APPENDIX M

Peer Review Comments and Responses

Jacques Whitford

Consolidated Peer Review Report

Report No 1009956. Environmental Site Assessment of CFB Gagetown, NB: Task 2B - Stage 3, Field Program

Ad Hoc Peer Review Panel,

May 1, 2006

Consolidated Peer Review Report: Organization and Format

Statement of Peer Review Process

Three ad hoc reviewers were consulted by DND to perform a peer review of the Jacques Whitford interim report for the *Environmental Site Assessment* of *CFB Gagetown from 1952 to Present: Task 2B* (ESA). All reviewers agreed to and signed the Conflict of Interest and Non-Disclosure Agreements Prepared by DND for the purpose of the peer review.

As per peer review terms of reference supplied by DND (See Appendix 1), each reviewer conducted an independent review of the ESA report over the period between April 10 – 24, 2006. Individual peer review documents were circulated between the peer reviewers after this time. On April 24, 2006, the three peer reviewers consulted with one another by conference call to discuss major findings, agree on the acceptance status of the ESA report and to discuss major recommendations to be included as part of a consolidated peer report. This document was generated largely from the outcome of the above teleconference and by incorporation of specific statements highlighted and provided by each of the peer reviewers. The ad hoc peer review panel (subsequently referred to as 'PRP' or 'Peer reviewers') were in agreement with all comments and recommendations included within the consolidated report.

Organization of Peer Review report

The consolidated peer review report is organized into the following sections:

Section 1: Overall Assessment.

This section summarizes the overall recommendation reached by the PRP. The section also outlines the suggested modifications which need to be addressed by the consultant prior to acceptance of the interim report.

Section 2: Peer review comments pertaining to peer review criteria outlined by DND terms of reference for the peer review process.

This section summarizes general statements generated by the PRP as well as specific comments highlighted by individual reviewers as they relate to each of the peer review criteria questions presented by the DND terms of reference for peer review (see Appendix 1 for terms of reference). General statements were developed by consensus from the PRP. They were intended to highlight major findings by the PRP as it pertained to each criteria question. Numbered specific statements were generated either by the PRP or included as approved statements taken from independent peer review reports. Each of the specific statements included in the consolidated report were reviewed and agreed upon by the PRP.

Section 3. Peer review comments organized by Task 2B Project Objectives as outlined by the DND SOW for Consultant Services, Aug 16, 2005

This section summarizes specific comments generated by the PRP and by individual peer reviewers organized according to the project objectives as outlined by the DND SOW for Consultant Services, Aug 16, 2005.

Section 4. Declarative Statements

Declarative statements by each of the peer reviewers are provided indicating that they have contributed to, reviewed and agree in principle with the consensus statements outlined in the consolidated peer review report. Peer reviewers may at their discretion attach additional comments to be appended with the consolidated peer review report at the time of its submission. These additional attachments will be identified as independent ad-hoc peer review contributed comments.

Appendix 1.

Peer Review Process: Environmental Site Assessment of CFB Gagetown, N.B.: Task 2B. April 5, 2006.

Section 1. Overall Assessment of ESA Report:

1.0 PRP Decision: Acceptable with major revision

The PRP has decided that the ESA report should be regarded as acceptable with major revision. All reviewers were generally impressed with the strategic approach of the field sampling program in terms of the identification of herbicide mixtures used within the RTA, delineation of areas of herbicide use, prioritization of chemicals of concern, prioritization of areas within the RTA for sampling and establishing a spatial sampling design for surface soil, surface water, groundwater, sediments and vegetation to determine the horizontal extent of surface contamination. Portions of the report that the PRP felt required further revision are documented below.

1.1 Need for Inclusion of Analytical Standard Operating Procedures for PCDD/Fs and other Detected Herbicide/Herbicide contaminants.

The analytical standard operating procedures (SOPs) need to be included within the report for all analytes which had concentrations above analytical detection limits. The panel felt that they were unable to fully review the report because of missing information that would be contained in analytical SOPs. Missing information included sample volumes (surface water and ground water) and sample mass (soil & sediment) collected by the field sampling program that was not identified in the field sampling protocols. Other aspects necessary to critically evaluate the quality assurance/quality control (QA/QC) parameters summarized in Appendix H were not available. For example, the acceptable ranges of % recoveries of surrogate standard spikes added to blanks, SRMs and samples were not described. The acceptable variation associated with field duplicates was not described. The later parameters would be contained within analytical SOPs and would permit independent evaluation of the QA/QC data presented in Appendix H. The peer reviewers concede that laboratory certificate tables supplied on CD-ROM with the report identify EPA method 1613B for PCDD/F analysis, however, this published method allows for multiple extraction and clean-up strategies and does not address all the questions described above.

Another missing component was that the method of blank correction of samples was not described. The method and rationale for replacing non-detected data for PCDD/F with method detection limits was also not described. A specific statement should be included in the report to whether or not the analytical methods used to characterize PCDD/F congeners would have been capable of identifying PCDD/F congeners other than the 17 reported in the analytical tables (specifically the PCDDs likely to be contaminants in formulations containing 2,4-D) and whether or not non-quantified PCDD/Fs would likely be present as trace contaminants in herbicide formulations.

1.2 The report failed to address all likely sources of PCDD/Fs within the RTA and to explain the predominance of OCDD found within the majority of soil samples.

The panel felt that the report did not fully address the identification of PCDD sources within the RTA. The reviewers suggested that a site outside of the RTA, but within the general geographic

region, should have been included in the sampling design as a background/reference location to distinguish long-range transport sources of PCDD/Fs from sources originating within the RTA.

The reviewers were dissatisfied with the sparse report interpretation regarding the high contribution of octachlorodibenzo-*p*-dioxin (OCDD) to the total PCDD/F composition of soil samples from within the RTA. The strategic approach assumed that 2,3,7,8-TCDD represented the major PCDD/F impurity within Agent Orange and other herbicide formulations and that the enrichment of this congener within Category 1 and 2 APECs would have identified herbicide application as the main source of PCDD/F and could be appropriately measured as TEQ's for these areas. The results did not support this assumption and it was consistently observed that OCDD contributed the greatest amount of total PCDD/Fs on a mass concentration basis (although not on a TEQ basis) in surface soil samples throughout the RTA. The report provided some discussion to indicate that preferential microbial degradation of 2,3,7,8-TCDD relative to more chlorinated PCDD/F congeners could have led to the observed PCDD/F congener profiles. The review panel felt that there were multiple alternate hypotheses that could explain the high OCDD enrichment, including other environmental degradation mechanisms, differences in environmental mobility among the PCDD/F congeners, or atmospheric transport of different PCDD/F congeners both from inside the RTA (e.g. fires, combustion sources, spills etc.) and from outside regional sources (e.g. solid waste incinerators, metal smelters and other major regional PCDD/F sources).

The panel felt that evidence (literature or direct laboratory analysis of herbicide formulations) should be included in the report to verify that OCDD and other identified PCDD/F congeners were indeed present within Agent Orange and/or herbicide formulations (such as 2,4-D, 2,4,5-T and other herbicides such as pentachlorophenol) used within the RTA. The panel also agreed that data on concentrations, congener profiles of PCDD/Fs and TEQs be incorporated (even from literature review data) from other sites in the geographic region located outside of the RTA to better interpret whether or not the elevated TEQs and PCDD/F profiles measured in APECs 2 and 3 reflect exceptional conditions in the geographic region. The reviewers suggest that in addition to herbicide application use patterns, the consultants should also consider compiling data on fires and controlled burns within the RTA since PCDD/Fs could be produced as a consequence of organic matter combustion. Finally, it was felt that a concurrent analysis of sum PCDD/F concentrations between the APECs using appropriate statistical tests in addition to the interpretation of PCDD/F TEQs would provide valuable additional information about possible sources that are masked by the TEQ calculation.

1.3 Failure of the field sampling design to account for vertical migration of PCDD/F in soils.

The panel had problems with the strategic approach in terms of whether the soil sampling design would have captured vertical migration of PCDD/Fs in soils and allowed robust estimates of total PCDD/F deposition on the soils. Although soil core samples were taken, the depth of soil cores was shallow (only 20 cm) and no data were presented on PCDD/F levels in soil cores. Other literature data (see Bruzy and Hites. 1995. Environmental Science and Technology, 29:2090-2098) indicate that vertical migration of PCDD/Fs varies widely among different sites depending on soil sorption properties for PCDD/F as defined by the soil organic matter content and

depending on the total PCDD/F deposition at the site. The latter studies demonstrated that in some cases maximum PCDD/F distribution in soils occurred at depths between 40-50 cm and elevated PCDD/F concentrations occurred as low as 90 cm. While it is recognized that a major component of the field sampling program was to establish human exposure risk to herbicide and herbicide contaminants in surface soils, the failure to sample soils below a depth of 20 cm (cores) places limitations on the use of the field sampling program results to evaluate soil remediation strategies and on estimating the total PCDD/F or herbicide mass present in the site soils. There is also a risk that the location within the RTA containing the highest PCDD/F mass was not identified because of the focus on 0-10 cm surface soil sampling. The panel recommends that the Recommendations Section of the interim report be modified to include long-core sampling and analysis at selected sites (areas both enriched with PCDD/Fs, some of the category 2 APECs suspected of receiving PCDD/F inputs through herbicide applications and in background reference areas).

The failure to analyze soil and sediment samples for soil organic matter content was an error in the strategic approach. Determination of soil organic matter content would have provided information about the potential for PCDD/F mobility within soils. Expressing PCDD/F concentrations on an organic carbon normalized basis could have provided additional interpretive value regarding the varying PCDD/F levels noted as well as PCDD/F bioavailability to soil invertebrates.

1.4 Problems with data reporting, summary statistics and statistical tests

There were several problems identified with data reporting, summary statistics and statistical tests. With respect to data reporting, particularly for PCDD/Fs, data presented in the analytical results appendix G contained several errors in the units of measurements as well as notable differences in values from data reported in the electronic database. A large area of confusion in this respect had to do with the fact that method detection limits (MDLs) appear to have been substituted for non-detected data for some of the PCDD/Fs. This type of data handling did not appear to be used for other herbicides reported in appendix G. MDLs for PCDD/Fs are also variable across sample batches adding to the confusion on what constituted the substituted values. There was no description of how the consultants handled non-detected data for PCDD/Fs, nor how they performed blank corrections to censor the data included in the electronic database. It was apparent that at least some of the TEQs calculated contained manufactured data (i.e. MDLs substituted for non-detected values) yet these data were not explicitly identified within the report. It is recommended that all data reported in Appendix G that contain MDL substituted values as well as summary statistics (e.g. raw sample TEQs and mean APEC TEQs) that contain manufactured data should be indicated by using a subscript, bold text or italics text in the report. The panel also found errors in the presentation of basic summary statistics such as the arithmetic mean. In this case, the consultants appear to be including both duplicate analytical results as independent sample values for calculating mean and standard deviation TEQs among composite samples from each APEC. This error needs to be corrected. It was also observed that the post-hoc comparisons performed with the analysis of variance was completed in an incorrect manner. This over-inflated the power of their post-hoc comparisons by subdividing contrasts between different APEC subsets. This is inappropriate because the same background samples are contained within each of the subset tests invalidating the Bonferoni correction applied to t-test

contrasts. The consultants should re-perform the statistical tests using appropriate statistical procedures such as Dunnett's Test which is a multiple comparison test specifically designed to compare treatment groups against a single control (background APECs).

1.5 Additional information that would have helped with the interpretation of the report.

The panel felt that additional information on priority chemical physicochemical properties including volatility, Henry's Law constants, soil mobility and half lives in water would have been helpful for inclusion in Table 2-2. The reviewers also felt that a table contrasting environmental quality guidelines with analytical method detection limits for the majority of herbicides not detected but analyzed for would have been helpful in Appendix G.

1.6 Unclear goals for project with respect to environmental site assessment and environmental impact assessment.

The reviewers were not clear regarding the priority placed between overall project goals relating to an environmental site assessment (ESA) relative to those associated with an environmental impact assessment (EIA) given that components of both types of assessments were included within the DND statement of work. The panel agreed that the draft interim report, accepting the above criticisms, provided for a very strong ESA but would not fully satisfy the requirements of an EIA. A comparison of analytical concentrations with environmental quality guidelines is an important step, but it is a small component of a full EIA. Qualifying statements in the recommendation section of the report should be made to indicate that additional measures of receptor toxicity beyond the hazard assessment approach taken would be required in the ecological and human risk assessment to be implemented at a later date.

Section 2. Peer review comments pertaining to peer review criteria outlined by DND terms of reference

DND Review Criteria questions supplied in the peer review terms of reference are presented in **bold** text. Summary statements and general recommendations generated by the Peer Review Panel pertaining to the DND review criteria questions are designated according to the numbering system: 2.1.x... The summary statements and general recommendations were intended to highlight major findings and comments developed by the PRP under each criteria question sub-heading. Specific review comments are also included (numbered 2.1.1.x) to provide more detail about reviewer findings. The specific comments included in the consolidated report were generated either by the PRP or as comments taken from individual peer review. All specific comments included in the consolidated report were reviewed by the PRP.

2.1 Is the selected team of specialists that contributed and produced the report appropriate?

2.1.1 It was generally agreed by the PRP that the team of specialists employed by Jacques Whitford was appropriate to the goals and objectives of the project.

2.2 Is the material in the report presented in a clear, logical and concise manner? Is the report complete? Please explain fully.

2.2.1 It was generally agreed that the report was presented in a clear, logical and concise manner. The rational for selection of priority chemicals, priority sampling areas and sampling design was well laid out. The data presentation using GIS-maps was very helpful, although in some cases (as identified below) the colour schemes used should have been more discriminatory. Missing components identified included: lack of analytical standard operating procedures and other details pertaining to data manipulation post analysis and a lack of description of herbicide use within the RTA after 2004. Sampling recently treated areas could have confirmed the presence of residues of the herbicides applied that year and would have facilitated estimates of their half-lives in soil at that site.

2.2.1.1 Once the reviewer/reader gets used to the countless acronyms and abbreviations (the alphabetical list was invaluable), the report is very clear, concise and easy to read. It is very well organized. Despite the complexity and numbers of tables, maps and other appendixes, items are fairly easy to locate.

2.2.1.2 One suggestion for the herbicide use maps is to choose a collection of colours that are more contrasting. For example, Roundup and Tordon are very different herbicides but their colours on the map were nearly indistinguishable.

2.2.1.3 Most of the objectives were met very well. A couple of exceptions are listed below. Although clearance of UXO is mentioned in the SOW, there is little discussion of this in the report. Perhaps, it should be removed from the SOW. In the SOW, there is mention (three times) that herbicides have been used at CFB Gagetown from 1952 and are still

being used today. In the report, there is no mention of herbicide use at CFB Gagetown since 2004.

2.2.1.4 The report is clearly and concisely written. The report presents clear explanations of the (i) focus of the ESA, (ii) the rationale for the approach taken in the investigation, (iii) extent of sampling and analysis of the soil, water and sediments, and (iv) the results obtained from the analysis of various samples, and (v) interpretation of the analytical results.

2.1.1.5 The report is generally complete, although more information is required for the analytical procedures used. There is very little information on the analytical procedures followed by the different laboratories. Although analyses were performed by the certified labs, some details on the protocols for analyses and/or standard methods used should be outlined.

2.1.1.6 The investigation provides an initial environmental assessment of the site, and it is clear from the results that additional sampling and characterization of some areas of the site is required.

2.1.1.7 The report is clear and well organized. There is a good description of the delineation of sampling areas, number of samples taken and selection of sampling sites within each delineated sampling zone (APECs). Table 4-1 was extremely useful as a summary of sampling efforts. The large number of GIS-maps supplied with the report documenting sampling areas and analytical results were helpful for data visualization.

2.1.1.8. The report did not include Analytical SOP's for critical parameters such as PCDD/Fs. Having went through the laboratory certificates CD, EPA Method 1613B was identified as being utilized for PCDD/F analysis. However, 1613B has some generalities associated with it (i.e. specifies different possible extraction protocols for water and different possible clean-up strategies for all matrices). Given that two different laboratories were used for PCDD/F, it would be useful to have analytical SOPs printed and included in an appendix. This information is also necessary to fully evaluate the QA/QC since trigger criteria used in the evaluation of analytical integrity of data are contained within the analytical SOPs. For example, while the text describes QA/QC evaluation of SRM's (i.e. use of control plots and Westgard rules), it does not describe minimum and maximum acceptable ranges for % recoveries nor does it describe maximum acceptable analyte concentrations in blanks. Analytical SOPs for other detected parameters e.g. polychlorinated benzenes would also be useful. Analytical SOPs for non-detected analytes should be provided in Adobe Acrobat – PDF file format on CD-ROM.

2.1.1.9 Some of the sampling procedures were not evident. Despite a lot of digging in ancillary supplied material, the volume of surface water or ground water sample taken from sampling sites could not be located. This information needs to be included within the sampling SOPs. The current SOP merely indicates that the field operator fills up a supplied chemically cleaned bottle with sample but not how much sample was actually taken.

2.3 In your opinion, does the Strategic Approach rationalize and validate the field investigation program in order to meet the overall objectives of the Environmental Site Assessment? Please explain fully.

2.3.1 The reviewers were generally impressed with the Strategic Approach that involved 1) establishment of priority chemicals of concern, 2) establishment of areas of potential environmental concern and 3) development and implementation of a geostatistical sampling design within defined sampling areas of the RTA. The panel agreed that additional sampling in reference areas outside of the RTA would have benefited the project further to help identify regional sources as contributors to PCDD/Fs within the RTA.

2.3.1.1 The Strategic Approach employed in the investigation involved development of a categorization system that delineated the site into different areas generally depending on areas of public concern, areas where the most potentially toxic contamination was expected, areas where human exposure potential was greatest, ecologically significant areas and background areas. Several Areas of Potential Concern were thus identified at the site for sampling and investigation. This approach provided a rationale for varying sampling intensity in different areas of the site, and thus targeting likely problem areas without intensive sampling of the entire, rather large site. Furthermore, the active ingredients and potentially toxic impurities of herbicide formulations applied to the site between 1952 and 2004 were identified and categorized in the context of their toxicological and physico-chemical properties that contribute to their persistence. This allowed for targeted analyses of chemicals of concern at the potential areas of concern. In the opinion of the Peer Review Panel, the Strategic Approach was appropriate for meeting the objectives of ESA as stated in the DND SOW.

2.3.1.2 The Strategic Approach provides a compromise in the ability to establish chemical contamination throughout the entire CFB Gagetown complex in order to better delineate areas of likely maximum contamination that would be of greater use towards developing ecological and human health risk assessments. The different APECs involve a wide range of spatial sizes and sampling densities that do not lend themselves towards spatial interpolation throughout non-sampled areas. The consultants seem to be aware of this limitation and restrict their data interpretation to the APECs themselves. The inclusion of APECs ‘representative’ of different land use patterns and herbicide application intensities partially overcomes the above issue however, and will allow weight of evidence approaches to be implemented for deducing likely contamination in the non-sampled regions of CFB Gagetown. The sampling protocol involving analysis of composites allowed characterization of average soil contamination in each APEC. This approach provided the ability to statistically contrast soil contamination in APECs which, in conjunction with herbicide application histories, could be used to deduce plausible contaminant sources. A very positive aspect of the Strategic Approach involved the ability to re-submit discrete samples forming a given composite to provide enhanced information on spatial trends of contamination within an APEC. This was a very efficient and effective way of identifying areas of maximum contamination and risk.

2.4 Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate? Please explain fully

2.4.1 There was general agreement that the consultant's interpretation of TEQs with respect to environmental quality guidelines was very thorough and appropriately completed. There were a number of concerns raised about data reporting (i.e. identifying samples where non-detected values were substituted for method detection limits), problems with the calculation of summary statistics (i.e. including duplicates as independent samples in arithmetic means) and post-hoc comparisons of ANOVA results that should be addressed. These concerns are elaborated fully in suggested modifications (point 1.4) and in the comments below.

2.4.1.1 There are a number of problems associated with data summary statistics and statistical tests used for data presentation. First, it only became apparent on close scrutiny of the data that some of the total TEQ values calculated for PCDD/Fs included MDLs in their estimation. While it is sometimes considered standard practice to substitute MDL's for non-detected data as a conservative approach to risk assessment, data that incorporate MDL's should be clearly marked and identified at all levels of data presentation. For example, mean APEC total TEQ values could include multiple MDL substitutions for different congeners among multiple composite samples. It is suggested that Table 8-5 of the report include two values for the mean APEC TEQs. One calculated as currently reported, by substituting non-detected values with the MDL and a second by substituting a value of zero for non-detected values. This would at least allow readers to gage the contribution of manufactured data to the total PCDD/F TEQ estimate

2.4.1.2 Having re-calculated some data (e.g. Swan Creek Lake Watershed sediment TEQs) from the electronic database, it became apparent that the report included both duplicate samples in the calculation of the arithmetic mean and standard deviation. In other words, for 6 samples + 1 duplicate, the consultants appeared to calculate mean TEQ values as the arithmatic mean of 7 concentration values. This is inappropriate because it provides an extra weight towards the duplicate sample and also provides the wrong standard deviation. The authors should re-calculate mean and standard deviations of total TEQs in the report. For duplicate samples, the average of the two analytical estimates should be used as a single concentration value during the estimation of the arithmetic mean and standard deviation.

