion to reduce TCE and daughter product groundwater concentrations. As a result, less TCE groundwater is discharged to Powder Mill Creek[47] and results in faster reduction of off-Boeing property risk to walkers that (ignoring the signage to stay on the trail) encounter those contaminated groundwater seeps and creek surface water and results in a greater improvement of the overall environmental quality. There is more certainty that groundwater entering the creek meets the surface water cleanup levels in a shorter timeframe if the entire groundwater body were aggressively treated using EISB in order to meet cleanup levels at an SPOC[9].

Risks to human health and the environment are finite and probable in the future, but alternative 4 affords more aggressive treatment to more quickly reduce contaminant mass in more areas of contaminated groundwater. Therefore resulting in lower TCE groundwater seep concentrations on the creek bank and lower TCE surface water concentrations, in the interim before groundwater cleanup levels are met.

Under Ecology's ranking, alternative 4 is the most protective alternative and far exceeds alternative 2a *and results in a greater improvement of the overall environmental quality*

Permanence (360(3)(f)(ii)): This criterion is used to compare the degree each remedial alternative *permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*

Alternative 4 is a more permanent remedy than alternative 2a. Alternative 4 more permanently reduces toxicity of the contaminated groundwater (more EISB treatment and less reliance on dilution and dispersion) AND also more effectively reduces the amount of TCE contaminated groundwater from entering Powder Mill Creek. Use of a groundwater SPOC results in a more permanent remedy than a CPOC.

Alternative 4 can immediately target the higher contamination zones within the TCE groundwater plume downgradient and on off-Boeing property that are currently accessible, thus maximizing the total mass of aquifer contamination permanently destroyed. This results in faster reductions in TCE contaminated groundwater concentrations downgradient and off-Boeing property versus alternative 2a.

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[47] Ecology notes that the interim action groundwater extraction wells do not eliminate but only reduce the amount of TCE groundwater discharging to Powder Mill Creek. Many groundwater bank seeps and surface water samples still contain TCE significantly above the surface water cleanup levels (0.3 µg/L).

Under Ecology's ranking, alternative 4 is the most permanent remedial option and far exceeds alternative 2a.

Cost (360(3)(f)(iii)):
Remedial alternative 4[48] and 2a cost estimates are approximately $24.7 million and $17 million[49], respectively. The cost estimates for alternatives 2a and 4 are based on the Landau technical memorandum dated November 2, 2016.

The Boeing preferred alternative 2a cost is expected to be the same as alternative 2 in the Landau technical memorandum, dated November 2, 2016. Alternative 2 and 2a both include source area only EISB, concurrent groundwater extraction, monitoring, institutional controls and O&M. Both alternatives rely only on dispersion and dilution to remediate downgradient and off-Boeing property groundwater contamination. Alternative 2 assumes a groundwater standard point of compliance and alternative 2a assumes a groundwater conditional point of compliance. However, Ecology has already noted under alternative 2a[41], the groundwater extraction wells near the creek will need to stay operational in order to assure groundwater near and discharging to the creek will meet surface water cleanup levels, which is identical to the requirement for groundwater extraction well operation under alternative 2. With either alternative, the groundwater plume contaminant concentrations will need to meet the surface water cleanup levels in most source and downgradient areas before groundwater extraction wells are shut off[50].

Furthermore, Boeing indicates its cost estimates are only accurate to within a range of -30% to +50% uncertainty. This uncertainty range alone results in the total costs for remedial alternatives 4 and 2a being essentially equivalent.

Long-term effectiveness (360(3)(f)(iv)) This criterion is used to compare the long-term effectiveness of each remedial alternative. *Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.*

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[48] In addition, the cost of additional groundwater monitoring (beyond what may be expected under alternative 2a) near the end of the 46 year restoration timeframe for alternative 4 is heavily discounted in the net present value cost estimate.

[49] The cost estimate for alternative 2a does not include the possible added expenses for reimbursing off property owners for damages, longer restoration timeframes than the Ecology preferred remedy and agreement to allow a groundwater conditional point of compliance (versus a groundwater standard point of compliance).

[50] Based on the current contaminant distribution in the groundwater, Ecology doesn't believe that there will be any reason to expect a significant decreasing TCE concentration gradient near the creek based on operation of the groundwater extraction wells alone such that –for example - TCE groundwater concentrations 10 feet from the creek decrease significantly to below 0.3 µg/L TCE (WQC) before entering the creek.

Ecology evaluates the relative degree of long-term effectiveness using more EISB groundwater treatment at downgradient and off-Boeing properties (alternative 4) to permanently degrade and destroy TCE and daughter products higher than relying on dilution, dispersion and discharge (alternative 2) to the creek[47]. Under Ecology's ranking, alternative 4 is the most permanent remedial option and far exceeds alternative 2a.

Consideration of public concerns (360(3)(f)(vii))
Refer to Section B.2.