2.4.1.3 The statistical distribution of the soil PCDD/F data was shown to be log-normal. This is also apparent from the high degree of heterogeneity of soil PCDD/F concentrations within most APECs. The consultants should include geometric mean data for each APEC in Table 8-5 in order to provide a comparable data with the ANOVA figures. As it stands, the rank order of total TEQs among the site differs between Figures 8-3, 8-4, 8-5 and Table 8-5.

2.4.1.4 One suggestion is that the consultants perform outlier tests to distinguish exceptional high samples for the discrete samples that were analyzed from a given composite. This would help establish if elevated mean TEQ values are driven by a single soil sample as appears to be the case in most APECs where discrete samples were analyzed.

2.4.1.5 The statistical test (ANOVA) followed by post-hoc comparisons (Bonferoni-corrected t-tests) artificially inflates the power of the test because the consultants subdivided comparisons into smaller numbers of groups (k). For example, post-hoc comparisons are made between geometric mean TEQs between background, APEC 1, APEC 2 and APEC3 (Test #1, k=4 groups), then another set of post-hoc comparisons are made between background and APECs 10, 13, 14, 15, 16, 4, 7, 8, CLONES and MURPHY (Test #2; k = 11 groups) and a third set of post-hoc comparisons are made between Background and APECs 17, 18, 19, 20, 21, 22 (Test #3; k = 7 groups). Yet the total number of groups in the post-hoc comparison should always be k = 16, not k = 4 for test #1, k = 12 for test #2 and k = 7 for test #3. This is because the same background data is used in the three sets of tests, violating the independence of the separate comparisons. Having re-ran the ANOVA using all APECs + background and used Tukey's HSD (a more conservative multiple-comparison test), APECs 2 and 3 were shown to be no longer significantly different than background. The consultants should re-perform the ANOVA using appropriate statistical methodology. Dunnett's test is suggested as an alternate test as this multiple comparison test is designed to test multiple treatment groups against a control group.

2.4.1.6 The consultants tested for differences between mean TEQ values at MURPHY bivouac with background vales. This is problematic because the mean TEQ value for MURPHY is based on 6 discrete sample replicates while the background value is based on 6 composite replicates (i.e. incorporating 36 discrete samples). The two data sets are not directly comparable with one another, unless discrete background replicates are re-analyzed for comparison with discrete MURPHY replicates.

2.4.1.7 Multivariate tests – principal components analysis. It was not apparent if the PCA was performed using a correlation (or autoscaled) matrix or a varian-covariance matrix. The panel had a difficult time interpreting Figure 8-6. The consultants should present this figure as mean centroid scores for a given site and include error bars on both the x- and y-scales. The separation of samples sites within the PCA does not in itself provide any probabilistic assessment of differences in congener signatures as appears to be interpreted within the report. The consultants should perform a MANOVA on the PCA scores to test for significant differences between PCDD/F congener profiles among the APECs. Discriminate function analysis could then be applied (similar to post-hoc comparisons with the ANOVA) to characterize which APECs significantly differ with respect to contaminant signatures. The reviewers also had some concerns about the discriminatory power of their multivariate analysis because of the inclusion of so much manufactured data (i.e. MDL substituting censored data). Many sites will appear similar to one another with respect to chemical signatures simply because the same MDL data are being substituted in different sets of samples. Typically a set of rules are established up front,

e.g. any given chemical being detected less than 50-60% of the time among all samples included in the PCA are removed as a dependent variable.

2.4.1.8 Figure 8-7 is not particularly meaningful. The consultants should instead provide a table of the loadings of each PCDD/F congener on each different PCA axis. This is in essence providing data on the correlation coefficient of each congener with each component axis. Given the expected contribution of 2,3,7,8-TCDD to Agent Orange formulations, it is probably better to determine if this congener has a strong loading (i.e. >0.7) to any on of the PCA axis rather than OCDD.

2.5 Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable? Please explain fully

2.5.1 The consultant used appropriate strategies to set priorities for chemicals (COPC) and areas of potential environmental concern (APEC). A good plan for sampling of priority areas was carried out followed by analytical determination of priority chemicals in samples from accredited laboratories. The report was particularly strong in the interpretation of analytical results in the context of environmental quality guidelines. There were some problems noted in the statistical comparison of TEQs among APECs that need to be addressed to fully support the report conclusions.

2.5.1.1 A Strategic Approach was employed to develop a categorization system that delineated the site into different areas generally depending on areas of public concern, areas where the most potentially toxic contamination was expected, areas where human exposure potential was greatest, ecologically significant areas and background areas in the site. Furthermore, the active ingredients and potentially toxic impurities of herbicide formulations applied to the site between 1952 and 2004 were identified and categorized in the context of their toxicological and physico-chemical properties that contribute to their persistence. This allowed for targeted analyses of chemicals of concern at the potential areas of concern. Data from the sampling and analyses at the site was performed methodically and documented adequately. Data was compared to regulatory criteria. Concentrations of COPCs were also compared to background levels. Soil screening levels were identified and the need for further sampling and analysis was identified. Further information on analytical procedures would be desirable, as stated above. Overall, the planning, data acquisition, data assessment and data interpretation was technically acceptable.

2.5.1.2 There is agreement with the planning and data acquisition components of the report. However, a number of issues with respect to presentation of analytical data, summary statistics and statistical tests that could have small impacts on the interpretation of the data have been identified. For example, the conclusion that APEC 2 and APEC 3 exhibit significantly different mean PCDD/F TEQs than background areas appears not to be true owing to inappropriate statistical testing procedures. However, the conclusion that a number of composite and discrete PCDD/F TEQ values exceed environmental quality

guidelines in these areas, are not disputed. Overall, suggested modifications to data analysis should reinforce many of the conclusions in the report

2.6 Does the work conducted yield scientifically credible conclusions?

2.6.1 There is general agreement that a number of the conclusions generated by the report are scientifically credible. The review panel was in agreement with the rational for delineating priority chemicals, sampling areas and most aspects of the sampling design. Some of the report interpretations, such as changes in PCDD/F congener profiles over time related to microbial degradation provide credible hypotheses but require further research to substantiate. Conclusions regarding the identification of sources of PCDD/F to the RTA remain unsubstantiated at this time.

2.6.1.1 The major conclusions about the residues of COPCs detected and how they compared to background and environmental quality guidelines established by governments is scientifically credible. However, the main body of the report should include a table that compares the limits of detection (LODs) and limits of quantitation (LOQs) for the COPCs from the laboratories involved with the environmental quality guidelines established by various levels of government. This accommodation should not pose a problem but these comparisons seem needed to confirm the credibility of the work.

2.6.1.2 Some very interesting scientific hypotheses emerged from the study. One was the comparison of PCDD/F congeners at CFB Gagetown versus a site where Agent Orange was used in Viet Nam. The data suggested that the congener profiles were different. This would be interesting to follow further in a research context. However, it would be essential to know the analytical capabilities for the various dioxin congeners for the Viet Nam analyses vs the analyses in this report. Do the differences, if real, reflect different chemicals and contaminants applied in the two areas or differences in ability to detect the different PCDD/F congeners? Another hypothesis was that OCDDs degrade in soil more slowly than lesser chlorinated PCDDs and that over time, OCDDs might be the remaining PCDD residues that predominate. At this point, these two hypotheses are logical interpretations of the data to suggest. However, more actual research would be needed to test these hypotheses.

2.6.1.3 The work conducted provides a preliminary estimate of the extent and level of contamination by various COPCs investigated. The sampling and analyses have been performed in a generally credible manner and thus provide credible conclusions.

2.6.1.4 The consultants implemented an appropriate geostatistical sampling design, field sampling quality assurance protocols and appropriate laboratory quality assurance/quality control protocols. The overall assessment of presence/absence of priority herbicides and herbicide impurities within the RTA is based on scientifically sound risk assessment procedures. There are weaknesses in aspects of the data presentation (incorrect units, inconsistencies in data tables), summary statistics (i.e. incorporating duplicates as independent replicates in computing APEC mean TEQ values) and statistical tests (inappropriate post-hoc comparisons) that can be fixed within a final report. There are

some weaknesses in the sampling approach, such as the failure to sample a background site outside of the RTA to control for long-range transport sources and failure to determine soil organic carbon content to evaluate potential transport and fate of persistent hydrophobic contaminants such as PCDD/Fs within the RTA. The soil organic carbon content can easily and economically be performed on archived soil composite and sediment composite samples. The background data on priority chemicals in reference areas outside of the RTA could be added by literature review. These weaknesses do not necessarily invalidate the current findings, but should be addressed within the final report to reinforce interpretations especially with respect to PCDD/F sources in soils of the RTA.

2.7 In your opinion, what are the weakest and the strongest aspects of the Strategic Approach and the Environmental Site Assessment that were developed to address the field investigation programs and the interpretation of the results? Please make suggestions on how the weakest parts can be strengthened.

Strongest Aspects:

2.7.1 The strongest aspects of the report were the strategic plan and methods for setting priorities in terms of designating priority chemicals and sampling areas. All reviewers were impressed with sample compositing approach and the fact that consultants provided a follow-up analysis of discrete samples for areas having elevated contaminants of concern. All of the reviewers agreed that the extensive data presentation using Tables and GIS-maps and figures was very clear and helpful.

2.7.1.1 The strategic plans for the study and the methods for setting the priorities were excellent. It was evident that an experienced, competent team was in charge. The work was well organized and the reports were well prepared. The results were perhaps more brief than expected since residues of so few of the many COPCs were detected and only some PCDD/F residues in a few areas exceeded established environmental quality guidelines.

2.7.1.2 Adding a table that compares the laboratory LODs and LOQs for the COPCs with the maximum residues that meet established environmental quality guidelines will confirm the credibility of their data and their conclusions.

2.7.1.3 Clear presentation of approach for the study.

2.7.1.4 Clear documentation of areas sampled, no. of samples taken, compositing strategy, and presentation of concentrations in COPCs sampled.

2.7.1.5 The strongest aspects of this report involved the initial evaluation process to prioritize herbicides and herbicide impurities and delineate APEC areas based on herbicide application histories and land use patterns. The consultants did a superb job of establishing appropriate geostatistical sampling designs within the designated APEC sampling areas. The QA/QC procedures implemented, both with respect to field (i.e. use of field blanks/trip blanks) and analytical (blind submission of sample duplicates,

surrogate standard recoveries, laboratory blanks and SRMs) was well conceived. The consultants also did a very thorough job of summarizing analytical results using a wide variety of maps and tables to clearly document the locations and spatial relationships of sampling sites (both composite and discrete samples) that had priority contaminant concentrations in excess of environmental quality guidelines.

Weakest Aspects

2.7.2 The weakest aspects of the report involved missing information on analytical SOPs necessary to fully evaluate quality assurance/quality control parameters, aspects of the sampling strategies employed such as a failure to include reference sampling areas outside the RTA to characterize regional sources of chemicals of concern, sampling only 10 cm of top soil and failure to analyze for soil organic matter content. There were also errors in the statistical methods employed to deduce differences in TEQs between sampling areas. Suggestions for how the consultants can address these weaknesses are provided in individual review comments as well as in other reviewer criteria questions covered within the consolidated peer review report.

2.7.2.1 Rationale for sampling only the 10 cm of top soil and not any deeper, was missing.

2.7.2.2 Background concentrations of COPCs in the general region of CFB Gagetown were not determined.

2.7.2.3 The main weaknesses of the report were: 1) failure to include analytical SOPs making independent evaluation of QA/QC parameters difficult or impossible; 2) inconsistencies and direct errors in hard copy reports of analytical results included in appendices, 3) failure to identify both in raw data included in appendices and in summary statistics of total TEQ values when method detection limits were substituted for non-detected values; 4) errors in the calculation of summary statistics such as including duplicates as two independent values when generating mean and standard deviations; 5) incorrect statistical tests for post-hoc comparisons of total TEQs between APECs and 6) failure to analyze for critical soil parameters such as total organic carbon content. Most of these weaknesses, with the exception of 6, can be corrected by re-analyzing existing analytical results or including additional materials within the appendices of an updated report. Specific aspects of these weaknesses are documented more fully in comments below.

2.8 Are there any elements missing from the report which you think need to be included or which would strengthen the documents? Please explain fully

2.8.1 Analytical standard operating procedures were the most consistently identified missing item from the report by the PRP teleconference. It was felt that hard copies of laboratory specific SOPs should be included as an appendix for each of the detected priority chemicals of concern. The panel was also interested in determining if the PCDD/F analysis methods were capable of detecting additional PCDD/F congeners potentially present in herbicide mixtures but not part of the 17 priority 2,3,7,8-subsituted congeners included in the analytical results section.

2.8.1.1 In the history of herbicide use at CFB Gagetown, 2,4-D was used more than perhaps any other herbicide because it is often combined with either 2,4,5-T, fenoprop, dicamba, dichlorprop, or picloram. (It is suspected that "Sylvaprop" in Table 2.4.1, p 17, is 2,4-D + dichlorprop).The other herbicides have each had their major use period but 2,4-D is often included as the second herbicide in the formulation. The most likely dioxin contaminants in 2,4-D are dichlorodioxins, trichlorodioxins, or perhaps the 1,3,6,8-tetrachloro-dibenzo-p-dioxin, none of which are nearly as toxic as 2,3,7.8-TCDD. Table 8-3, page 122 should include the likely dioxin contaminants of 2,4-D. If the analytical methods should have "seen" the likely dioxins in 2,4-D, this should be clearly stated. If the analytical methods would not have seen these dioxins, this is a serious omission.

2.8.1.2 Missing Items: a) Analytical SOPs for PCDD/Fs and polychlorinated benzenes b) Tables added to Appendix H that document threshold criteria that would result in failure of QA/QC review; c) Identifying all data that contain manufactured results (i.e. substitution of MDLs for analytical values) within the report, including raw data presented in appendices, TEQ calculations and summary statistics e.g. mean TEQs within a given APEC;

2.8.2 The PRP felt that inclusion of PCDD/F soil concentration data from outside the RTA, but representative of regional background areas, would be of high value towards characterizing potential sources of PCDD/F in the RTA and also to establish if the relative exposure risk to dioxin-like toxicity was exceptionally high within the RTA. The latter could be addressed at present using literature data.

2.8.3 It is also suggested that some areas of the RTA receiving herbicide applications during 2004 and 2005 should have been sampled and analyzed. Comparison of analytical results in these areas would provide good confirmatory evidence for the lack of persistence of applied herbicides over a relatively short duration.

2.8.3.1 In the SOW, there is mention (three times) that herbicides have been used at CFB Gagetown from 1952 and are still being used today. In the report, there is no mention of herbicide use at CFB Gagetown since 2004. What happened during 2004 and 2005? Were herbicides used? Were these treated areas sampled and analyzed? Confirming residues of the actual herbicides as well as their contaminants in areas treated in 2005 would have provided nice "O time" data for comparison with the other results. It would also confirm the ability of the laboratories to detect the herbicides involved and would facilitate estimates of herbicide half-lives in soil at these sites.

2.8.4. Some components could have used further explanation. For example, the method of randomization of sampling sites within the wide-area sampling zones (page 36) was not fully described as it was in the targeted sampling areas. Details about the randomization – e.g. were each of the 6 sectors in a wide-area APEC subdivided into a grid with random selection of cells for sampling? Were there dispersion criteria i.e. samples could not be spaced less than 10 m etc. apart?

2.9 Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully

2.9.1 The reviewers were not aware of equivalent studies of this nature with the possible exception of the Vietnam PCDD/F soil enrichment/human risk assessment studies that are already cited as part of the report. The reviewers were confident that soil PCDD/F data sets do exist for the East Coast to provide some comparison with sum PCDD/F concentrations and PCDD/F contributed TEQs measured in soils at CFB Gagetown. The PRP suggests that a more thorough literature review be performed by the consultants to include such data within their report.

2.9.1.1 The team should have done a more thorough review of the literature and presented more material on the physical/chemical properties and characteristics of the chemicals present, especially on all or the COPCs. Information on expected half-lives in soil was a start. Information on volatility, soil mobility and half-lives in water was also needed to help interpret the results.

2.9.1.2 The prevalence of OCDD as the major PCDD contaminant detected was unexpected for the peer reviewers and wasn't listed as a high priority by the study team. It is a likely contaminant of pentachlorophenol but quite unlikely to be a contaminant of the other COPCs used at Gagetown. Pentachlorophenol was one of the herbicides detected at one site. Is there a recent use of this product to explain this? More literature review on the occurrence of OCDD as a contaminant and on its persistence is needed for the report.

2.9.1.3 Related literature that could be helpful

Bruzy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098.

Albrecht, I. D.; Barkovskii, A. L.; Adriaens, P.. Production and Dechlorination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Historically-Contaminated Estuarine Sediments. Environmental Science and Technology (1999), 33(5), 737-744.

2.9.1.4 The report is appropriately focussed on data generated as part of the field sampling program. The subsequent ecological and human risk assessment will involve greater emphasis on additional literature. However, the authors should have included literature review data within the report to document the range of PCDD/F congeners and TEQs within soil, water and sediments of other background areas in the province of New Brunswick. This would facilitate much better understanding of the relative risk presented by PCDD/Fs related to herbicide spray events. There is also a need to establish whether the Category 5 designated APECs are truly representative of background contamination, especially given that Category 5 APECs were not shown to have the lowest amount of chemical contamination .

2.10 Are the stated goals realistic? Are the stated objectives adequately met? Please explain fully

2.10.1 A large focus of the individual review comments were directed towards the degree to which the project fulfilled project objectives as specified by the DND statement of work (SOW) and are compiled in Section 3.0 of the consolidated peer review report. Notably, the reviewers agreed that most aspects of the DND SOW were fulfilled and that the project provided a good environmental site assessment, particularly for PCDD/F in soils. As detailed in suggested modifications, Point #1.6, not all aspects of an environmental impact assessment could have been realistically addressed within the time constraints of this study. The reviewers were impressed with the detailed comparison of soil PCDD/F contributed TEQs with existing environmental quality guidelines. Some shortcomings were noted with respect to the delineation of possible PCDD/F sources to soils in the RTA. Because the proximity of selected background sampling areas did not appear to be sufficiently isolated from category 1-2 APECs, it was felt that data from outside the RTA should have been secured to distinguish regional atmospheric deposition of PCDD/F as potential sources. There were also shortcomings related to the depth of the soil core samples (see Point # 3.3a.6 of Section 3).

Section 3. Peer review comments pertaining to DND SOW Consultant Services Task 2B Objectives

Specific peer review comments generated by the PRP were also organized according to project objectives as outlined by the DND SOW Consultant Services, Aug 16 2006 and are numbered below. The Task 2B Project Objectives in the SOW are supplied in **bold** text. Specific comments generated by the PRP are numbered accordingly in normal text.

3.1 The Consultant shall conduct the ESI as necessary to meet the following project objectives and requirements:

3.1a Development of a communication plan to address management and site activities.

3.1a.1 A communication plan was developed and described in the report.

3.1b Development of a health and safety plan for all field activities.

3.1b.1 A health and safety plan was developed and described in the report.

3.1c Conduct a field investigation program using a logical, structured, and cost effective approach. The information gathered will assist in developing a strong, factual, and defendable understanding of the extent and severity of present and predicted future environmental impacts in areas of suspected environmental concerns.

3.1c.1 The field investigative program was completed and described by the interim report. The reviewers were impressed with the geostatistical sampling design and quality assurance/quality control procedures implemented within designated sampling areas of the RTA. The information gathered from the field sampling program will be of high values towards future environmental impact studies that may be conducted within the RTA.

3.1d Collect and have analysed media that may consist of soil, sediment, ambient air, vegetation, groundwater, and surface water samples over a representative area using consistent sampling procedures and QA/QC program. The intent is to evaluate parameters applicable to this investigation, in comparison to background levels and in comparison to applicable guidelines.

3.1d.1 Samples of surface soils, soil cores (20 cm depth), surface water, sediment, vegetation and groundwater were collected using consistent sampling procedures, field blanks and field duplicates. Priority chemicals of concern were analyzed in the collected samples at various accredited laboratories which adopted additional quality control/quality assurance procedures to ensure the production of a robust data ect. All analytical data were interpreted to deduce spatial patterns of priority chemicals within designated sampling

areas of the RTA and to contrast residue levels with existing federal and provincial environmental quality guidelines.

3.1e Manage and coordinate analytical testing with an accredited laboratory.

3.1e.1 Samples were analyzed for identified priority chemicals of concern by accredited analytical laboratories.

3.1f Interpret all physical and chemical data compared to background data, applicable regulatory criteria, project objectives, and future operational use to determine the level of on-site and potential off-site environmental impacts. This information will be used to establish the extent and severity of potential environmental impacts.

3.1f.1 All chemical data were compared to applicable regulatory criteria to provide a screening level hazard assessment for potential on-site environmental impacts. Spatial contamination of detected priority chemicals of concern were compared with areas within the RTA designated as background/reference areas. Data on background concentrations of priority chemicals of concern outside of the RTA, but representative of the region, were not provided. Without the latter information it is somewhat difficult to place the severity of potential environmental impacts into proper context. However, the consultants have provided some interpretive statements as to the degree of severity, based on number of samples and magnitude of concentrations by which sample residues have exceeded existing environmental quality guidelines.

3.2 Background Levels: The identification of background levels representative of the area is vital to the determination and clear understanding of true environmental impacts associated with the use of herbicides in the RTA. Factors to consider (but not be limited to), in determining background levels include other potential sources of herbicides, metabolites or herbicides contaminants, and other types of activities or incidents which may have contributed to the presence of these substances;

3.2.1 Sampling of areas of the site where there were no records of herbicide application, and the biophysical environment was representative of the areas of concern at the site, were undertaken. The concentrations of target chemicals at the background areas were found to be low.

3.2.2 There is no data presented in the report on wind directions that would allow assessment if herbicides or herbicide contaminated surface soils could be transported to the background areas.

3.2.3 Some sampling should have been carried out in areas outside the RTA, and where herbicide application or other anthropogenic activities do not occur. These would have provided a better estimate of the background concentrations of the various target contaminants in the general region where the RTA is located.

3.2.4 The sampling strategy did not include the entire RTA in its coverage, but rather used a directed sampling approach among 22 pre-defined sampling zones (APECs) that varied in spatial dimensions but encompassed different exposure risks (i.e. herbicide application histories) and land use patterns. From Map 2-3, it would appear that roughly 30-40% of the total RTA area was sampled as part of the APEC coverage. The focussing of sampling effort within designated APECs appears to be well justified given limitations in sampling effort, analytical expenses and need to address both spatial coverage of contamination as well as to identify potential hot spots within the RTA that will later be useful to the ecological risk assessment. The large spatial coverage of Category 2 and 4 APECs should provide adequate representation of background herbicide levels within the RTA. Further extrapolation to non-sampled areas can be inferred by weight of evidence approaches and considering land use patterns in a manner similar to those used to designated different APEC categories.

3.2.5 The inclusion of three background reference APECs permitted comparison of detected herbicides and trace contaminant impurities between Category 1-4 APECs with assumed unimpacted areas within the RTA (Category 5 APECs). As in all cases involving selection of reference locations, the criteria for selecting category 5 APEC reference areas are somewhat subjective and the close proximity of some background areas (e.g. background area 1 to APEC 1, background area 2 to APEC 3 and Background area 3 to Murphy Bivouac) to hotspots suggest a potential for background areas to have become contaminated as a result of chemical dispersion over time. It would have been appropriate to include at least one additional background area outside of the RTA to ensure environmental dispersion within the RTA did not compromise the designation of Category 5 APECs as background reference areas. Interestingly, lower than background levels (non-detection of most herbicides) and low PCDD/F TEQ values were observed in some of the APECs (e.g. APEC #22). The consultants should provide additional literature review of PCDD/F concentrations and TEQ estimates in other New Brunswick areas deemed to be unimpacted to contrast with that of Category 5 designated APECs.

3.3 Field Investigation: The Consultant shall conduct a field investigation program that may take the form of test pits, boreholes, monitoring wells, and sampling to determine, as required:

3.3a The types, physical-chemical characteristics, concentrations, and volumes of the contaminants present. Determine the state in which they occur in the saturated and unsaturated zones (e.g. dissolved, immiscible, and/or vapour phases);

3.3a.1 The team should have done a more thorough review of the literature and presented more material on the physical/chemical properties and characteristics of the chemicals present, especially on all or the COPCs. Information on expected half-lives in soil was a start. Information on volatility, soil mobility and half-lives in water was also needed to help interpret the results.

3.3a.2 Some relevant physico-chemical properties of the target contaminants, namely, carcinogenic, biomagnification, bioaccumulation potentials, the octanol-water partitioning coefficient (as a measure of hydrophobicity), persistence and probable half-lives of the contaminants have been listed in Table 2-2, Page 19. Appropriate references should be provided for the data on Log Kow and half-lives of the COPCs shown in Table 2-2.

3.3a.3 The concentrations of the COPCs were determined in soil, sediment, plant, surface and groundwater samples. Generally PCDD/Fs were found in all soil, sediment, surface and groundwater samples and in 25% of the plant samples. Several samples had levels of PCDD/F at concentrations higher than that of the CCME criteria. OCDD was the most abundant congener in the majority of the soil samples and the maximum OCDD concentration encountered in a sample was 34,000 pg/g. Some of the other COPCs were detected only in a few samples and were always found to be below environmental quality criteria, if any were available for those compounds.

3.3a.4 The report does not contain any discussions on whether the COPCs present in soil were sorbed on soil, or present in dissolved or gas phases.

3.3a.5 The volume (or mass) of contaminants present in the site was not estimated in the report. Given that the number of samples obtained from each well-defined APEC was recorded, the mass of contaminants present in the surface soils can be estimated easily.

3.3a.6 It should be noted that the reporting of the PCDD/F concentrations in soil and sediment samples from the site in terms of the TEQ (toxic equivalent factor) does not provide a direct understanding of the mass of PCDD/F in the soil and sediment samples. PCDD/Fs are commonly found as complex mixtures of different congeners in environmental media. All congeners are not taken up by receptors in equal amounts and the toxicity of each congener may be different to a receptor. To derive a single value that is indicative of the overall toxicity for the mixture of congeners present in a sample, the concentrations of each congener is multiplied by a toxicity equivalent factor (TEF). This suggests that the toxicologically significant congeners are being weighted more than other congeners. Although this may be very appropriate in the context of risk assessment, use of TEQ may pose some disadvantages in understanding the true extent of PCDD/F distribution in soils and sediments, and its transport and fate after release from sources. If the estimation of contaminant masses at the site is an objective, studying the concentration of all tetra- through octa- homologues with equal importance is perhaps more helpful for understanding the extent of environmental contamination.

3.3a.6 The rationale for sampling the top 10 cm of soil is unclear. It may have been based on the Vietnam Study by Hatley Consultants. In effect the sampling procedure presented in the report assumes that 0-10 cm of the surface retains the majority of the PCDD/Fs deposited. This assumption, if incorrect, may have lead to underestimation of PCCD/F concentrations and masses at the site. The work of Bruzy and Hites (1995)* should be considered in deciding on soil sampling depths. Bruzy and Hites (1995) observed that most PCDD/F was present in the upper 25 cm of the soil for soils sampled at various

sites. However, at sites where heavy PCDD/F deposition occurred and the soil had very low organic matter the PCDD/F was distributed over a depth of up to 90 cm of the soil with maximum concentrations at the 40-50 cm depth. Sampling 0-10 cm of the soil horizon, would have severely underestimated PCDD/F concentrations at such sites. The anomalous behaviour at sites where the PCDD/F was distributed over depths of up to 90 cm is attributed to the fact that the capacity of the upper A horizon of the soil (i.e. depth of soil corresponding to the organic rich layer) to adsorb PCDD/Fs was exceeded due to excessive PCDD/F deposition and the relatively low amounts of organic carbon. The surface soil column may be considered analogous to the stationary phase in a chromatographic system, and the capacity of the soil to retain PCDD/F will depend both on the amount of PCDD/F being deposited on the soil and the amount of organic carbon in the soil (stationary phase thickness). *Bruzy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-*p*-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098.

3.3a.7 It is unclear if the concentrations of chemicals are reported on the basis of soil dry weight or wet weight. This should be clearly stated in data tables. The use of dry weight of soil instead of the total weight can cause soil concentration magnitudes to change by up to approximately 20%. For PCDD/F, the literature indicates that both dry and wet mass of soils have been used by various studies to compute PCDD/F soil concentrations. For example, Grundy et al., 1997; Fattore et al., 1997, and Chen et al., 2003 have used soil dry mass to quantify PCDD/F soil concentrations whereas the soil wet weight has been used by Wagrowski and Hites, 2000, and Bruzy and Hites, 1995.

3.3a.8 The rationale for selection of analytes to be examined was based on historical use of herbicide formulations within the RTA along with additional consideration for bioaccumulative trace impurities (PCDD/F and HCB) present in some of the herbicide formulations used. With the exception of the most recent two years, the consultants appear to have done a thorough job of compiling herbicide application histories in the RTA and summarizing this data in Appendix A. A rational was provided for ranking herbicides and herbicide impurities as category 1 and category 2 priority chemicals based on risk to human health, potential carcinogen status, bioaccumulation/biomagnification potential, environmental persistence and application history. Category 1 chemicals (high risk category) received more intensive study with respect to the number of samples analyzed (between 217-342 samples) than category 2 chemicals. The difference in analytical effort between chemical categories appears justified by the above criteria.

3.3a.9 This project would have benefited from the use of background tracer chemicals, e.g. PCBs or other ubiquitous contaminants that may be found within the RTA as a result of long range atmospheric transport processes or other sources not directly related to herbicide applications. Had the consultants included these types of tracers in their analysis they would have been better able to distinguish herbicide application sources of PCDD/F sources compared to other non-specified sources e.g. transport from air or other vectors. The inclusion of such analytes would have also greatly aided the discriminating power of the multivariate analysis.

3.3b The subsurface geology of the site including type, thickness and changes in soil stratigraphy, heterogeneity, depth to bedrock, presence of confining layers, soil profile and the presence of underground anomalies;

3.3b.1 Qualitative descriptions of the surface geology and topography of the site and of the sampling locations have been provided. The depth of surface layers and deposits have been stated in Section 1.1. Average estimates of groundwater hydraulic conductivity, depth of the water table and the bedrock depth have been stated.

3.3b.2 There is no information provided on the soil organic matter (SOM) content of soil and sediment samples. The SOM level has a strong effect on the vertical distribution of contaminants and soils with low SOM may require sampling over depths greater that 10 cm. Further discussion on this is presented above.

3.3b.3 Map No. 1.2. details surface geology of the entire RTA separated into Sand/Gravel, Till, Ablation Till and Bedrock categories. The data used to generate the map were obtained from DND without confirmation. Additional information concerning landscape characteristics, vegetation coverage/type, visual characteristics of soil for each APEC are provided in Chapter 7.0 and Appendix E of the report. While useful, the latter details are mostly qualitative and of limited use for assessment of soil characteristics with respect to understanding contaminant fate within soils. Analytical determination of soil characteristics such as total organic carbon content would have been highly relevant towards further understanding PCDD/F distribution within the RTA. Additional parameters such as soil moisture content and grain size distribution should also have been determined as components related to characterization of the surface geology of the site. These parameters were not included with the report either in hardcopy or electronic format.

3.3c If microbial processes are contributing to the degradation or persistence of contaminants;

3.3c.1 See discussion of PCDD/F congener results in soil at CFB Gagetown, 8.2.4, page 153. In the history of herbicide use at CFB Gagetown, it is likely that 2,4-D was used more than perhaps any other herbicide because it is often combined with either 2,4,5-T, fenoprop, dicamba, dichlorprop, or picloram. ("Sylvaprop" in Table 2.4.1, p 17, is likely 2,4-D + dichlorprop).The other herbicides have each had their major use period but 2,4-D is often included in the formulation or in the spray tank. The most likely dioxin contaminants in 2,4-D are dichlorodioxins, trichlorodioxins, or perhaps the 1,3,6,8-tetrachloro-dibenzo-p-dioxin, none of which are nearly as toxic as 2,3,7.8-TCDD. Table 8-3, page 122 should include the TEFs for the likely dioxin contaminants of 2,4-D. If the analytical methods for dioxins should have "seen" the likely dioxins in 2,4-D, this should be clearly stated. If the analytical methods would not have seen these dioxins, then this is a serious omission.

3.3c.2 There should be a declaration from the laboratory on the PCDDs that would have been detected in their analyses. LODs should also be reported for those PCDDs that could be detected.

3.3c.3 OCDD is a fully chlorinated dibenzo-p-dioxin. It is the most likely dioxin contaminant in the pesticide, pentachlorophenol. It is surprising that it was the most common dioxin found in this study. It was found even more often than the expected, 2,3,7,8-TCDD, in 2,4,5-T. There should be more discussion in the report for it being one of the most commonly found dioxin residues. There is no evidence that pentachlorophenol was used widely.

3.3c.4 Is there evidence that OCDD is a common but trace contaminant in other chlorophenol based herbicides? In the literature? Being fully chlorinated and degradable only in anaerobic conditions (as suggested in the report), is it highly persistent? Is there information in the literature on the relative half-lives of the various dioxins?

3.3c.5 If we are interpreting the discussion in this section correctly, the suggestion is that the "lesser chlorinated dioxins" are oxidatively degraded by microorganisms more rapidly than is true for OCDD and that over a long period of time OCDD would predominate as the major dioxin contaminant remaining. Is this just a hypothesis or is there some support for this in the literature? What is also missing is some reason that OCDD was widely present in the first place. Perhaps, more rigorous review of the literature is needed on the occurrence and sources of OCDD as a contaminant as well as on its persistence. It is comforting to see that its TEF is so low, Table 8-3, page 122.

3.3c.6 A concise summary of the biodegradation mechanisms of PCDD/F is present in Page 153. It should be noted that PCDD dechlorination may also be facilitated by humic acids, zerovalent- or organometal minerals (Albrecht et al., 1999).** ** Albrecht, I. D.; Barkovskii, A. L.; Adriaens, P.. Production and Dechlorination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Historically-Contaminated Estuarine Sediments. Environmental Science and Technology (1999), 33(5), 737-744.

3.3c.7 The persistence of other COPCs have been discussed in Table 2-2 and the associated text.

3.3c.8 The report did not directly address the issue of whether or not microbial degradation of persistent contaminants such as PCDD/Fs altered relative concentrations of these contaminants within soils of the RTA. The consultants speculate that preferential degradation of 2,3,7,8-TCDD compared to OCDD may be one reason for the greater relative abundance of OCDD in soils compared to the expected major peak of 2,3,7,8-TCDD as the main PCDD/F impurity of Agent Orange herbicide formulations. The statements are qualitative and the consultant provides no empirical evidence of the relative proportions of PCDD/F congeners within herbicide formulations nor evidence to confirm the presence of OCDD in such formulations. The large differences in physical-chemical properties, e.g. hydrophobicity and volatility provide alternate, and equally plausible explanations that could contribute to changes in PCDD/F distribution related to weathering processes independent of microbial degradation. The only way to address

microbial degradation of PCDD/F would be to perform laboratory batch degradation experiments using soils collected, preferably from identified hotspots, and spiking these soils with labelled 2,3,7,8-TCDD and other priority chemicals of concern. Alternatively, soil column leach tests could be performed in conjunction with analysis of soil cores to invalidate the alternate hypothesis that more mobile tetrachlorinated PCDD/Fs were lost from soils as a result of leaching over time.

3.3d If concentrations exceed the applicable federal, provincial or municipal criteria or are within background ranges for the area;

3.3d.1 The study plan and the report were very strong on this point. All detectable residues were clearly and in some cases statistically compared with background levels. Comparisons were also made with acceptable federal levels in soil or water if available and when not available, federally, with acceptable provincial levels e.g. Ontario or B.C.

3.3d.2 The Results section discusses the concentrations of COPCs in soil, sediment, water and vegetation samples in the context of background concentrations and relevant environmental quality guidelines/criteria as applicable. Statistical assessments of the relation of PCDD/F concentrations in various APECs with background concentrations were performed. APECs 2, 3 and the Murphy bivouac were found to have PCDD/F levels higher than the background areas.

3.3d.3 Table 4-3 is missing existing Environmental Quality Criteria for pentachlorobenzene and tetrachlorobenzene, where federal water quality quality guidelines (protection of aquatic life) are available (see CCME 1999).

3.3d.4 Table 4-3 – There is a more restrictive CCME interim sediment quality guideline for TCDD of 0.85 ng TEQ/kg. The consultants should justify why they chose to use the less restrictive Probable Effects Level guideline value as their screening tool for this media. This is particularly relevant to the Swan Creek Lake Watershed which had mean PCDD/F TEQ value (9.3 pg TEQ/g) above the interim guideline (0.85 pg TEQ/g) but less then the probable effects level guideline (21.5 pg TEQ/g).

3.3d.5 The consultants provided a very thorough discussion of every soil sample having analyte concentrations that were in excess of established environmental quality guidelines. The decision to re-analyze discrete samples within composite samples exceeding environmental quality criteria or which approached guideline values and failed the data quality assessment (DQA) procedure provided highly valuable data to further identify the extent of aerial contamination within a given APEC. The consultants also provided spatial mapping of PCDD/F contamination in soils from all studied APECs and applied geostatistical techniques to extrapolate mean PCDD/F concentrations for each sampling zone.

3.3d.5 One potential problem inherent in comparing analytical results with established environmental quality guidelines for PCDD/Fs is the use of TEQ values. Unfortunately, other chemicals (e.g. co-planar and mono-*ortho*-PCBs, chlorinated naphtahlenes, ect.)

also contribute to TEQs, and most often contribute to the majority of TEQs within a given sample. Therefore it is very likely that TEQs were underestimated within the RTA even though this result may not be directly related to PCDD/Fs or herbicide applications. Thus, as a screening tool for the potential of herbicide applications contributing to dioxin exposures, the methodology is adequate. However, as a screening tool to establish overall risk to dioxin-like activity, the approach may be lacking. As indicated in previous comments, an analysis of PCBs (including NO-PCBs and MO-PCBs), would have also been beneficial in this case to establish better TEQ estimates and to allocate the proportion of TEQs attributed to PCDD/Fs. For example, suppose PCBs were also found to contribute to the majority of TEQs (as is often the case) throughout most of the RTA including APEC#2 and 3. This would strongly suggest that PCDD/F and herbicide applications were not the main contributors to dioxin-like toxicity at the site. One suggestion is that the subsequent ecological characterization adopt bioassay approaches to the measurement of TEQs. In this case, a lack of relationship between analytically-calculated TEQs (being less than bioassay measured TEQs) could be used as grounds to trigger a more thorough analytical investigation for other contaminants within soils.

3.3e The type, form, concentrations, and horizontal and vertical extent of contamination for each contaminant in each media; (Sample analyses and subsurface investigations shall be done concurrently to limit unnecessary drilling and sampling);

3.3e.1 The design of their study and sampling plan did not permit assessment of horizontal movement of contaminants in water. However, when the highest soil residue of a contaminant was not obviously confined by being surrounded by samples with lower residues, they reported this. They then either carried out more sampling or recommended that this be done to define the horizontal extent of the higher level of contamination.

3.3e.2 Historical records of areas of herbicide applications and areas of significance in the context of human exposure and ecological impact were identified. Sampling was focused on these areas, and sampling was undertaken in such a way that estimates of mean concentrations of COPCs would be obtained without excessive sampling.

3.3e.3 The study program was highly focussed on characterization of category 1, herbicides and herbicide impurities in soils (177 composite + 119 discrete samples) within the targeted sampling zones. A smaller number of potable water samples (12), surface water (30), sediment (30) and vegetation (36) samples were examined. The level of intensity of sampling efforts in soils, as a more probable human exposure vector and greater proportion of landscape coverage justified the above sampling distribution effort.

3.3e.4 There are noticeable areas within the RTA that were not sampled presumably because they failed to meet criteria involved in delineating APEC zones or were not accessible. However, these gaps do not appear to be restricted to a given area with the RTA (i.e. sampling bias) and the overall coverage associated with sampled APECs provides an adequate representation of horizontal contamination. The geostatistical sampling design applied to APECs was appropriate providing economy of analysis, a high degree of

spatial coverage and minimizing dilution of samples. The ability to re-analyze discrete samples forming a given composite also provided enhanced information to further evaluate the extent of spatial contamination for notable hotspots. The consultants should be commended in the implementation of a very well conceived sampling approach.

3.3f The potential contaminant sources, the surface and subsurface routes for contaminant migration and down gradient receptors. Determine other contributing factors to the degree of contaminant distribution and potential transport of contaminants such as retardation factors; and

3.3f.1 Contamination sources were presumed to be related to previous use of herbicides and associated contaminants when detected residues were above background. No likely sources, incineration etc. were suggested for residues of contaminants at background levels.

3.3f.2 [This Comment was described previously but is repeated here owing to the direct applicability of comment to DND sub-objective]. The rationale for sampling the top 10 cm of soil is unclear. It seems to have been based solely on the Vietnam Study by Hatley Consultants. In effect the sampling procedure presented in the report assumes that 0-10 cm of the surface retains the majority of the PCDD/Fs deposited. This assumption, if incorrect, may have lead to underestimation of PCCD/F concentrations and masses at the site. The work of Bruzy and Hites (1995)* should be considered in deciding on soil sampling depths. Bruzy and Hites (1995) observed that most PCDD/F was present in the upper 25 cm of the soil for soils sampled at various sites. However, at sites where heavy PCDD/F deposition occurred and the soil had very low organic matter the PCDD/F was distributed over a depth of up to 90 cm of the soil with maximum concentrations at the 40-50 cm depth. Sampling 0-10 cm of the soil horizon, would have severely underestimated PCDD/F concentrations at such sites. The anomalous behaviour at sites where the PCDD/F was distributed over depths of up to 90 cm is attributed to the fact that the capacity of the upper A horizon of the soil (i.e. depth of soil corresponding to the organic rich layer) to adsorb PCDD/Fs was exceeded due to excessive PCDD/F deposition and the relatively low amounts of organic carbon. The surface soil column may be considered analogous to the stationary phase in a chromatographic system, and the capacity of the soil to retain PCDD/F will depend both on the amount of PCDD/F being deposited to the soil and the amount of organic carbon in the soil (stationary phase thickness). *Bruzy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098.