Implementability (360(3)(f)(vi)) This criterion is used to compare the degree each remedial alternative is able to be *implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*

Alternative 4 and alternative 2a are both technically and administratively implementable by this above definition. Enhanced bioremediation is a well-established groundwater treatment technology. Boeing would state that less EISB groundwater injections under alternative 2a would of course be easier to implement than more injections. Based on site groundwater data (post enhanced bioremediation interim action), Ecology does not see significant technical or administrative hurdles to implementing either alternative, given engineering design modification proposed by Boeing[51], if necessary, to mitigate some of Boeing's concerns such as fouling and metals precipitation.

Ecology reiterates its belief that the additional engineering design features such as those included in the Landau November 2, 2016 technical memo can be implemented and are reasonable design modifications (TOC + metals groundwater pre-treatment facility and associated O&M, GET system replacement, biofouling equipment maintenance/replacement, and GW sampling for EISB parameters) and are reasonable costs to incur in order to implement Ecology's preferred alternative 4.

Management of short-term risks (360(3)(f)(v))
This criterion is used to compare the degree each remedial alternative presents *risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*

As noted above for Implementability, the purpose of the "management of short-term risks" consideration is not to simply favor alternatives that propose to *do less* over those cleanup options proposing to *do more*. It is important, therefore, to fairly credit more aggressive alternatives when they can be designed to effectively manage those potential risks associated with their construction and implementation. Ecology believes alternatives 4 and 2a can be

[51] Landau technical memorandum dated November 2, 2016

designed so that the risk of danger to the public, environment and site workers is minimal. The Uplands FS report (page 8-25) appears to concur: *These risks can typically be managed effectively through careful design and implementation, however the risks are present.*

In our view, then, the construction and implementation of alternatives 4 and 2a can be designed to effectively manage these risks.

C. Ecology Selection of Preferred Remedial Alternative: EPM K Powder Mill Gulch (PMG)

Ecology has determined that **alternative 4** is permanent to the maximum extent practicable. Alternative 2a[41] falls short in most of the DCA categories when compared to alternative 4. The cost estimates of both alternatives are approximately equal (within-30%/+50% uncertainties in these types of high level estimates). Our reasons for this determination are summarized below:

Conclusions:

The MTCA regulations require the feasibility study to include at least one permanent cleanup action alternative to serve as a baseline against which other alternatives shall be evaluated for the purpose of determining whether the cleanup action selected is permanent to the maximum extent practicable. Remedial alternative 4 is the baseline remedial alternative because it is the most permanent remedy.

The MTCA regulations also require that remedial alternatives which **meet threshold and other minimum requirements** be ranked from most to least permanent and evaluated by the DCA process[46]. Ecology ranks the alternatives from most permanent to least permanent in the following order: alternative 4, (alternative 2[52]), then alternative 2a.

As stated above, Ecology considers alternatives 4, (2,) and 2a[41] to meet threshold and other minimum requirements. However, in our opinion, alternative 4 scores much higher than alternative 2a in the categories of protectiveness, permanence, long-term effectiveness, and public acceptability. And the approximately $7 million dollar difference between alternatives 4 and 2a is not cost disproportionate given the benefits of much greater protectiveness, permanence, long-term effectiveness, and public acceptability with alternative 4. Ecology believes that Alternative 4 can be implemented with engineering design considerations to minimize short-term risks. Based on the groundwater data immediately downgradient from the TCE groundwater EISB interim action area, engineering design modifications can be made to reduce the potential for fouling the groundwater extraction wells and treatment system, Ecology believes that alternative 4 is *technically possible* to implement with minimal negative impact to the GET system.

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[52] Following the same DCA analysis, Ecology would arrive at the conclusion that alternative 2 (as stated in the Landau technical memorandum dated November 2, 2016 using a groundwater SPOC, same groundwater CULs as alternative 4, but only source area EISB injections) is more permanent than alternative 2a but less permanent than alternative 4.

If EISB injections on downgradient and off-Boeing property were reduced, revised, (or eliminated) based on the phase 1 (pilot) EISB injection results, the DCA would still favor this modified alternative 4 (where groundwater cleanup levels[4] are still met at the groundwater SPOC) for the same reasons alternative 4 is favored over alternative 2a.

Furthermore, Alternative 2a has an over-reliance on institutional controls, when more groundwater EISB treatment can be performed downgradient and off-Boeing property. Ecology is confident that institutional controls can be effective when applied at property owned and/or under the control of Boeing. We are less confident about their effectiveness/enforceability when employed on non-Boeing owned property. Even though the City of Everett has placed several signs[53] in the area to stay on the walking trails and away from the creek and creek banks (containing TCE groundwater seeps) during the current creek and groundwater remediation, those institutional controls alone are not sufficient cleanup actions under MTCA.

[53] At Ecology's request, the City of Everett placed signs on Lot #9 property in 2009 to stay out of the creek during the interim TCE groundwater cleanup action.