3.3f.3 The COPCs were identified to be active ingredients or manufacturing impurities in the herbicides used at CFB Gagetown. PCDD/F, and impurity present in several herbicide formulations was widely detected at the site.

3.3f.4 The largest potential sources of PCDD/F in US and Europe are municipal solid waste incinerators, medical waste incinerators, secondary copper smelters, hazardous waste burning cement kilns, sinter plants, and diesel trucks (Lohman and Seigneur, 2001).

Wood and wood-residue burning, residential wood-stoves, backyard trash burning and vegetation fires are also considered to be significant sources of PCDD/F emissions. No review of the existence of nearby facilities were mentioned.

3.3f.5 The designation of APECs into 5 categories attempted to delineate areas receiving a high degree of herbicide application and separate these zones from background areas or areas containing sensitive ecological receptors. There was no attempt to correlate herbicide application rates or mass balance with measured spatial contamination trends. However, it is acknowledged that given the lack of data on application methods, differences in herbicide formulations, different composition of trace impurities within various herbicide formulations, long periods of time over which herbicides were applied and different timing of herbicide applications make such a task likely to fail.

3.3f.6 The ability to designate APECs having unique contaminant concentrations and chemical fingerprints was not entirely successful. Some APECs, e.g. APEC # 2, 3, 4, 13 and Murphy Bivouac appear to have exhibited higher PCDD/F concentrations than background levels. There were flaws in the statistical determination of significant enrichment of these areas (See comment on statistical tests above). Likewise, multivariate analysis provided qualitative indication of differences in chemical signatures at APEC 2 and Murphy bivouac. The failure to perform additional tests such as discriminate functions analysis (DFA) on the principle components scores precludes statistical determination of significant differences in chemical signatures at the latter two APECs (see comment on statistical tests above). There were also concerns regarding the ability of multivariate analyses to discriminate sources. The principal components analysis was restricted to PCDD/Fs as this was the only group of consistently detected chemicals. Yet, the different PCDD/F congeners may have had a common source. The consultants indicate that Agent Orange formulations contain predominately 2,3,7,8-TCDD as the PCDD/F impurity, yet they did not provide evidence for the presence or absence of other PCDD/F congeners in this and other herbicide formulations applied within the RTA. If all PCDD/F congeners originated from the same source and these were the only congeners included in the multivariate analysis, the analysis would not be able to distinguish different sources within the RTA. In this case, inclusion of ubiquitous tracer chemicals such as PCBs may have been helpful to locating areas of chemical enrichment in the RTA that are not associated with chemical focussing processes on site.

3.3f.7 The analysis of discrete samples within APECs showing elevated PCDD/F concentrations suggest considerable heterogeneity of soil PCDD/F concentrations. APEC #2 was unique in the number of discrete samples with PCDD/F concentrations above soil quality guidelines, however, it is difficult to understand why soil concentrations were so heterogenous (CV = 5.2) given that herbicides would have been applied to these study plots in a relatively uniform manner. The consultant should comment on this, especially with respect to APEC #2.

3.3f.8 There was little discussion in the report regarding contaminant transport mechanisms. One weakness of the study was the failure to determine soil organic carbon content and to jointly analyze PCDD/F data on a dry weight basis and on an organic carbon normalized

basis. If heterogeneity of PCDD/F distribution in soil was shown to be decreased by OC normalization this would suggest that air deposition of PCDD/Fs represent a potential source of dioxins to the RTA. If heterogeneity of PCDD/Fs is increased by OC normalization, this could suggest evidence of point sources. Finally, the inability to document PCDD/F soil residues in reference areas outside of the RFA (even if this only reflects literature review data) further confounds identification of possible dioxin sources and environmental transport mechanisms within the RTA.

3.3f.9 There is agreement with the statement provided on page 144 section 8.2.1.12: 'Overall, the APECs where PCDD/F exceeded CCME SQG of 4 pg TEQ/g should not be cause for extreme control measures at this point. Rather, they point to the need for further assessment….' However, there is a need to quantify total TEQs (not just those associated with PCDD/F) at the designated PCDD/F hotspots and in randomly selected composite samples from other APECs to provide a better risk assessment. After all, the study identified that the major contributor to PCDD/Fs was OCDD that was not anticipated to be an important impurity of herbicide formulations. The consultants interpret this to be a result of preferential degradation of 2,3,7,8-TCDD over OCDD, yet other alternate hypotheses are equally plausible. It may be that non-herbicide sources of PCDD/Fs have contributed to observed enrichments, in which case other contaminants such as PCBs, PAHs and mercury might also be enriched. Once total TEQ's have been determined, the soil TEQs measured within the RTA could be better interpreted in the context of other contaminated sites (for example the lakewide TEQ for Lake Ontario Sediments exceeds 100 pg TEQ/g, well above any of the TEQs measured for the RFA (Marvin et al 2002 JGLR 28:437-450;).

3.4 Sampling and Analysis: As par of a separate contract, the Consultant is required to manage coordinate analytical testing with an accredited laboratory. This may consist of the following:

3.4.1 It is not known whether the Jacques Whitford company has their own analytical chemical laboratory and could have done these analyses if time permitted. To meet the time constraints, it was good they could make arrangements with a number accredited laboratories. With this approach, they could select the most competent labs for the various types of chemistry.

3.4a Propose the parameters for analysis. A laboratory that is certified and accredited by CAEAL for the parameters tested must conduct all analysis.

3.4a.1 The list of parameters for analysis was clearly stated in the report.

3.4a.2 The list of analytes chosen for chemical analysis was based on pre-evaluation of the types of herbicide formulations applied within the RTA with consideration for active ingredients and trace impurities which could exhibit high persistence and bioaccumulation potentials. The analytical packages developed for different herbicides and trace impurities (Table 5-1) was appropriate for the objectives of the project.

3.4a.3 Additional parameters such as ubiquitous pollutants not present within herbicide formulations would have been highly beneficial to the interpretation of results as their inclusion would have allow better distinction between within RTA-sources from long-range transport processes. Example chemicals would include PCBs and PAHs. Also, the failure to measure soil and sediment total organic carbon content represents a critical missing parameter for assessing the fate and possible source delineation of PCDD/Fs.

3.4b Provide detailed records of the sample collection process, total number of samples collected and which subsequent samples were submitted for analysis shall be kept and provided in the report;

3.4b.1 The records of sample locations, numbers taken, and numbers analyzed were good.

3.4b.2 An important omission, at least in the body of the report, was the sample volume sizes for water samples, surface soil samples, core soil samples and plant tissue samples. The volumes that were subsequently extracted would also be very important to include. This information is required to assess their limits of detection.

3.4b.3 The detailed records of samples collected, along with maps of locations sampled, total number of samples collected and composited have been presented very clearly. A summary of samples analysed is provided in Table 5-5.

3.4b.4 The consultants provided a very thorough overview of the sampling design, number of samples collected, rational and means by which various discrete samples were composited and numbers/rational for samples that were submitted for laboratory analysis. The information is presented in several tables and detailed for each APEC are provided in Chapter 7.0.

3.4c Establish appropriate Quality Assurance (QA)/Quality Control (QC) procedures for sampling and analysis to ensure accuracy and precision of results. Sample analysis shall follow appropriate standard analytical practices including confirmatory samples.

3.4c.1 The system of collecting and using field blanks, field duplicates, lab duplicates, purchased reference samples and spiked reference samples appeared to be very adequate for QA and QC requirements.

3.4c.2 The QA/QC program is detailed in Section 6. Appropriate field blanks, trip blanks and duplicates were obtained and analyzed. The accuracy and precision of the analytical methods and the analyses were performed.

3.4c.3 Laboratory QA/QC protocols are documented in Chapter 6.0. The text describes the collection of field duplicates and blind submission of field duplicates to analytical laboratories, spiking of samples with isotopic labelled surrogate standards to determine % recoveries for each sample analysis, use of matrix blanks, field blanks, trip blanks, rinsate blanks and standard reference materials to check for analysis accuracy. The numbers of

QA/QC samples analysed in conjunction with sample batches are documented (Table 6-1).

3.4c.4 There was an adequate description of the evaluation of SRM data in that the consultant described the use of control charts and Westgard rules to trigger a non-compliance report for sample batches that could potentially fail QA/QC. However, rules used to trigger failure of QA/QC for other parameters are not stated in the report. For example, % recovery data for surrogate standard spikes are collected for each blank, sample and SRM and summarized in the data tables of Appendix H. However, the report does not indicate what the acceptable range is for % recoveries. Having went through EPA method 1613B, it became apparent that recoveries in the range of 17% to 185% are acceptable (variable range for individual PCDD/F congeners) according to the method. There is a need to include a description of acceptable and non-acceptable recovery ranges in the Tables associated with Appendix H to appropriately evaluate these criteria.

3.4c.5 Similarly, the acceptable concentration of PCDD/Fs in blank samples should have definite trigger points that would initiate failure of QA/QC. EPA Method 1613B specifies these general criteria in the range of 1-10 pg/g depending on the PCDD/F congener. EPA Method 1613B also specifies 'If any 2,3,7,8-substitutded CDD/CDF (Table 1) is found in the blank at greater than minimum levels (Table 2) or one third the regulatory compliance level, whichever is greater….'. Based on data of maximum detected values of PCDD/F in Laboratory Soil/Sediment Blanks (Table H-19), one or more of the blanks should have failed the 1/3 compliance rule and necessitated a re-analysis. The PCDD/F TEQ for the maximum detected Soil/Sediment blank value was 3.3 pg TEQ/g based on data presented in Table H-19 and applying congener specific TEF values of Table 8-3 which approaches the TEQ guideline of 4 pg/g. The consultants should review high blank concentrations and check that blank PCDD/F did not exceed the 1/3 compliance rule.

3.4c.6 The data tables indicate that data were blank-corrected prior to calculating concentrations. The blank correction methodology is not specified (again, a problem with not including analytical SOP's with this report). The electronic database provides the fields 'CorrectedSubtractedBlankValue' and 'SubtractedBlankValue'. It is not apparent what these fields mean and there are no annotations to define these terms. Finally, some concentration values reported in the data tables of Appendix G are less then the minimum reported detection limits specified in Table H-10 of Appendix H. E.g. a number of soil 2,3,7,8-TCDD concentrations in soil samples are reportedly at 0.01 pg/g while the minimum detection limit for the method is reported as 0.03 pg/g. The electronic database provides qualifiers and it became apparent that several congeners had PCDD/F concentrations below MDL's, yet numerical values equal to the MDL are indicated in the data fields and hardcopy data reports of Appendix G. Only after thorough review of the electronic data did it become apparent that PCDD/F TEQs values were being generated by replacing Non-Detected data with MDLs in some cases. This manufactured data then presumably gets built into the summary statistics e.g. mean APEC TEQ values. There is no place in the text that qualifies which TEQs include MDL substituted data. The consultants should review the analytical data reports and ensure that data are appropriately censored according to the method detection limits and flagged in the

corresponding hard copy data report tables as well as in summary statistics presented throughout the report.

3.4c.7 The data on SRMs and general observation of sample recoveries suggest good accuracy and repeatability of the analytical methods for PCDD/Fs. Based on data reported in Appendix H, there appears to be a high degree of confidence in the analytical integrity of sample analysis for the samples with high PCDD/F concentrations (e.g. above 9 pg TEQ/g), but there are questions about some of the results demonstrating lower concentration values owing to issues with blanks, blank correction and substitution of non-detected data with MDL values as described above.

3.4d Provide analytical results in data tables including comparison to applicable regulatory criteria and previous analytical results. Historical results for all parameters that exceeded guidelines must be reviewed in light of new guidelines. DND shall be contacted as soon as analytical results are received and interpreted by the consultant for further discussion.

3.4d.1 The presentation of the analytical results in tables and graphs and comparisons with regulatory criteria was clear.

3.4d.2 Some PCDD/F concentrations reported in Appendix G are clearly lower than the detection limits reported in Appendix H. For example, Table H-27 states that the minimum detection limit of 2,3,7,8-TCDD in soil was 0.01 pg/g. Table G-2 reports a value of 0.005 pg/g for sample A2-S1SS-2. It is not clear if half the minimum detection limit is being used as a finite value for non-detected samples. This should be explained clearly.

3.4d.3 Units for soil concentrations in Tables (e.g. Table G2) of Appendix G have an incorrect table heading in terms of the units for PCDD/F concentrations. It is assumed that all results are reported in pg/g and not in mg/Kg.

3.4d.4 Analytical results are reported in data tables in Appendix G of the report. In many cases the units of measurement are in error, or at least deemed to be in error due to conflict of units presented in the electronic database and hardcopy. For example, Table G-2 reports the soil PCDD/F concentrations are expressed in mg/kg which is one million fold higher than reported in the electronic database (pg/g). It is suspected the pg/g unit is the correct one. There is also no indication as to whether the data are reported in wet weight or dry weight, although reporting the data on a dry weight basis is more standard. For sediments, Table G-8 reports the analytical units as pg/L but the electronic database reports the units as pg/g. Again, it is suspected that the pg/g designation is the correct one. For water, Table G-14 identifies the units of measurement as pg/L which is consistent with the electronic database, however, the TEQ values for water are reported in pg TEQ/g whereas the text and electronic database reports the water TEQ in units of pg TEQ/L. These inconsistencies in unit reporting need to be fixed. Hard copy data tables should flag (e.g. bold or italic font) any values where the MDL was substituted for

true analytical values. TEQ calculations should also flag values where MDL substitutions contributed to the TEQ value.

3.4d.5 All analytical data are compared with regulatory criteria. Exceptions include failure to account for regulatory guidelines available for tetrachlorobenzenes and pentachlorobenzenes in water and use of a less stringent probable effects level screening criteria for PCDD/Fs in sediment rather than the interim sediment quality guideline. The text should be modified to incorporate these exceptions; however, it will not substantially alter the interpretation of the data.

3.5 Data Interpretation: Based on the results of the environmental field investigation program, the Consultant shall confirm the presence or absence of environmental impacts. The consultant shall (if required):

3.5a Use the CCME criteria as well as other relevant and applicable federal, provincial and municipal guidelines to evaluate the results of the chemical analyses;

3.5a.1 CCME criteria and other provincial criteria are presented in the report. The COPC concentrations have been compared to the regulatory criteria where applicable for specific media.

3.5a.2 Data were compared to CCME environmental quality criteria as well as provincial guideline for available analytical parameters. There are some concerns regarding the comparison of TEQ values to guidelines when the TEQs include manufactured data e.g. substitution of non-detected values with the MDL. TEQ values reported in the text and data tables that include MDL estimators should be flagged using bold or italics font.

3.5b Submit electronic data in a flat file format with the following fields: Chain of Custody, Number, Lab ID, Sample ID, Date sampled, Date tested, Matrix, Result, MDL, Units, Parameter description, Laboratory parameter code (if used by the lab), Additional fields: Sampling method, Sampler, and Report Number. If further information regarding file format is required by the lab, then questions should be directed to the DND project manager. Station Names for new sample location shall be approved by the DND Project Manager prior to use;

3.5b.1 Protocols for sample handling have been stated and they are adequate.

3.5b.2 All of the above fields appear to be available in the electronic database although not within a single query table. The biggest problem has to do with the inconsistencies between hard copy data report tables and electronic report tables. Areas of confusion in this regard include: appropriate units of measurement and whether a datum refers to a true analytical value or an MDL substituted value. There are also many inconsistencies in data reported in the hard copy tables and electronic database.

3.5c Interpret the data to determine and identify the environmental impacts; and

3.5c.1 There was little discussion of "environmental impact" on vegetation or non-target organisms other than humans. Other than physical characterization of sampling sites and data on residues of COPC, no additional data on vegetation of other non-target organisms was collected that would permit the identification of environmental impacts.

3.5c.2 The concentrations of COPCs in different media were presented in a detailed manner. These have been compared to background area levels and to regulatory criteria. Multivariate analyses (e.g. principal component analyses) were performed to identify the degree of similarity and differences in the PCDD/F congener patterns at different locations of the site. The report concludes that further sampling for COPCs other than PCDD/Fs are not required. Further sampling of PCDD/F may be required depending on exposure-based on soil quality objectives and for a better characterization of impacts on ecological receptors (vegetation and small animals) may be required.

3.5c.3 The report provides as detailed as possible an interpretation of the spatial extent of soil herbicide/herbicide impurity contamination within the RTA. Environmental impacts were interpreted in light of the number of samples that exceed environmental quality objectives and spatial extent of guideline exceedances. The consultants are appropriately cautions concerning conclusions about human risk related to areas having somewhat elevated soil PCDD/Fs and provide recommendations to develop site specific human and ecological soil quality objectives that better incorporate actual exposure conditions on site.

3.5d Prepare scaled drawings of the site showing analytical results and indicating the areas of environmental impacts.

3.5d.1 Good maps were provided to indicate the precise location of samples with higher PCDD/F residues.

3.5d.2 Detailed drawings of the areas and locations sampled are presented. Soil samples that provided the highest concentrations in a sampling area were shown in the drawings. Data tables clearly list the concentrations obtained for each sample analyzed.

3.5d.3 The consultants provided a very extensive summary of analytical data in GIS-format. Detailed GIS-maps of all sampling sites and APEC sampling zones are provided. Further, several GIS-maps are presented that yield different levels of data interpretation to include categorization of total TEQ ranges within sampled APECs and individual sectors within each APEC containing one or more discrete samples having total TEQ values above environmental quality guidelines.

3.6 Evaluation and Recommendations: Based on the results, the Consultant shall make recommendations including:

3.6.1 It is clearly stated in the SOW (No.10, page 3) that the consultant is required to conduct and Environmental Site Investigation (ESI) of the Range and Training Area (RTA) at CFB Gagetown. It is very clear that they have done this.

3.6.2 In the SOW (No. 17, pages 5 and 6), it is stated that the consultant shall "on the basis of results from the ESI confirm the presence or absence of environmental impacts and shall (if required) interpret the data to identify the environmental impacts. Was there a high priority to confirm the presence or absence of environmental impacts? It appears that this was a low priority at this stage because there was no plan to collect and compare data on the occurrence of vegetation or other non-target organisms in sprayed areas compared to non-sprayed, background areas. Clearly, there was a goal of DND to have a major environmental impact on the vegetation to reduce fire risks in live fire areas (SRIA). Beyond these and related impacts, what other environmental, as compared to human health, impacts is DND concerned about?

3.6.3 Section 9 of the report provides recommendations based on interpreted results. The main recommendations, to focus on areas showing elevated soil Total TEQ values and perform a more detailed human health and ecological risk assessment in these areas appears to be warranted based on the field sampling results and data interpretation. There is agreement with the recommendation to examine for PCDD/F bioaccumulation in soil invertebrates to verify the lack of dioxin bioavailability suggested by the vegetation sampling efforts. The authors should consider re-analyzing some of the samples of other contaminant classes such as PAHs, PCBs (including mono-*ortho* and coplanar PCBs) or OC pesticides to provide better estimates of total TEQs and to establish whether areas of PCDD/F enrichment are correlated with enrichment of other contaminants likely to have multiple-long range sources.

Section 4.0 Declarative Statements

Declarative statements by each of the peer reviewers are provided indicating that they have contributed to, reviewed and agree in principle with the consensus statements outlined in the consolidated peer review report.

Declarative Statement:

I have reviewed Report No 1009956 - Environmental Site Assessment of CFB Gagetown, NB: Task 2B – Stage 1 (Final Report), Stage 2 (Final Report) and Stage 3 (Interim Report), Field Program provided to me by DND. I have performed an independent review of the supplied document(s) which is included as an appendix to the consolidated peer review report. I have participated in the teleconference call on April 24, 2006 to discuss my peer review findings with the other two peer reviewers and have subsequently reviewed the consolidated peer review report generated from the above conference call. I am in general agreement with the findings and recommendations of the consolidated peer review report.

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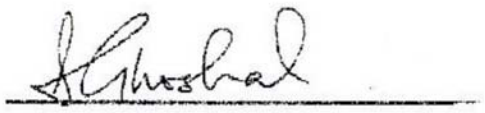

April 28, 2006

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Declarative Statement:

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April 30/2006

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APPENDIX 1: Peer Review Guidance Document, supplied by DND April 6, 2006.

Environmental Site Assessment of CFB Gagetown, N.B.: Task 2B

1. PEER REVIEW PROCESS

1.1. Objective

The objective of the peer review of the Jacques Whitford's interim report for the *Environmental Site Assessment* of *CFB Gagetown from 1952 to Present: Task 2B* (ESA) is to assess its adequacy in determining the environmental conditions that may exist on the ranges and training areas as a result of the application of herbicides at CFB Gagetown from 1952 to present and whether cumulative effects may have resulted from their use.

1.2. Peer Review Mechanism

An ad hoc panel, formed of three independent peer reviewers, shall conduct an independent review and analysis of the ESA report, and as a group, agree and consolidate their findings into one final report.

The peer review candidates include experts from academia, provincial governmental agencies, and industry.

Peer reviewers will be provided with the Statement of Work for Task 2B, the interim report, and a series of questions to guide them through the review of the report. This document outlines the objective of the peer review of the ESA report by providing questions in Section 2.2 that will simplify the task of analyzing, synthesizing, and collating the peer review comments.

1.3. Peer Reviewer Responsibility

Peer review panel members shall:

1.2.1. Ascertain that he/she shall be the only ones to perform work under this peer review and will sign a *Non-Disclosure Agreement*; and

1.2.2. Collectively provide a single consolidated report containing written comments directly to DND's Project Manager and to the following by the specified deadline:

Jacques Whitford
2781 Lancaster Road
Suite 200
Ottawa, Ontario
K1B 1A7

Attention: Mr. François Lauzon, Project Manager

Or by e-mail at: francois.lauzon@jacqueswhitford.com

and

Health Canada
A/Manager, Contaminated Sites Division
Healthy Environments and Consumer Safety Branch
400 - 4595 Canada Way
Burnaby, British Columbia
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Attention: Ms. Sanya Petrovic

Or by e-mail at: sanya_petrovic@hc-sc.gc.ca

1.4. Conflict of Interest Declaration

Each peer reviewer will be required to disclose any actual or potential personal, organizational or legal conflicts of interest and shall sign and submit the enclosed *Conflict of Interest Form*. The peer reviewers are required to ensure that none of the conflicts disclosed are so direct and substantial as to rule out a particular reviewer.

The peer reviewers will have a continuing obligation to identify and report to DND's Project Manager any conflicts of interest arising during the performance of the peer review.

1.5. Non-Disclosure Agreement

One of the major responsibilities of the peer reviewers shall be to ensure confidentiality of the peer reviewed report and database and subsequent comments. Each peer reviewer shall be informed of the need for confidentiality with regard to the release of DND products that are stamped as "DRAFT" or "INTERIM". Premature release of these DND products, views, or positions, is inappropriate and can damage the credibility of a number of stakeholders including the peer reviewer. Peer reviewers will be required to sign the enclosed *Non-Disclosure Agreement*.

1.6. Peer Review Communications

Peer reviewers will be provided with the Terms of Reference for the peer review of the ESA report to ensure that they have a clear understanding of the expectations associated with the completion of the peer review.

The point of contact within DND for the peer reviewers for any administrative clarifications required during the peer review process is Ms. Élise Lemoine, DND's Project Manager. Any

questions that arise prior to and during the review process shall be forwarded to Ms. Lemoine in writing, who will, in turn, distribute a copy of the question (s) and answer (s) to all peer reviewers.

Contact information for Ms. Lemoine is as follows:

By mail: Ms. Élise Lemoine, D Env P 4-3
Environmental Project Specialist
Directorate Environmental protection
National Defence
101 Colonel By Drive
Ottawa, Ontario
K1A 0K2

By e-mail: lemoine.emjs@forces.gc.ca

By telephone: (613) 995-5152

1.7. Reference Material

Peer reviewers shall be given a copy of the following documents for the peer review:

1.2.1. The Interim ESA report with associated background material;
1.2.2. Terms of Reference for the required peer review with the goal to focus the individual and collective peer review efforts; and
1.2.3. Statement of Work for the Task.

1.8. Assessment

Based on the review and analysis of the information provided, the ad hoc peer review panel will be asked to provide an overall assessment including comments on the ESA report. The assessment will be presented as one of the following:

1.2.1. Acceptable as is;
1.2.2. Acceptable with minor revision (as indicated);
1.2.3. Acceptable with major revision (as outlined); or
1.2.4. Not acceptable under any circumstance (as outlined).

1.9. Completion of the Peer Review

The completion of the peer review will allow the finalization of the ESA report. As a result, the peer review process will entail the evaluation of comments and recommendations, utilization of peer review comments for completing the final report and database, and organizing and maintaining a record of the peer review.

Issues and observations raised by the peer review will be included in the front of the final report

and database, along with information on how they were incorporated or not incorporated in the final report and database.

1.10. Peer Review Record

The DND Project Manager shall collect and maintain the following materials as part of this peer review:

1.10.1 Interim report and database submitted for peer review;
1.10.2 Comments, information, and materials received from peer reviewers;
1.10.3 Any materials and information given to the peer reviewer;
1.10.4 Information about the peer reviewer(s) (e.g., names, affiliations, etc.); and
1.10.5 Any logistical information (e.g., times; locations; duration, etc.).

Jacques Whitford's Project Manager shall collect and maintain the following materials as part of this peer review:

1.10.6 Comments, information, and materials received from peer reviewers.

1.11. Schedule

The peer review is scheduled to take a total of three weeks to complete. Two weeks are scheduled for the independent review of the reports by each peer reviewer, and one week is scheduled for the agreement and consolidation of findings into a final peer review report. The proposed schedule is as follows:

1. Selection of peer reviewers	week of 3 April 2006
2. Distribution of and review by peer reviewers of the interim ESA report	3 – 13 April 2006
3. Agreement and consolidation of comments	17 – 20 April 2006
4. Submission of final peer review report	24 April 2006
5. Consultant's review of the peer review report / changes to interim ESA report	25 April – 12 May 2006
6. Delivery of final ESA report to MND/FFOC	12 May 2006

DND's Project Manager shall monitor the peer reviewers' progress to ensure timely completion.

1.12 Reimbursement of Costs

Peer reviewers will be invited to submit a proposal for the completion of the peer review, which will include confirmation of their availability as per the schedule outlined in the Terms of Reference, an estimation of the level of effort required to conduct this review and proposed fees for service or grant/contribution.

No travel is anticipated under this peer review. Any travel directly associated with this peer review process must be submitted and approved by DND's Project Manager.

2. INTRODUCTION – PEER REVIEW OF ESA

The Government of Canada has committed to identifying and reporting on facts surrounding the experimental use of Agent Orange and Agent Purple and other herbicides during the specific test periods in June 1966 and June 1967. The Government of Canada has also committed to identifying and reporting on facts surrounding the use of herbicides and any herbicide-related contaminants, particularly dioxins, sprayed at CFB Gagetown during the 8 to 12 weeks per year when spraying occurred each summer from 1952 to present day.

2.1. Background

The Department of National Defence is responsible for vegetation management on the 110,000-hectare training area at CFB Gagetown where large vast open grassland is maintained for the purpose of military training. Vegetation management, and access to the areas used for it, are tightly controlled. The use of herbicides has been a tool of choice to control secondary growth as well as to control fuel load in these grassed areas, where a mix of military activities have occurred.

Safety is paramount on the ranges which means targets must be visible, in some cases from as far away as four (4) kilometres. In order for this to be achieved, vegetation height and type also have to be controlled. In general, the base uses a variety of methods to manage vegetation growth in the training area, which in most part includes burning, spraying, cutting, crushing, and grubbing, and is always looking for alternatives with a lesser impact on the environment.

Grass burning is considered the most appropriate method in reducing the fire load and has the least amount of environmental impacts and cost. In addition, this method allows personnel to monitor the fire from a safe distance due to the presence of unexploded explosive ordnance (UXO). Spraying is another preferred method, as burning does not remove secondary vegetation, such as hardwoods, and softwoods, and it is effective and relatively low in cost per hectare. As well, it promotes personnel safety and removes the risk of interaction with UXO.

The Static Range Impact Area (SRIA) is located at the northern end of the Base. This is where all live firing occurs and where significant herbicides applications have occurred in the past and today. The SRIA is approximately 275 km^2 in area and has varied amounts of UXO. Live fire in the SRIA results in fires where there is an abundance of flammable material such as dry grass, stumps, shrubs, and forest re-growth. As a result, there continues to be a requirement to keep the SRIA free of softwoods and hardwoods in order to provide the military with line of sight during operations and to reduce the risk of wildfires resulting from live firing. The other areas where herbicides were applied were in the manoeuvre areas and dry training areas, which are in most

part used for mounted manoeuvres.

Grass burning is considered the most appropriate method in reducing the fire load and has the least amount of environmental impacts and cost. In addition, this method allows personnel to monitor the fire from a safe distance due to the presence of UXO. Spraying is another preferred method, as burning does not remove secondary vegetation, such as hardwoods, and softwoods, and it is effective and relatively low in cost per hectare. As well, it promotes personnel safety and removes the risk of interaction with UXO.

2.2 Review Criteria

Peer reviewers shall address/comment on the following:

2.2.1. Is the selected team of specialists that contributed and produced the report appropriate?
2.2.2. Is the material in the report presented in a clear, logical and concise manner? Is the report complete? Please explain fully.
2.2.3. In your opinion, does the Strategic Approach rationalize and validate the field investigation program in order to meet the overall objectives of the Environmental Site Assessment? Please explain fully.
2.2.4. Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate? Please explain fully.
2.2.5. Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable? Please explain fully.
2.2.6. Does the work conducted yield scientifically credible conclusions?
2.2.7. In your opinion, what are the weakest and the strongest aspects of the Strategic Approach and the Environmental Site Assessment that were developed to address the field investigation programs and the interpretation of the results? Please make suggestions on how the weakest parts can be strengthened.
2.2.8. Are there any elements missing from the report which you think need to be included or which would strengthen the documents? Please explain fully.
2.2.9. Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully.
2.2.10. Are the stated goals realistic? Are the stated objectives adequately met? Please explain fully.

Review Criteria	Review Comment	Jacques Whitford Response
Section 1.:	**Overall Assessment of ESA Report**	
1.0 PRP Decision: Acceptable with major revision	The PRP has decided that the ESA report should be regarded as acceptable with major revision. All reviewers were generally impressed with the strategic approach of the field sampling program in terms of the identification of herbicide mixtures used within the RTA, delineation of areas of herbicide use, prioritization of chemicals of concern, prioritization of areas within the RTA for sampling and establishing a spatial sampling design for surface soil, surface water, groundwater, sediments and vegetation to determine the horizontal extent of surface contamination. Portions of the report that the PRP felt required further revision are documented below.	Comment only – No action required
1.1 Need for Inclusion of Analytical Standard Operating Procedures for PCDD/Fs and other Detected Herbicide/ Herbicide contaminants.	1.1a The analytical standard operating procedures (SOPs) need to be included within the report for all analytes which had concentrations above analytical detection limits. The panel felt that they were unable to fully review the report because of missing information that would be contained in analytical SOPs. 1.1b Missing information included sample volumes (surface water and ground water) and sample mass (soil & sediment) collected by the field sampling program that was not identified in the field sampling protocols. Other aspects necessary to critically evaluate the quality assurance/quality control (QA/QC) parameters summarized in Appendix H were not available. 1.1c For example, the acceptable ranges of % recoveries of surrogate standard spikes added to blanks, SRMs and samples were not described. The acceptable variation associated with field duplicates was not described. The later parameters would be contained within analytical SOPs and would permit independent evaluation of the QA/QC data presented in Appendix H. The peer reviewers concede that laboratory certificate tables supplied on CD-ROM with the report identify EPA method 1613B for PCDD/F analysis, however, this published method allows for multiple extraction and clean-up strategies and does not address all the questions described above. 1.1d Another missing component was that the method of blank correction of samples was not described. The method and rationale for replacing non-detected data for PCDD/F with method detection limits was also not described. A specific statement should be included in the report to whether or not the analytical methods used to characterize PCDD/F congeners would have been capable of identifying PCDD/F congeners other than the 17 reported in the analytical tables (specifically the PCDDs likely to be contaminants in formulations containing 2,4-D) and whether or not non-quantified PCDD/Fs would likely be present as trace contaminants in herbicide formulations.	Agreed – Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns Agreed – these details have been included in the Field Sampling SOPs (Appendix B). Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns There is no accepted variation in field duplicates as they are merely an indication of the heterogeneity of the sample matrix. That being said anything above 30% would suggest a great deal of heterogeneity in the samples. This discussion has been added to Section 8.2 of the report. These congeners could have been detected and reported by the laboratory, however, given that they are much less toxic than other PCDD/F congeners and act in a different toxicological manner they are not included as part of the TEQ calculation and thus were not reported.

Review Criteria	Review Comment	Jacques Whitford Response
1.2 The report failed to address all likely sources of PCDD/Fs within the RTA and to explain the predominance of OCDD found within the majority of soil samples.	The panel felt that the report did not fully address the identification of PCDD sources within the RTA. The reviewers suggested that a site outside of the RTA, but within the general geographic region, should have been included in the sampling design as a background/reference location to distinguish long-range transport sources of PCDD/Fs from sources originating within the RTA. The reviewers were dissatisfied with the sparse report interpretation regarding the high contribution of octachlorodibenzo-p-dioxin (OCDD) to the total PCDD/F composition of soil samples from within the RTA. The strategic approach assumed that 2,3,7,8-TCDD represented the major PCDD/F impurity within Agent Orange and other herbicide formulations and that the enrichment of this congener within Category 1 and 2 APECs would have identified herbicide application as the main source of PCDD/F and could be appropriately measured as TEQ's for these areas. The results did not support this assumption and it was consistently observed that OCDD contributed the greatest amount of total PCDD/Fs on a mass concentration basis (although not on a TEQ basis) in surface soil samples throughout the RTA. The report provided some discussion to indicate that preferential microbial degradation of 2,3,7,8-TCDD relative to more chlorinated PCDD/F congeners could have led to the observed PCDD/F congener profiles. The review panel felt that there were multiple alternate hypotheses that could explain the high OCDD enrichment, including other environmental degradation mechanisms, differences in environmental mobility among the PCDD/F congeners, or atmospheric transport of different PCDD/F congeners both from inside the RTA (e.g. fires, combustion sources, spills etc.) and from outside regional sources (e.g. solid waste incinerators, metal smelters and other major regional PCDD/F sources). The panel felt that evidence (literature or direct laboratory analysis of herbicide formulations) should be included in the report to verify that OCDD and other identified PCDD/F congeners were indeed present within Agent Orange and/or herbicide formulations (such as 2,4-D, *2,4,5-T* and other herbicides such as pentachlorophenol) used within the RTA. The panel also agreed that data on concentrations, congener profiles of PCDD/Fs and TEQ5 be incorporated (even from literature review data) from other sites in the geographic region located outside of the RTA to better interpret whether or not the elevated TEQ5 and PCDD/F profiles measured in APECs 2 and 3 reflect exceptional conditions in the geographic region. The reviewers suggest that in addition to herbicide application use patterns, the consultants should also consider compiling data on fires and controlled bums within the RTA since PCDD/Fs could be produced as a consequence of organic matter combustion. Finally, it was felt that a concurrent analysis of sum PCDD/F concentrations between the APECs using appropriate statistical tests in addition to the interpretation of PCDD/F TEQ5 would provide valuable additional information about possible sources that are masked by the TEQ calculation.	Potential PCDD sources within the RTA have been included in the discussion relating to the Strategic Approach (Section 2.4). As to sampling outside of the RTA, this issue was proposed initially in the consultation for the design of the strategic approach (Stage 1 Report dated December 14, 2005). Clear direction was given to Jacques Whitford by DND that this Phase of the work was to necessarily remain within the RTA. An expanded discussion on this topic is now included in Section 8.2.4 of the report. Simply OCDD is the dominant congener in most environmental background and impacted soil samples collected globally. Therefore, it is not attributable to a single type of source of dioxin. A reference to literature confirming the potential existence of TCDD and TCDF as compounds formed as impurities during the manufacturing process of other compounds such as herbicides has been added to Section 2.2. In addition, text was added to Section 8.2.4. Regulatory agencies were contacted and literature was searched to gain information on relevant background contamination data in the Province. As a result, some text has been added to Section 2.5.5. The compilation of data on fires and controlled bums within the RTA, although relevant, was outside the scope of work for this initial phase of the presence/absence survey. This comment is addressed in detail below.

Review Criteria	Review Comment	Jacques Whitford Response
1.3 Failure of the field sampling design to account for vertical migration of PCDD/F in soils.	The panel had problems with the strategic approach in terms of whether the soil sampling design would have captured vertical migration of PCDD/Fs in soils and allowed robust estimates of total PCDD/F deposition on the soils. Although soil core samples were taken, the depth of soil cores was shallow (only 20 cm) and no data were presented on PCDD/F levels in soil cores. Other literature data (see Bruzy and Hites. *1995.* Environmental Science and Technology, 29:2090- 2098) indicate that vertical migration of PCDD/Fs varies widely among different sites depending on soil sorption properties for PCDD/F as defined by the soil organic matter content and depending on the total PCDD/F deposition at the site. The latter studies demonstrated that in some cases maximum PCDD/F distribution in soils occurred at depths between 40-50 cm and elevated PCDD/F concentrations occurred as low as 90 cm. While it is recognized that a major component of the field sampling program was to establish human exposure risk to herbicide and herbicide contaminants in surface soils, the failure to sample soils below a depth of 20 cm (cores) places limitations on the use of the field sampling program results to evaluate soil remediation strategies and on estimating the total PCDD/F or herbicide mass present in the site soils. There is also a risk that the location within the RTA containing the highest PCDD/F mass was not identified because of the focus on 0-10 cm surface soil sampling. The panel recommends that the Recommendations Section of the interim report be modified to include long-core sampling and analysis at selected sites (areas both enriched with PCDD/Fs, some of the category 2 APECs suspected of receiving PCDD/F inputs through herbicide applications and in background reference areas). The failure to analyze soil and sediment samples for soil organic matter content was an error in the strategic approach. Determination of soil organic matter content would have provided information about the potential for PCDD/F mobility within soils. Expressing PCDD/F concentrations on an organic carbon normalized basis could have provided additional interpretive value regarding the varying PCDD/F levels noted as well as PCDD/F bioavailability to soil invertebrates.	A review of the Bruzy and Hites article has been included in Section 4.1.1 of the report. The overall conclusion as to the proposed Strategic Approach remains unchanged as the 0-10 cm interval is the most appropriate for the initial field assessment study. Recommendations for more depth samples as well as for the analysis of organic carbon content have been added to the conclusions and recommendations. Section of the report. Disagree - Although soil organic matter content may have provided some information relevant to contaminant mobility, the PCDD/F TEQ for soil is not adjusted for soil organic matter content.. Regardless, recommendations for this analysis have been added for the suggested follow-up work.
1.4 Problems with data reporting, summary statistics and statistical tests	There were several problems identified with data reporting, summary statistics and statistical tests. With respect to data reporting, particularly for PCDD/Fs, data presented in the analytical results appendix G contained several errors in the units of measurements as well as notable differences in values from data reported in the electronic database. A large area of confusion in this respect had to do with the fact that method detection limits (MDLs) appear to have been substituted for non-detected data for some of the PCDD/Fs. This type of data handling did not appear to be used for other herbicides reported in appendix G. MDLs for PCDD/Fs are also variable across sample batches adding to the confusion on what constituted the substituted values. There was no description of how the consultants handled non-detected data for PCDD/Fs, nor how they performed blank corrections to censor the data included in the electronic database. It was apparent that at least some of the TEQ5 calculated contained manufactured data (i.e. MDLs substituted for non-detected values) yet these data were not explicitly identified within the report. It is recommended that all data reported in Appendix G that contain MDL substituted values as well as summary statistics (e.g. raw sample TEQ5 and mean APEC TEQs) that contain manufactured data should be indicated by using a subscript, bold text or italics text in the report. The panel also found errors in the presentation of basic summary statistics such as the arithmetic mean. In this case, the consultants appear to be including both duplicate analytical results as independent sample values for calculating mean and standard deviation TEQ5 among composite samples from each APEC. This error needs to be corrected. It was also observed that the posthoc comparisons performed with the analysis of variance was completed in an incorrect manner. This over-inflated the power of their post-hoc comparisons by subdividing contrasts between different APEC subsets. This is inappropriate because the same background samples are contained within each of the subset tests invalidating the Bonferoni correction applied to t-test contrasts. The consultants should re-perform the statistical tests using appropriate statistical procedures such as Dunnett's Test which is a multiple comparison test specifically designed to compare treatment groups against a single control (background APEC5).	Many of these statements are dealt with in more detail in Section 2.4 of the review. Section 8.2 of the report now provides details on how MDL data was treated. It is believed this should clear up most of the confusion and issues in this section. Uncorrected data tables have been included in Appendix G as Tables G-3, G-10, G-17, and G-24. Jacques Whitford agrees that duplicate samples should be averaged and presented in a single result in the statistical treatment of the data. This was the case for all soil samples reported. However, the Peer Review team correctly points out that the sediment sample duplicates did not get averaged. This has been corrected in the report in Section 8.2.6. It did not materially affect any of the conclusions of the report. Jacques Whitford disagrees with this assessment. ANOVA tests and post-hoc Bonferoni tests were applicable, as there were three distinct populations of types of APECs that were being compared to Background. Therefore, it was appropriate to conduct the test in this manner. The use of the Dunnett's Test could have also been appropriate if the basic hypothesis was as stated by the Peer Review panel. Regardless the Dunnett's test would provide a less conservative estimate of statistical variance in the data, thus the Bonferoni test is believed to be correctly applied in this case, and regardless is more conservative. No changes to the text or statistics were made.

Review Criteria	Review Comment	Jacques Whitford Response
1.5 Additional information that would have helped with the interpretation of the report.	The panel felt that additional information on priority chemical physicochemical properties including volatility, Henry's Law constants, soil mobility and half lives in water would have been helpful for inclusion in Table 2-2. The reviewers also felt that a table contrasting environmental quality guidelines with analytical method detection limits for the majority of herbicides not detected but analyzed for would have been helpful in Appendix G.	Details of this nature are found in the report for Task 2A of the CFB Gagetown Project. This has been completed and can be found at Appendix D and inserted in the body of the text as Table 4-3
1.6 Unclear goals for project with respect to environmental site assessment and environmental impact assessment.	The reviewers were not clear regarding the priority placed between overall project goals relating to an environmental site assessment (ESA) relative to those associated with an environmental impact assessment (ETA) given that components of both types of assessments were included within the DND statement of work. The panel agreed that the draft interim report, accepting the above criticisms, provided for a very strong ESA but would not fully satisfy the requirements of an ETA. A comparison of analytical concentrations with environmental quality guidelines is an important step, but it is a small component of a full ETA. Qualifying statements in the recommendation section of the report should be made to indicate that additional measures of receptor toxicity beyond the hazard assessment approach taken would be required in the ecological and human risk assessment to be implemented at a later date.	The DND SOW as presented and explained in various meetings, as well as the resulting Jacques Whitford accepted proposal were very clear in their objective to complete an Environmental Site Assessment aimed at determining the presence/absence of herbicides and their manufacturing impurities in the CFB Gagetown RTA only. Given that this was a presence / absence survey, details about how the ecological and human health risk assessment should be carried out are not appropriate. This will be up to the selected consultants and DND to discuss in future work.
Section 2. Peer review comments pertaining to peer review criteria outlined by DND terms of reference	DND Review Criteria questions supplied in the peer review terms of reference are presented in **bold** text. Summary statements and general recommendations generated by the Peer Review Panel pertaining to the DND review criteria questions are designated according to the numbering system: 2.1 .x... The summary statements and general recommendations were intended to highlight major findings and comments developed by the PRP under each criteria question subheading. Specific review comments are also included (numbered 2.1.1 .x) to provide more detail about reviewer findings. The specific comments included in the consolidated report were generated either by the PRP or as comments taken from individual peer review. All specific comments included in the consolidated report were reviewed by the PRP.	Comment only – No action required
2.1 Is the selected team of specialists that contributed and produced the report appropriate?	2.1.1 It was generally agreed by the PRP that the team of specialists employed by Jacques Whitford was appropriate to the goals and objectives of the project.	Comment only – No action required
2.2 Is the material in the report presented in a clear, logical and concise manner? Is the report complete? Please explain fully.	2.2.1 It was generally agreed that the report was presented in a clear, logical and concise manner. The rational for selection of priority chemicals, priority sampling areas and sampling design was well laid out. The data presentation using GIS-maps was very helpful, although in some cases (as identified below) the colour schemes used should have been more discriminatory. Missing components identified included: lack of analytical standard operating procedures and other details pertaining to data manipulation post analysis and a lack of description of herbicide use within the RTA after 2004. Sampling recently treated areas could have confirmed the presence of residues of the herbicides applied that year and would have facilitated estimates of their half-lives in soil at that site.	Comment only – No action required Due to the large number of features and products identified on the maps, the use of all distinguishable colors was made and underwent various modifications in an attempt to make the maps as clear as possible.. See above comment in Section 1.1 for analytical SOPs DND reported to Jacques Whitford that there were no herbicide applications made in the RTA post 2004. A detail to this effect has been included in the Introduction at Section 1.0 as well as in Section 2.3
	2.2.1.1 Once the reviewer/reader gets used to the countless acronyms and abbreviations (the alphabetical list was invaluable), the report is very clear, concise and easy to read. It is very well organized. Despite the complexity and numbers of tables, maps and other appendixes, items are fairly easy to locate.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
	2.2.1.2 One suggestion for the herbicide use maps is to choose a collection of colours that are more contrasting. For example, Roundup and Tordon are very different herbicides but their colours on the map were nearly indistinguishable.	Due to the large number of features and products identified on the maps, the use of all distinguishable colors was made and underwent various modifications in an attempt to make the maps as clear as possible. The electronic GIS provided in final report should alleviate issue limited by the printing
	2.2.1.3 Most of the objectives were met very well. A couple of exceptions are listed below. Although clearance of UXO is mentioned in the SOW, there is little discussion of this in the report. Perhaps, it should be removed from the SOW. In the SOW, there is mention (three times) that herbicides have been used at CFB Gagetown from 1952 and are still being used today. In the report, there is no mention of herbicide use at CFB Gagetown since 2004.	DND reported to Jacques Whitford that there were no herbicide applications made in the RTA post 2004. A detail to this effect has been included in the Introduction at Section 1.0 as well as in Section 2.3. The DND SOW cannot be changed. The issue of UXO was critical in the execution of the field work (safety issue), but not to the overall environmental aspects.
	2.2.1.4 The report is clearly and concisely written. The report presents clear explanations of the (i) focus of the ESA, (ii) the rationale for the approach taken in the investigation, (iii) extent of sampling and analysis of the soil, water and sediments, and (iv) the results obtained from the analysis of various samples, and (v) interpretation of the analytical results.	Comment only – No action required
	2.1.1.5 The report is generally complete, although more information is required for the analytical procedures used. There is very little information on the analytical procedures followed by the different laboratories. Although analyses were performed by the certified labs, some details on the protocols for analyses and/or standard methods used should be outlined.	Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns
	2.1.1.6 The investigation provides an initial environmental assessment of the site, and it is clear from the results that additional sampling and characterization of some areas of the site is required.	Comment only – No action required
	2.1.1.7 The report is clear and well organized. There is a good description of the delineation of sampling areas, number of samples taken and selection of sampling sites within each delineated sampling zone (APECs). Table 4-1 was extremely useful as a summary of sampling efforts. The large number of GIS-maps supplied with the report documenting sampling areas and analytical results were helpful for data visualization.	Comment only – No action required
	2.1.1 .8.The report did not include Analytical SOP's for critical parameters such as PCDD/Fs. Having went through the laboratory certificates CD, EPA Method 1613B was identified as being utilized for PCDD/F analysis. However, 1613B has some generalities associated with it (i.e. specifies different possible extraction protocols for water and different possible clean-up strategies for all matrices). Given that two different laboratories were used for PCDD/F, it would be useful to have analytical SOPs printed and included in an appendix. This information is also necessary to fully evaluate the QA/QC since trigger criteria used in the evaluation of analytical integrity of data are contained within the analytical SOPs. For example, while the text describes QA/QC evaluation of SRM's (i.e. use of control plots and Westgard rules), it does not describe minimum and maximum acceptable ranges for % recoveries nor does it describe maximum acceptable analyte concentrations in blanks. Analytical SOPs for other detected parameters e.g. polychlorinated benzenes would also be useful. Analytical SOPs for non-detected analytes should be provided in Adobe Acrobat — PDF file format on CD-ROM.	Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns

Review Criteria	Review Comment	Jacques Whitford Response
	2.1.1.9 Some of the sampling procedures were not evident. Despite a lot of digging in ancillary supplied material, the volume of surface water or ground water sample taken from sampling sites could not be located. This information needs to be included within the sampling SOPs. The current SOP merely indicates that the field operator fills up a supplied chemically cleaned bottle with sample but not how much sample was actually taken.	These details have been added to the Field SOPs at Appendix B
2.3 In your opinion, does the Strategic Approach rationalize and validate the field investigation program in order to meet the overall objectives of the Environmental Site Assessment? Please explain fully.	2.3.1 The reviewers were generally impressed with the Strategic Approach that involved 1) establishment of priority chemicals of concern, 2) establishment of areas of potential environmental concern and 3) development and implementation of a geostatistical sampling design within defined sampling areas of the RTA. The panel agreed that additional sampling in reference areas outside of the RTA would have benefited the project further to help identify regional sources as contributors to PCDD/Fs within the RTA.	Jacques Whitford was restricted to sampling background areas on the base as per directive by DND. It is felt that there was sufficient setback from the three background areas to the spray areas in the RTA to constitute true background. In addition, the prevailing winds in the summer at CFB Gagetown are from the southwest, placing the background areas up wind from spray areas.
	2.3.1.1 The Strategic Approach employed in the investigation involved development of a categorization system that delineated the site into different areas generally depending on areas of public concern, areas where the most potentially toxic contamination was expected, areas where human exposure potential was greatest, ecologically significant areas and background areas. Several Areas of Potential Concern were thus identified at the site for sampling and investigation. This approach provided a rationale for varying sampling intensity in different areas of the site, and thus targeting likely problem areas without intensive sampling of the entire, rather large site. Furthermore, the active ingredients and potentially toxic impurities of herbicide formulations applied to the site between 1952 and 2004 were identified and categorized in the context of their toxicological and physico-chemical properties that contribute to their persistence. This allowed for targeted analyses of chemicals of concern at the potential areas of concern. In the opinion of the Peer Review Panel, the Strategic Approach was appropriate for meeting the objectives of ESA as stated in the DND SOW.	Comment only – No action required
	2.3.1.2 The Strategic Approach provides a compromise in the ability to establish chemical contamination throughout the entire CFB Gagetown complex in order to better delineate areas of likely maximum contamination that would be of greater use towards developing ecological and human health risk assessments. The different APECs involve a wide range of spatial sizes and sampling densities that do not lend themselves towards spatial interpolation throughout non-sampled areas. The consultants seem to be aware of this limitation and restrict their data interpretation to the APECs themselves. The inclusion of APECs 'representative' of different land use patterns and herbicide application intensities partially overcomes the above issue however, and will allow weight of evidence approaches to be implemented for deducing likely contamination in the non-sampled regions of CFB Gagetown. The sampling protocol involving analysis of composites allowed characterization of average soil contamination in each APEC. This approach provided the ability to statistically contrast soil contamination in APECs which, in conjunction with herbicide application histories, could be used to deduce plausible contaminant sources. A very positive aspect of the Strategic Approach involved the ability to re-submit discrete samples forming a given composite to provide enhanced information on spatial trends of contamination within an APEC. This was a very efficient and effective way of identifying areas of maximum contamination and risk.	Comment only – No action required
2.4 Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate? Please explain fully	2.4.1 There was general agreement that the consultant's interpretation of TEQs with respect to environmental quality guidelines was very thorough and appropriately completed. There were a number of concerns raised about data reporting (i.e. identifying samples where non-detected values were substituted for method detection limits), problems with the calculation of summary statistics (i.e. including duplicates as independent samples in arithmetic means) and post-hoc comparisons of ANOVA results that should be addressed. These concerns are elaborated fully in suggested modifications (point 1.4) and in the comments below.	Disagree - See comments in Section 1.4 of this review response.

Review Criteria	Review Comment	Jacques Whitford Response
	2.4.1.1 There are a number of problems associated with data summary statistics and statistical tests used for data presentation. First, it only became apparent on close scrutiny of the data that some of the total TEQ values calculated for PCDD/Fs included MDLs in their estimation. While it is sometimes considered standard practice to substitute MDL's for non-detected data as a conservative approach to risk assessment, data that incorporate MDL's should be clearly marked and identified at all levels of data presentation. For example, mean APEC total TEQ values could include multiple MDL substitutions for different congeners among multiple composite samples. It is suggested that Table *8-5* of the report include two values for the mean APEC TEQ5. One calculated as currently reported, by substituting non-detected values with the MDL and a second by substituting a value of zero for non-detected values. This would at least allow readers to gage the contribution of manufactured data to the total PCDD/F TEQ estimate	See comments in Section 1.4 of this review response
	2.4.1.2 Having re-calculated some data (e.g. Swan Creek Lake Watershed sediment TEQ5) from the electronic database, it became apparent that the report included both duplicate samples in the calculation of the arithmetic mean and standard deviation. In other words, for 6 samples + 1 duplicate, the consultants appeared to calculate mean TEQ values as the arithmatic mean of 7 concentration values. This is inappropriate because it provides an extra weight towards the duplicate sample and also provides the wrong standard deviation. The authors should re-calculate mean and standard deviations of total TEQ5 in the report. For duplicate samples, the average of the two analytical estimates should be used as a single concentration value during the estimation of the arithmetic mean and standard deviation.	See comments in Section 1.4 of this review response. Again only sediment samples were miscalculated. They have been fixed in report and no material impact on report.
	2.4.1.3 The statistical distribution of the soil PCDD/F data was shown to be log-normal. This is also apparent from the high degree of heterogeneity of soil PCDD/F concentrations within most APECs. The consultants should include geometric mean data for each APEC in Table *8-5* in order to provide a comparable data with the ANOVA figures. As it stands, the rank order of total TEQ5 among the site differs between Figures 8-3, 8-4, *8-5* and Table *8-5*.	Although geometric mean concentrations could have been provided, there are always less than the arithmetic mean concentrations. Therefore, in order not to confuse the issue they were not included in the report.
	2.4.1.4 One suggestion is that the consultants perform outlier tests to distinguish exceptional high samples for the discrete samples that were analyzed from a given composite. This would help establish if elevated mean TEQ values are driven by a single soil sample as appears to be the case in most APECs where discrete samples were analyzed.	Given that means were typically based on composite samples it would not be appropriate to exclude outliers in summary stats. In the event there were outliers there will be a focus on this APEC for future work regardless.
	2.4.1.5 The statistical test (ANOVA) followed by post-hoc comparisons (Bonferoni-corrected t-tests) artificially inflates the power of the test because the consultants subdivided comparisons into smaller numbers of groups (k). For example, post-hoc comparisons are made between geometric mean TEQ5 between background, APEC 1, APEC 2 and APEC3 (Test #1, k=4 groups), then another set of post-hoc comparisons are made between background and APECs 10, 13, 14, 15, 16, 4, 7, 8, CLONES and MURPHY (Test #2; k = 11 groups) and a third set of post-hoc comparisons are made between Background and APECs 17, 18, 19, 20, 21, 22 (Test #3; k = 7 groups). Yet the total number of groups in the post-hoc comparison should always be k = 16, not k = 4 for test #1, k = 12 for test #2 and k = 7 for test #3. This is because the same background data is used in the three sets of tests, violating the independence of the separate comparisons. Having re-ran the ANOVA using all APECs **+** background and used Tukey's HSD (a more conservative multiple-comparison test), APECs 2 and 3 were shown to be no longer significantly different than background. The consultants should re-perform the ANOVA using appropriate statistical methodology. Dunnett's test is suggested as an alternate test as this multiple comparison test is designed to test multiple treatment groups against a control group.	Disagree. See comments in Section 1.4 of this review response
	2.4.1.6 The consultants tested for differences between mean TEQ values at MURPHY bivouac with background vales. This is problematic because the mean TEQ value for MURPHY is based on 6 discrete sample replicates while the background value is based on 6 composite replicates (i.e. incorporating 36 discrete samples). The two data sets are not directly comparable with one another, unless discrete background replicates are reanalyzed for comparison with discrete MURPHY replicates.	Agreed. However, this a imitation of the dataset and nature of the presence / absence survey. Each of the individual samples collected at bivouac sites can be considered a composite sample at a local scale, similar to the manner in which APECs were sampled. Regardless it is prudent to follow-up at the Murphy bivouac.

Review Criteria	Review Comment	Jacques Whitford Response
	2.4.1.7 Multivariate tests — principal components analysis. It was not apparent if the PCA was performed using a correlation (or autoscaled) matrix or a varian-covariance matrix. The panel had a difficult time interpreting Figure 8-6. The consultants should present this figure as mean centroid scores for a given site and include error bars on both the x- and yscales. The separation of samples sites within the PCA does not in itself provide any probabilistic assessment of differences in congener signatures as appears to be interpreted within the report. The consultants should perform a MANOVA on the PCA scores to test for significant differences between PCDD/F congener profiles among the APECs. Discriminate function analysis could then be applied (similar to post-hoc comparisons with the ANOVA) to characterize which APECs significantly differ with respect to contaminant signatures. The reviewers also had some concerns about the discriminatory power of their multivariate analysis because of the inclusion of so much manufactured data (i.e. MDL substituting censored data). Many sites will appear similar to one another with respect to chemical signatures simply because the same MDL data are being substituted in different sets of samples. Typically a set of rules are established up front, e.g. any given chemical being detected less than 50-60% of the time among all samples included in the PCA are removed as a dependent variable.	Agreed that significantly more statistics could be performed. However, given the nature of the presence / absence survey it is felt that the level of effort provided is sufficient. Preliminary discussions have been held with DND representatives to discuss that there is a tremendous potential to data mine the results contained within this report. However, for the purposes of environmental presence/absence survey it is felt this is sufficient detail. Given that the majority of PCDD/F and other COPCs were less than applicable guidelines this additional work may not be warranted.
	2.4.1.8 Figure 8-7 is not particularly meaningful. The consultants should instead provide a table of the loadings of each PCDD/F congener on each different PCA axis. This is in essence providing data on the correlation coefficient of each congener with each component axis. Given the expected contribution of 2,3,7,8-TCDD to Agent Orange formulations, it is probably better to determine if this congener has a strong loading (i.e. >0.7) to any on of the PCA axis rather than OCDD.	Disagree. This provides context to OCDD driving the PCA. Regardless, as above there is considerably more one could do with the datasets, which was outside this Scope of Work.
2.5 Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable? Please explain fully	2.5.1 The consultant used appropriate strategies to set priorities for chemicals **(COPC)** and areas of potential environmental concern (APEC). A good plan for sampling of priority areas was carried out followed by analytical determination of priority chemicals in samples from accredited laboratories. The report was particularly strong in the interpretation of analytical results in the context of environmental quality guidelines. There were some problems noted in the statistical comparison of TEQ5 among APECs that need to be addressed to fully support the report conclusions.	See above comments
	2.5.1.1 A Strategic Approach was employed to develop a categorization system that delineated the site into different areas generally depending on areas of public concern, areas where the most potentially toxic contamination was expected, areas where human exposure potential was greatest, ecologically significant areas and background areas in the site. Furthermore, the active ingredients and potentially toxic impurities of herbicide formulations applied to the site between 1952 and 2004 were identified and categorized in the context of their toxicological and physico-chemical properties that contribute to their persistence. This allowed for targeted analyses of chemicals of concern at the potential areas of concern. Data from the sampling and analyses at the site was performed methodically and documented adequately. Data was compared to regulatory criteria. Concentrations of COPCs were also compared to background levels. Soil screening levels were identified and the need for further sampling and analysis was identified. Further information on analytical procedures would be desirable, as stated above. Overall, the planning, data acquisition, data assessment and data interpretation was technically acceptable.	Comment only – No action required Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns
	2.5.1.2 There is agreement with the planning and data acquisition components of the report. However, a number of issues with respect to presentation of analytical data, summary statistics and statistical tests that could have small impacts on the interpretation of the data have been identified. For example, the conclusion that APEC 2 and APEC 3 exhibit significantly different mean PCDD/F TEQs than background areas appears not to be true owing to inappropriate statistical testing procedures. However, the conclusion that a number of composite and discrete PCDD/F TEQ values exceed environmental quality guidelines in these areas, are not disputed. Overall, suggested modifications to data analysis should reinforce many of the conclusions in the report	Disagree. As stated in Section 1.4 of this review Jacques Whitford believes that the statistical tests applied were appropriate. Regardless, it does not materially impact the outcome of the findings that there are elevated concentrations of PCDD/F in APEC 2 and APEC 3, whether they are statistically different than background soil concentrations.

Review Criteria	Review Comment	Jacques Whitford Response
2.6 Does the work conducted yield scientifically credible conclusions?	2.6.1 There is general agreement that a number of the conclusions generated by the report are scientifically credible. The review panel was in agreement with the rational for delineating priority chemicals, sampling areas and most aspects of the sampling design. Some of the report interpretations, such as changes in PCDD/F congener profiles over time related to microbial degradation provide credible hypotheses but require further research to substantiate. Conclusions regarding the identification of sources of PCDD/F to the RTA remain unsubstantiated at this time.	Further discussion on potential global sources of PCCD/F at CFB Gagetown are now provided. Further interpretation or research is beyond the Scope of Work for this project and could be considered by DND in the future.
	2.6.1.1 The major conclusions about the residues of COPCs detected and how they compared to background and environmental quality guidelines established by governments is scientifically credible. However, the main body of the report should include a table that compares the limits of detection (LOD5) and limits of quantitation (LOQ5) for the COPCs from the laboratories involved with the environmental quality guidelines established by various levels of government. This accommodation should not pose a problem but these comparisons seem needed to confirm the credibility of the work.	Agree. As above Table 4-3 and Appendix D have been modified as per this comment.
	2.6.1.2 Some very interesting scientific hypotheses emerged from the study. One was the comparison of PCDD/F congeners at CFB Gagetown versus a site where Agent Orange was used in Viet Nam. The data suggested that the congener profiles were different. This would be interesting to follow further in a research context. However, it would be essential to know the analytical capabilities for the various dioxin congeners for the Viet Nam analyses vs the analyses in this report. Do the differences, if real, reflect different chemicals and contaminants applied in the two areas or differences in ability to detect the different PCDD/F congeners? Another hypothesis was that OCDDs degrade in soil more slowly than lesser chlorinated PCDDs and that over time, OCDDs might be the remaining PCDD residues that predominate. At this point, these two hypotheses are logical interpretations of the data to suggest. However, more actual research would be needed to test these hypotheses.	Agree. In order to make much more interpretation out of this preliminary work then considerable time and investment would be required.
	2.6.1.3 The work conducted provides a preliminary estimate of the extent and level of contamination by various COPCs investigated. The sampling and analyses have been performed in a generally credible manner and thus provide credible conclusions.	Comment only – No action required
	2.6.1.4 The consultants implemented an appropriate geostatistical sampling design, field sampling quality assurance protocols and appropriate laboratory quality assurance/quality control protocols. The overall assessment of presence/absence of priority herbicides and herbicide impurities within the RTA is based on scientifically sound risk assessment procedures. There are weaknesses in aspects of the data presentation (incorrect units, inconsistencies in data tables), summary statistics (i.e. incorporating duplicates as independent replicates in computing APEC mean TEQ values) and statistical tests (inappropriate post-hoc comparisons) that can be fixed within a final report. There are some weaknesses in the sampling approach, such as the failure to sample a background site outside of the RTA to control for long-range transport sources and failure to determine soil organic carbon content to evaluate potential transport and fate of persistent hydrophobic contaminants such as PCDD/Fs within the RTA. The soil organic carbon content can easily and economically be performed on archived soil composite and sediment composite samples. The background data on priority chemicals in reference areas outside of the RTA could be added by literature review. These weaknesses do not necessarily invalidate the current findings, but should be addressed within the final report to reinforce interpretations especially with respect to PCDD/F sources in soils of the RTA.	Jacques Whitford has made corrections to the final report based on the findings of the Peer Review with respect to errors in reporting of units in some tables. Jacques Whitford was restricted to sampling background areas in the RTA as directed by DND. It is felt that there was sufficient setback from the three background areas to the spray areas in the RTA to constitute true background. The analysis of soil organic carbon content has been included in the recommendations.

Review Criteria	Review Comment	Jacques Whitford Response
2.7 In your opinion, what are the weakest and the strongest aspects of the Strategic Approach and the Environmental Site Assessment that were developed to address the field investigation programs and the interpretation of the results? Please make suggestions on how the weakest parts can be strengthened.		
Strongest Aspects:	2.7.1 The strongest aspects of the report were the strategic plan and methods for setting priorities in terms of designating priority chemicals and sampling areas. All reviewers were impressed with sample compositing approach and the fact that consultants provided a follow-up analysis of discrete samples for areas having elevated contaminants of concern. All of the reviewers agreed that the extensive data presentation using Tables and GIS-maps and figures was very clear and helpful.	Comment only – No action required
	2.7.1.1 The strategic plans for the study and the methods for setting the priorities were excellent. It was evident that an experienced, competent team was in charge. The work was well organized and the reports were well prepared. The results were perhaps more brief than expected since residues of so few of the many COPCs were detected and only some PCDD/F residues in a few areas exceeded established environmental quality guidelines.	Comment only – No action required
	2.7.1.2 Adding a table that compares the laboratory LODs and LOQ5 for the COPCs with the maximum residues that meet established environmental quality guidelines will confirm the credibility of their data and their conclusions.	Added to Table 4-3 and Appendix D
	2.7.1.3 Clear presentation of approach for the study.	Comment only – No action required
	2.7.1.4 Clear documentation of areas sampled, no. of samples taken, compositing strategy, and presentation of concentrations in COPCs sampled.	Comment only – No action required
	2.7.1.5 The strongest aspects of this report involved the initial evaluation process to prioritize herbicides and herbicide impurities and delineate APEC areas based on herbicide application histories and land use patterns. The consultants did a superb job of establishing appropriate geostatistical sampling designs within the designated APEC sampling areas. The QA/QC procedures implemented, both with respect to field (i.e. use of field blanks/trip blanks) and analytical (blind submission of sample duplicates, surrogate standard recoveries, laboratory blanks and SRMs) was well conceived. The consultants also did a very thorough job of summarizing analytical results using a wide variety of maps and tables to clearly document the locations and spatial relationships of sampling sites (both composite and discrete samples) that had priority contaminant concentrations in excess of environmental quality guidelines.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
Weakest Aspects	2.7.2 The weakest aspects of the report involved missing information on analytical SOPs necessary to fully evaluate quality assurance/quality control parameters, aspects of the sampling strategies employed such as a failure to include reference sampling areas outside the RTA to characterize regional sources of chemicals of concern, sampling only 10 cm of top soil and failure to analyze for soil organic matter content. There were also errors in the statistical methods employed to deduce differences in TEQ5 between sampling areas. Suggestions for how the consultants can address these weaknesses are provided in individual review comments as well as in other reviewer criteria questions covered within the consolidated peer review report.	Agreed – Only summary SOPs have been included as Appendix L to the report as the full detailed SOPs were not released by the analytical laboratories for proprietary reasons/concerns. Potential PCDD sources within the RTA have been included in the discussion relating to the Strategic Approach (Section 2.4). As to sampling outside of the RTA, this issue was proposed initially in the consultation for the design of the strategic approach (Stage 1 Report dated December 14, 2005). Clear direction was given to Jacques Whitford by DND that this Phase of the work was to necessarily remain within the RTA. A review of the Bruzy and Hites article has been included in Section 4.1.1 of the report. The overall conclusion as to the proposed Strategic Approach remains unchanged as the 0-10 cm interval is the most appropriate for the initial field assessment study. Recommendations for more depth samples as well as for the analysis of organic carbon content have been added to the conclusions and recommendations. Section of the report. Although soil organic matter content may have provided some information relevant to contaminant mobility, the PCDD/F TEQ for soil is not adjusted for soil organic matter content.. Regardless, recommendations for this analysis has been added for the suggested follow-up work. See above comments
	2.7.2.1 Rationale for sampling only the 10 cm of top soil and not any deeper, was missing.	See above comments
	2.7.2.2 Background concentrations of COPCs in the general region of CFB Gagetown were not determined.	See above comments
	2.7.2.3 The main weaknesses of the report were: 1) failure to include analytical SOPs making independent evaluation of QA/QC parameters difficult or impossible; 2) inconsistencies and direct errors in hard copy reports of analytical results included in appendices, 3) failure to identify both in raw data included in appendices and in summary statistics of total TEQ values when method detection limits were substituted for non-detected values; 4) errors in the calculation of summary statistics such as including duplicates as two independent values when generating mean and standard deviations; *5)* incorrect statistical tests for post-hoc comparisons of total TEQ5 between APECs and 6) failure to analyze for critical soil parameters such as total organic carbon content. Most of these weaknesses, with the exception of 6, can be corrected by re-analyzing existing analytical results or including additional materials within the appendices of an updated report. Specific aspects of these weaknesses are documented more fully in comments below.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
2.8 Are there any elements missing from the report which you think need to be included or which would strengthen the documents? Please explain fully	2.8.1 Analytical standard operating procedures were the most consistently identified missing item from the report by the PRP teleconference. It was felt that hard copies of laboratory specific SOPs should be included as an appendix for each of the detected priority chemicals of concern. The panel was also interested in determining if the PCDD/F analysis methods were capable of detecting additional PCDD/F congeners potentially present in herbicide mixtures but not part of the 17 priority 2,3,7,8-subsituted congeners included in the analytical results section.	See above comments
	2.8.1.1 In the history of herbicide use at CFB Gagetown, 2,4-D was used more than perhaps any other herbicide because it is often combined with either 2,4,5-T, fenoprop, dicamba, dichlorprop, or picloram. (It is suspected that “Sylvaprop” in Table 2.4.1, p 17, is 2,4-D + dichlorprop).The other herbicides have each had their major use period but 2,4-D is often included as the second herbicide in the formulation. The most likely dioxin contaminants in 2,4-D are dichlorodioxins, trichlorodioxins, or perhaps the 1,3,6,8-tetrachloro-dibenzo- p-dioxin, none of which are nearly as toxic as 2,3,7.8-TCDD. Table 8-3, page 122 should include the likely dioxin contaminants of 2,4-D. If the analytical methods should have “seen” the likely dioxins in 2,4-D, this should be clearly stated. If the analytical methods would not have seen these dioxins, this is a serious omission.	See above comments
	2.8.1.2 Missing Items: a) Analytical SOPs for PCDD/Fs and polychlorinated benzenes b) Tables added to Appendix H that document threshold criteria that would result in failure of QA/QC review; c) Identifying all data that contain manufactured results (i.e. substitution of MDLs for analytical values) within the report, including raw data presented in appendices, TEQ calculations and summary statistics e.g. mean TEQs within a given APEC;	See above comments
	2.8.2 The PRP felt that inclusion of PCDD/F soil concentration data from outside the RTA, but representative of regional background areas, would be of high value towards characterizing potential sources of PCDD/F in the RTA and also to establish if the relative exposure risk to dioxin-like toxicity was exceptionally high within the RTA. The latter could be addressed at present using literature data.	See above comments
	2.8.3 It is also suggested that some areas of the RTA receiving herbicide applications during 2004 and 2005 should have been sampled and analyzed. Comparison of analytical results in these areas would provide good confirmatory evidence for the lack of persistence of applied herbicides over a relatively short duration.	As See above comments
	2.8.3.1 In the SOW, there is mention (three times) that herbicides have been used at CFB Gagetown from 1952 and are still being used today. In the report, there is no mention of herbicide use at CFB Gagetown since 2004. What happened during 2004 and 2005? Were herbicides used? Were these treated areas sampled and analyzed? Confirming residues of the actual herbicides as well as their contaminants in areas treated in 2005 would have provided nice “0 time” data for comparison with the other results. It would also confirm the ability of the laboratories to detect the herbicides involved and would facilitate estimates of herbicide half-lives in soil at these sites.	See above comments
	2.8.4. Some components could have used further explanation. For example, the method of randomization of sampling sites within the wide-area sampling zones (page 36) was not fully described as it was in the targeted sampling areas. Details about the randomization — e.g. were each of the 6 sectors in a wide-area APEC subdivided into a grid with random selection of cells for sampling? Were there dispersion criteria i.e. samples could not be spaced less than 10 m etc. apart?	Section 4.1.2.1. in the report was expanded to include a description of the methodology for sample location selection in APECs 1 to 14 as well as all 3 Background Areas.

Review Criteria	Review Comment	Jacques Whitford Response
2.9 Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully	2.9.1 The reviewers were not aware of equivalent studies of this nature with the possible exception of the Vietnam PCDD/F soil enrichment/human risk assessment studies that are already cited as part of the report. The reviewers were confident that soil PCDD/F data sets do exist for the East Coast to provide some comparison with sum PCDD/F concentrations and PCDD/F contributed TEQ5 measured in soils at CFB Gagetown. The PRP suggests that a more thorough literature review be performed by the consultants to include such data within their report.	Regulatory agencies were contacted and literature was searched to gain information on relevant background contamination data in the Province. As a result, some text has been added to Section 2.5.5 of the Report. A thorough literature review is considered to be outside of the scope of the current contract.
	2.9.1.1 The team should have done a more thorough review of the literature and presented more material on the physical/chemical properties and characteristics of the chemicals present, especially on all or the COPCs. Information on expected half-lives in soil was a start. Information on volatility, soil mobility and half-lives in water was also needed to help interpret the results.	Again this is information contain in CFB Gagetown Task 2A
	2.9.1.2 The prevalence of OCDD as the major PCDD contaminant detected was unexpected for the peer reviewers and wasn't listed as a high priority by the study team. It is a likely contaminant of pentachlorophenol but quite unlikely to be a contaminant of the other COPCs used at Gagetown. Pentachlorophenol was one of the herbicides detected at one site. Is there a recent use of this product to explain this? More literature review on the occurrence of OCDD as a contaminant and on its persistence is needed for the report.	See above comments – agreed that it is also a contaminant of PCP, however, PCP was only applied in limited areas at the base. See Section 8.2.4 of the report for further discussion
	2.9.1.3 Related literature that could be helpful Bruzy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098. Albrecht, I. D.; Barkovskii, A. L.; Adriaens, P.. Production and Dechlorination of 2,3,7, 8-Tetrachlorodibenzo-p-dioxin in Historically-Contaminated Estuarine Sediments. Environmental Science and Technology (1999), *33(5),* 737-744.	Jacques Whitford has retrieved these articles and referenced as appropriate in the final report.
	2.9.1.4 The report is appropriately focussed on data generated as part of the field sampling program. The subsequent ecological and human risk assessment will involve greater emphasis on additional literature. However, the authors should have included literature review data within the report to document the range of PCDD/F congeners and TEQ5 within soil, water and sediments of other background areas in the province of New Brunswick. This would facilitate much better understanding of the relative risk presented by PCDD/Fs related to herbicide spray events. There is also a need to establish whether the Category 5 designated APECs are truly representative of background contamination, especially given that Category 5 APECs were not shown to have the lowest amount of chemical contamination.	See above comments
2.10 Are the stated goals realistic? Are the stated objectives adequately met? Please explain fully	2.10.1 **A large** focus of the individual review comments were directed towards the degree to which the project fulfilled project objectives as specified by the DND statement of work (SOW) and are compiled in Section 3.0 of the consolidated peer review report. Notably, the reviewers agreed that most aspects of the DND SOW were fulfilled and that the project provided a good environmental site assessment, particularly for PCDD/F in soils. As detailed in suggested modifications, Point #1.6, not all aspects of an environmental impact assessment could have been realistically addressed within the time constraints of this study. The reviewers were impressed with the detailed comparison of soil PCDD/F contributed TEQ5 with existing environmental quality guidelines. Some shortcomings were noted with respect to the delineation of possible PCDD/F sources to soils in the RTA. Because the proximity of selected background sampling areas did not appear to be sufficiently isolated from category 1-2 APECs, it was felt that data from outside the RTA should have been secured to distinguish regional atmospheric deposition of PCDD/F as potential sources. There were also shortcomings related to the depth of the soil core samples (see Point # 3.3a.6 of Section 3).	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
Section 3. Peer review comments pertaining to DND SOW Consultant Services Task 2B Objectives	Specific peer review comments generated by the PRP were also organized according to project objectives as outlined by the DND SOW Consultant Services, Aug 16 2006 and are numbered below. The Task 2B Project Objectives in the SOW are supplied in **bold** text. Specific comments generated by the PRP are numbered accordingly in normal text.	
3.1 The Consultant shall conduct the ESI as necessary to meet the following project objectives and requirements: **3.1a Development of a communication plan to address management and site activities.**	3.1a1 A communication plan was developed and described in the report.	Comment only – No action required
3.1b Development of a health and safety plan for all field activities.	31b.1 A health and safety plan was developed and described in the report.	Comment only – No action required
3.1c Conduct a field investigation program using a logical, structured, and cost effective approach. The information gathered will assist in developing a strong, factual, and defendable understanding of the extent and severity of present and predicted future environmental impacts in areas of suspected environmental concerns.	3.1c1 The field investigative program was completed and described by the interim report. The reviewers were impressed with the geostatistical sampling design and quality assurance/quality control procedures implemented within designated sampling areas of the RTA. The information gathered from the field sampling program will be of high values towards future environmental impact studies that may be conducted within the RTA.	Comment only – No action required
3.1d Collect and have analysed media that may consist of soil, sediment, ambient air, vegetation, groundwater, and surface water samples over a representative area using consistent sampling procedures and QA/QC program. The intent is to evaluate parameters applicable to this investigation, in comparison to background levels and in comparison to applicable guidelines.	3.1d1 Samples of surface soils, soil cores (20 cm depth), surface water, sediment, vegetation and groundwater were collected using consistent sampling procedures, field blanks and field duplicates. Priority chemicals of concern were analyzed in the collected samples at various accredited laboratories which adopted additional quality control/quality assurance procedures to ensure the production of a robust data ect. All analytical data were interpreted to deduce spatial patterns of priority chemicals within designated sampling areas of the RTA and to contrast residue levels with existing federal and provincial environmental quality guidelines.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
3.1e Manage and coordinate analytical testing with an accredited laboratory.	3.1e1 Samples were analyzed for identified priority chemicals of concern by accredited analytical laboratories.	Comment only – No action required
3.1f Interpret all physical and chemical data compared to background data, applicable regulatory criteria, project objectives, and future operational use to determine the level of on-site and potential off-site environmental impacts. This information will be used to establish the extent and severity of potential environmental impacts.	3.1f.1 All chemical data were compared to applicable regulatory criteria to provide **a** screening level hazard assessment for potential on-site environmental impacts. Spatial contamination of detected priority chemicals of concern were compared with areas within the RTA designated as background/reference areas. Data on background concentrations of priority chemicals of concern outside of the RTA, but representative of the region, were not provided. Without the latter information it is somewhat difficult to place the severity of potential environmental impacts into proper context. However, the consultants have provided some interpretive statements as to the degree of severity, based on number of samples and magnitude of concentrations by which sample residues have exceeded existing environmental quality guidelines.	See above comments
3.2 Background Levels: The identification of background levels representative of the area is vital to the determination and clear understanding of true environmental impacts associated with the use of herbicides in the RTA. Factors to consider (but not be limited to), in determining background levels include other potential sources of herbicides, metabolites or herbicides contaminants, and other types of activities or incidents which may have contributed to the presence of these substances;	3.2.1 Sampling of areas of the site where there were no records of herbicide application, and the biophysical environment was representative of the areas of concern at the site, were undertaken. The concentrations of target chemicals at the background areas were found to be low.	Comment only – No action required
	3.2.2 There is no data presented in the report on wind directions that would allow assessment if herbicides or herbicide contaminated surface soils could be transported to the background areas.	Section 2.5.5 provided details that the predominate wind direction in the summer at CFB Gagetown is generally from the sourthwest (Environment Canada meteorological data). Therefore all three background locations would be located up wind of the applied areas. There was also a set back of at least 2 km from nearest application APEC.
	3.2.3 Some sampling should have been carried out in areas outside the RTA, and where herbicide application or other anthropogenic activities do not occur. These would have provided a better estimate of the background concentrations of the various target contaminants in the general region where the RTA is located.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
	3.2.4 The sampling strategy did not include the entire RTA in its coverage, but rather used a directed sampling approach among 22 pre-defined sampling zones (APECs) that varied in spatial dimensions but encompassed different exposure risks (i.e. herbicide application histories) and land use patterns. From Map 2-3, it would appear that roughly 30-40% of the total RTA area was sampled as part of the APEC coverage. The focussing of sampling effort within designated APECs appears to be well justified given limitations in sampling effort, analytical expenses and need to address both spatial coverage of contamination as well as to identify potential hot spots within the RTA that will later be useful to the ecological risk assessment. The large spatial coverage of Category 2 and 4 APECs should provide adequate representation of background herbicide levels within the RTA. Further extrapolation to non-sampled areas can be inferred by weight of evidence approaches and considering land use patterns in a manner similar to those used to designated different APEC categories.	Comment only – No action required
	3.2.5 The inclusion of three background reference APECs permitted comparison of detected herbicides and trace contaminant impurities between Category 1-4 APECs with assumed unimpacted areas within the RTA (Category *5* APEC5). As in all cases involving selection of reference locations, the criteria for selecting category *5* APEC reference areas are somewhat subjective and the close proximity of some background areas (e.g. background area 1 to APEC 1, background area 2 to APEC 3 and Background area 3 to Murphy Bivouac) to hotspots suggest a potential for background areas to have become contaminated as a result of chemical dispersion over time. It would have been appropriate to include at least one additional background area outside of the RTA to ensure environmental dispersion within the RTA did not compromise the designation of Category *5* APECs as background reference areas. Interestingly, lower than background levels (non-detection of most herbicides) and low PCDD/F TEQ values were observed in some of the APECs (e.g. APEC #22). The consultants should provide additional literature review of PCDD/F concentrations and TEQ estimates in other New Brunswick areas deemed to be unimpacted to contrast with that of Category *5* designated APECs.	See above comments
3.3 Field Investigation: The Consultant shall conduct a field investigation program that may take the form of test pits, boreholes, monitoring wells, and sampling to determine, as required:		
3.3a The types, physical-chemical characteristics, concentrations, and volumes of the contaminants present. Determine the state in which they occur in the saturated and unsaturated zones (e.g. dissolved, immiscible, and/or vapour phases);	3.3a.1 The team should have done **a more thorough** review of the literature and presented more material on the physical/chemical properties and characteristics of the chemicals present, especially on all or the COPCs. Information on expected half-lives in soil was a start. Information on volatility, soil mobility and half-lives in water was also needed to help interpret the results.	This information is captured in Task 2A
	3.3a.2 Some relevant physico-chemical properties of the target contaminants, namely, carcinogenic, biomagnification, bioaccumulation potentials, the octanol-water partitioning coefficient (as a measure of hydrophobicity), persistence and probable half- lives of the contaminants have been listed in Table 2-2, Page 19. Appropriate references should be provided for the data on Log Kow and half-lives of the COPCs shown in Table 2-2.	This information is captured in Task 2A

Review Criteria	Review Comment	Jacques Whitford Response
	3.3a.3 The concentrations of the COPCs were determined in soil, sediment, plant, surface and groundwater samples. Generally PCDD/Fs were found in all soil, sediment, surface and groundwater samples and in *25%* of the plant samples. Several samples had levels of PCDD/F at concentrations higher than that of the CCME criteria. OCDD was the most abundant congener in the majority of the soil samples and the maximum OCDD concentration encountered in a sample was 34,000 pg/g. Some of the other COPCs were detected only in a few samples and were always found to be below environmental quality criteria, if any were available for those compounds.	Comment only – No action required
	3.3a.4 The report does not contain any discussions on whether the COPCs present in soil were sorbed on soil, or present in dissolved or gas phases.	The COPCs that were present in soil were measured as being sorbed on soil and not in the dissolved or gas phase. This would have required different type of sampling and analysis and would be out side the scope of the presence / absence survey.
	3.3a.5 The volume (or mass) of contaminants present in the site was not estimated in the report. Given that the number of samples obtained from each well-defined APEC was recorded, the mass of contaminants present in the surface soils can be estimated easily.	Although this value could have been generated it is not deemed relevant for this ESA. This calculation becomes more important during risk management planning.
	3.3a.6 It should be noted that the reporting of the PCDD/F concentrations in soil and sediment samples from the site in terms of the TEQ (toxic equivalent factor) does not provide a direct understanding of the mass of PCDD/F in the soil and sediment samples. PCDD/Fs are commonly found as complex mixtures of different congeners in environmental media. All congeners are not taken up by receptors in equal amounts and the toxicity of each congener may be different to a receptor. To derive a single value that is indicative of the overall toxicity for the mixture of congeners present in a sample, the concentrations of each congener is multiplied by a toxicity equivalent factor (TEF). This suggests that the toxicologically significant congeners are being weighted more than other congeners. Although this may be very appropriate in the context of risk assessment, use of TEQ may pose some disadvantages in understanding the true extent of PCDD/F distribution in soils and sediments, and its transport and fate after release from sources. If the estimation of contaminant masses at the site is an objective, studying the concentration of all tetrathrough octa- homologues with equal importance is perhaps more helpful for understanding the extent of environmental contamination.	This information can be found in Appendix G where the total concentrations of each congener are reported along with the TEQ.
	3.3a.6 The rationale for sampling the top 10 cm of soil is unclear. It may have been based on the Vietnam Study by Hatley Consultants. In effect the sampling procedure presented in the report assumes that 0-10 cm of the surface retains the majority of the PCDD/Fs deposited. This assumption, if incorrect, may have lead to underestimation of PCCD/F concentrations and masses at the site. The work of Bruzy and Hites *(1995)** should be considered in deciding on soil sampling depths. Bruzy and Hites (1995) observed that most PCDD/F was present in the upper *25* cm of the soil for soils sampled at various sites. However, at sites where heavy PCDD/F deposition occurred and the soil had very low organic matter the PCDD/F was distributed over a depth of up to 90 cm of the soil with maximum concentrations at the *40-50* cm depth. Sampling 0-10 cm of the soil horizon, would have severely underestimated PCDD/F concentrations at such sites. The anomalous behaviour at sites where the PCDD/F was distributed over depths of up to 90 cm is attributed to the fact that the capacity of the upper A horizon of the soil (i.e. depth of soil corresponding to the organic rich layer) to adsorb PCDD/Fs was exceeded due to excessive PCDD/F deposition and the relatively low amounts of organic carbon. The surface soil column may be considered analogous to the stationary phase in a chromatographic system, and the capacity of the soil to retain PCDD/F will depend both on the amount of PCDD/F being deposited on the soil and the amount of organic carbon in the soil (stationary phase thickness). *Bpazy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
	3.3a.7 It is unclear if the concentrations of chemicals are reported on the basis of soil dry weight or wet weight. This should be clearly stated in data tables. The use of dry weight of soil instead of the total weight can cause soil concentration magnitudes to change by up to approximately 20%. For PCDD/F, the literature indicates that both dry and wet mass of soils have been used by various studies to compute PCDD/F soil concentrations. For example, Grundy et al., 1997; Fattore et al., 1997, and Chen et al., 2003 have used soil dry mass to quantify PCDD/F soil concentrations whereas the soil wet weight has been used by Wagrowski and Hites, 2000, and Bruzy and Hites, 1995.	Concentrations are reported as dry weight.
	3.3a.8 The rationale for selection of analytes to be examined was based on historical use of herbicide formulations within the RTA along with additional consideration for bioaccumulative trace impurities (PCDD/F and HCB) present in some of the herbicide formulations used. With the exception of the most recent two years, the consultants appear to have done a thorough job of compiling herbicide application histories in the RTA and summarizing this data in Appendix A. A rational was provided for ranking herbicides and herbicide impurities as category 1 and category 2 priority chemicals based on risk to human health, potential carcinogen status, bioaccumulationlbiomagnification potential, environmental persistence and application history. Category 1 chemicals (high risk category) received more intensive study with respect to the number of samples analyzed (between 2 17-342 samples) than category 2 chemicals. The difference in analytical effort between chemical categories appears justified by the above criteria.	Comment only – No action required As stated by DND, the last year of application of herbicides in the RTA was in 2004.
	3.3a.9 This project would have benefited from the use of background tracer chemicals, e.g. PCBs or other ubiquitous contaminants that may be found within the RTA as a result of long range atmospheric transport processes or other sources not directly related to herbicide applications. Had the consultants included these types of tracers in their analysis they would have been better able to distinguish herbicide application sources of PCDD/F sources compared to other non-specified sources e.g. transport from air or other vectors. The inclusion of such analytes would have also greatly aided the discriminating power of the multivariate analysis.	Agree. The Peer Reviewers raise an interesting concept about the use of PCBs as a tracer for these samples and may provide additional information on the type of aerial distribution and source loading to CFB Gagetown. However, if DND wishes to pursue this option Jacques Whitford cautions that PCBs are not globally transported at the same rate as dioxins and furans and this would have to be a very carefully planned out exercise.
3.3b The subsurface geology of the site including type, thickness and changes in soil stratigraphy, heterogeneity, depth to bedrock, presence of confining layers, soil profile and the presence of underground anomalies;	3.3b.1 Qualitative descriptions of the surface geology and topography of the site and of the sampling locations have been provided. The depth of surface layers and deposits have been stated in Section 1.1. Average estimates of groundwater hydraulic conductivity, depth of the water table and the bedrock depth have been stated.	Comment only – No action required
	3.3b.2 There is no information provided on the soil organic matter (SOM) content of soil and sediment samples. The SOM level has a strong effect on the vertical distribution ofcontaminants and soils with low SOM may require sampling over depths greater that 10 cm. Further discussion on this is presented above.	See above comments
	3.3b.3 Map No. 1.2. details surface geology of the entire RTA separated into SandlGravel, Till, Ablation Till and Bedrock categories. The data used to generate the map were obtained from DND without confirmation. Additional information concerning landscape characteristics, vegetation coverage/type, visual characteristics of soil for each APEC are provided in Chapter 7.0 and Appendix E of the report. While useful, the latter details are mostly qualitative and of limited use for assessment of soil characteristics with respect to understanding contaminant fate within soils. Analytical determination of soil characteristics such as total organic carbon content would have been highly relevant towards further understanding PCDD/F distribution within the RTA. Additional parameters such as soil moisture content and grain size distribution should also have been determined as components related to characterization of the surface geology of the site. These parameters were not included with the report either in hardcopy or electronic format.	A reference to the DRDC (2005) report was added in Section 1.1.1. Recommendation have been included to address more extensive characterization of the soils and sediments in future work to include parameters such as soil organic carbon content, moisture, pH, and grain size distribution. These parameters were not considered critical in the first stage of the assessment as the focus was on presence/absence of chemicals. The expanded suite of parameters will be more useful in the recommended risk assessment and further delineation work.

Review Criteria	Review Comment	Jacques Whitford Response
3.3c **If microbial processes are contributing to the degradation or persistence of contaminants;**	3.3c.1 See discussion of PCDD/F congener results in soil at CFB Gagetown, 8.2.4, page *153.* In the history of herbicide use at CFB Gagetown, it is likely that 2,4-D was used more than perhaps any other herbicide because it is often combined with either *2,4,5-T,* fenoprop, dicamba, dichlorprop, or picloram. ("Sylvaprop" in Table 2.4.1, p 17, is likely 2,4-D + dichlorprop).The other herbicides have each had their major use period but 2,4-D is often included in the formulation or in the spray tank. The most likely dioxin contaminants in 2,4-D are dichlorodioxins, trichlorodioxins, or perhaps the 1,3 ,6,8-tetrachloro-dibenzo-p-dioxin, none of which are nearly as toxic as 2,3,7.8-TCDD. Table 8-3, page 122 should include the TEFs for the likely dioxin contaminants of 2,4-D. If the analytical methods for dioxins should have "seen" the likely dioxins in 2,4-D, this should be clearly stated. If the analytical methods would not have seen these dioxins, then this is a serious omission.	See above comments
	3.3c.2 There should be a declaration from the laboratory on the PCDDs that would have been detected in their analyses. LODs should also be reported for those PCDDs that could be detected.	See above comments
	3.3c.3 OCDD is a fully chlorinated dibenzo-p-dioxin. It is the most likely dioxin contaminant in the pesticide, pentachlorophenol. It is surprising that it was the most common dioxin found in this study. It was found even more often than the expected, 2,3,7,8-TCDD, in *2,4,5-T.* There should be more discussion in the report for it being one of the most commonly found dioxin residues. There is no evidence that pentachlorophenol was used widely.	See above comments
	3.3c.4 Is there evidence that OCDD is a common but trace contaminant in other chlorophenol based herbicides? In the literature? Being fully chlorinated and degradable only in anaerobic conditions (as suggested in the report), is it highly persistent? Is there information in the literature on the relative half-lives of the various dioxins?	See above comments
	3.3c.5 If we are interpreting the discussion in this section correctly, the suggestion is that the "lesser chlorinated dioxins" are oxidatively degraded by microorganisms more rapidly than is true for OCDD and that over a long period of time OCDD would predominate as the major dioxin contaminant remaining. Is this just a hypothesis or is there some support for this in the literature? What is also missing is some reason that OCDD was widely present in the first place. Perhaps, more rigorous review of the literature is needed on the occurrence and sources of OCDD as a contaminant as well as on its persistence. It is comforting to see that its TEF is so low, Table 8-3, page 122.	See above comments
	3.3c.6 A concise summary of the biodegradation mechanisms of PCDD/F is present in Page 153. It should be noted that PCDD dechlorination may also be facilitated by humic acids, zerovalent- or organometal minerals (Albrecht et al., 1999).** ** Albrecht, I. D.; Barkovskii, A. L.; Adriaens, P.. Production and Dechlorination of 2,3,7,8- Tetrachlorodibenzo-p-dioxin in Historically-Contaminated Estuarine Sediments. Environmental Science and Technology (1999), *33(5),* 737-744.	Agree. Added to Section 8.2.4
	3.3c.7 The persistence of other COPCs have been discussed in Table 2-2 and the associated text.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
	3.3c.8 The report did not directly address the issue of whether or not microbial degradation of persistent contaminants such as PCDD/Fs altered relative concentrations of these contaminants within soils of the RTA. The consultants speculate that preferential degradation of 2,3,7,8-TCDD compared to OCDD may be one reason for the greater relative abundance of OCDD in soils compared to the expected major peak of 2,3,7,8- TCDD as the main PCDD/F impurity of Agent Orange herbicide formulations. The statements are qualitative and the consultant provides no empirical evidence of the relative proportions of PCDD/F congeners within herbicide formulations nor evidence to confirm the presence of OCDD in such formulations. The large differences in physicalchemical properties, e.g. hydrophobicity and volatility provide alternate, and equally plausible explanations that could contribute to changes in PCDD/F distribution related to weathering processes independent of microbial degradation. The only way to address microbial degradation of PCDD/F would be to perform laboratory batch degradation experiments using soils collected, preferably from identified hotspots, and spiking these soils with labelled 2,3,7,8-TCDD and other priority chemicals of concern. Alternatively, soil column leach tests could be performed in conjunction with analysis of soil cores to invalidate the alternate hypothesis that more mobile tetrachlorinated PCDD/Fs were lost from soils as a result of leaching over time.	Agreed. However likely not relevant at this stage and is something that could be pursued by DND in the future
3.3d If concentrations exceed the applicable federal, provincial or municipal criteria or are within background ranges for the area;	3.3d.1 The study plan and the report were very strong on this point. All detectable residues were clearly and in some cases statistically compared with background levels. Comparisons were also made with acceptable federal levels in soil or water if available and when not available, federally, with acceptable provincial levels e.g. Ontario or B.C.	Comment only – No action required
	3.3d.2 The Results section discusses the concentrations of COPCs in soil, sediment, water and vegetation samples in the context of background concentrations and relevant environmental quality guidelines/criteria as applicable. Statistical assessments of the relation of PCDD/F concentrations in various APECs with background concentrations were performed. APECs 2, 3 and the Murphy bivouac were found to have PCDD/F levels higher than the background areas.	See above comments
	3.3d.3 Table 4-3 is missing existing Environmental Quality Criteria for pentachlorobenzene and tetrachlorobenzene, where federal water quality quality guidelines (protection of aquatic life) are available (see CCME 1999).	Added to Table 4-3 and Appendix D
	3.3d.4 Table 4-3 — There is a more restrictive CCME interim sediment quality guideline for TCDD of 0.85 ng TEQ/kg. The consultants should justify why they chose to use the less restrictive Probable Effects Level guideline value as their screening tool for this media. This is particularly relevant to the Swan Creek Lake Watershed which had mean PCDD/F TEQ value (9.3 pg TEQ/g) above the interim guideline (0.85 pg TEQ/g) but less then the probable effects level guideline (21.5 pg TEQ/g).	The ISQG is an indication that potentially more work should be done in the area, however, it is common practice in environmental consulting to take no further action of detailed sediment quality studies and benthic survery, etc. without exceeding the probable effects level (PEL).
	3.3d.5 The consultants provided a very thorough discussion of every soil sample having analyte concentrations that were in excess of established environmental quality guidelines. The decision to re-analyze discrete samples within composite samples exceeding environmental quality criteria or which approached guideline values and failed the data quality assessment (DQA) procedure provided highly valuable data to further identify the extent of aerial contamination within a given APEC. The consultants also provided spatial mapping of PCDD/F contamination in soils from all studied APECs and applied geostatistical techniques to extrapolate mean PCDD/F concentrations for each sampling zone.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
	3.3d.5 One potential problem inherent in comparing analytical results with established environmental quality guidelines for PCDD/Fs is the use of TEQ values. Unfortunately, other chemicals (e.g. co-planar and mono-ortho-PCBs, chlorinated naphtahlenes, ect.) also contribute to TEQ5, and most often contribute to the majority of TEQ5 within a given sample. Therefore it is very likely that TEQ5 were underestimated within the RTA even though this result may not be directly related to PCDD/Fs or herbicide applications. Thus, as a screening tool for the potential of herbicide applications contributing to dioxin exposures, the methodology is adequate. However, as a screening tool to establish overall risk to dioxin-like activity, the approach may be lacking. As indicated in previous comments, an analysis of PCBs (including NO-PCBs and MO-PCBs), would have also been beneficial in this case to establish better TEQ estimates and to allocate the proportion of TEQs attributed to PCDD/Fs. For example, suppose PCBs were also found to contribute to the majority of TEQs (as is often the case) throughout most of the RTA including APEC#2 and 3. This would strongly suggest that PCDD/F and herbicide applications were not the main contributors to dioxin-like toxicity at the site. One suggestion is that the subsequent ecological characterization adopt bioassay approaches to the measurement of TEQs. In this case, a lack of relationship between analytically- calculated TEQ5 (being less than bioassay measured TEQ5) could be used as grounds to trigger a more thorough analytical investigation for other contaminants within soils.	The CCME soil quality guideline for PCDD/F is based on only the 17 congeners provided in this report and their TEFs, summed to provide a TEQ. It is true that inclusion of PCBs to the overall TEQ for the AhR is done at times during risk assessments, it is not relevant to this presence / absence survey. In addition, the summation of PCB TEFs with dioxin TEFs typically occurs on sites where the two are sited as co-contaminants.
3.3e **The type, form, concentrations, and horizontal and vertical extent of contamination for each contaminant in each media; (Sample analyses and subsurface investigations shall be done concurrently to limit unnecessary drilling and sampling);**	3.3e.1 The design of their study and sampling plan did not permit assessment of horizontal movement of contaminants in water. However, when the highest soil residue of a contaminant was not obviously confined by being surrounded by samples with lower residues, they reported this. They then either carried out more sampling or recommended that this be done to define the horizontal extent of the higher level of contamination.	Comment only – No action required
	3.3e.2 Historical records of areas of herbicide applications and areas of significance in the context of human exposure and ecological impact were identified. Sampling was focused on these areas, and sampling was undertaken in such a way that estimates of mean concentrations of COPCs would be obtained without excessive sampling. 3.3e.3 The study program was highly focussed on characterization of category 1, herbicides and herbicide impurities in soils (177 composite + 119 discrete samples) within the targeted sampling zones. A smaller number of potable water samples (12), surface water (30), sediment (30) and vegetation (36) samples were examined. The level of intensity of sampling efforts in soils, as a more probable human exposure vector and greater proportion of landscape coverage justified the above sampling distribution effort.	Comment only – No action required
	3.3e.4 There are noticeable areas within the RTA that were not sampled presumably because they failed to meet criteria involved in delineating APEC zones or were not accessible. However, these gaps do not appear to be restricted to a given area with the RTA (i.e. sampling bias) and the overall coverage associated with sampled APECs provides an adequate representation of horizontal contamination. The geostatistical sampling design applied to APECs was appropriate providing economy of analysis, a high degree of spatial coverage and minimizing dilution of samples. The ability to re-analyze discrete samples forming a given composite also provided enhanced information to further evaluate the extent of spatial contamination for notable hotspots. The consultants should be commended in the implementation of a very well conceived sampling approach.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
3.3f The potential contaminant sources, the surface and subsurface routes for contaminant migration and down gradient receptors. Determine other contributing factors to the degree of contaminant distribution and potential transport of contaminants such as retardation factors; and	3.3f.1 Contamination sources were presumed to be related to previous use of herbicides and associated contaminants when detected residues were above background. No likely sources, incineration etc. were suggested for residues of contaminants at background levels.	See above comments
	3.3f.2 [This Comment was described previously but is repeated here owing to the direct applicability of comment to DND sub-objective]. The rationale for sampling the top 10 cm of soil is unclear. It seems to have been based solely on the Vietnam Study by Hatley Consultants. In effect the sampling procedure presented in the report assumes that 0-10 cm of the surface retains the majority of the PCDD/Fs deposited. This assumption, if incorrect, may have lead to underestimation of PCCD/F concentrations and masses at the site. The work of Bruzy and Hites (1995)* should be considered in deciding on soil sampling depths. Bruzy and Hites *(1995)* observed that most PCDD/F was present in the upper *25* cm of the soil for soils sampled at various sites. However, at sites where heavy PCDD/F deposition occurred and the soil had very low organic matter the PCDD/F was distributed over a depth of up to 90 cm of the soil with maximum concentrations at the *40-50* cm depth. Sampling 0-10 cm of the soil horizon, would have severely underestimated PCDD/F concentrations at such sites. The anomalous behaviour at sites where the PCDD/F was distributed over depths of up to 90 cm is attributed to the fact that the capacity of the upper A horizon of the soil (i.e. depth of soil corresponding to the organic rich layer) to adsorb PCDD/Fs was exceeded due to excessive PCDD/F deposition and the relatively low amounts of organic carbon. The surface soil column may be considered analogous to the stationary phase in a chromatographic system, and the capacity of the soil to retain PCDD/F will depend both on the amount of PCDD/F being deposited to the soil and the amount of organic carbon in the soil (stationary phase thickness). *Bpazy, L.P. and Hites, R.A. (1995) Estimating the Atmospheric Deposition of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Soils. Environmental Science and Technology, 29:2090-2098.	See above comments
	3.3f.3 The COPCs were identified to be active ingredients or manufacturing impurities in the herbicides used at CFB Gagetown. PCDD/F, and impurity present in several herbicide formulations was widely detected at the site.	Comment only – No action required
	3.3f.4 The largest potential sources of PCDD/F in US and Europe are municipal solid waste incinerators, medical waste incinerators, secondary copper smelters, hazardous waste burning cement kilns, sinter plants, and diesel trucks (Lohman and Seigneur, 2001).Wood and wood-residue burning, residential wood-stoves, backyard trash burning and vegetation fires are also considered to be significant sources of PCDD/F emissions. No review of the existence of nearby facilities were mentioned.	See above comments
	3.3f.5 The designation of APECs into *5* categories attempted to delineate areas receiving a high degree of herbicide application and separate these zones from background areas or areas containing sensitive ecological receptors. There was no attempt to correlate herbicide application rates or mass balance with measured spatial contamination trends. However, it is acknowledged that given the lack of data on application methods, differences in herbicide formulations, different composition of trace impurities within various herbicide formulations, long periods of time over which herbicides were applied and different timing of herbicide applications make such a task likely to fail.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
	3.3f.6 The ability to designate APECs having unique contaminant concentrations and chemical fingerprints was not entirely successful. Some APECs, e.g. APEC # 2, 3, 4, 13 and Murphy Bivouac appear to have exhibited higher PCDD/F concentrations than background levels. There were flaws in the statistical determination of significant enrichment of these areas (See comment on statistical tests above). Likewise, multivariate analysis provided qualitative indication of differences in chemical signatures at APEC 2 and Murphy bivouac. The failure to perform additional tests such as discriminate functions analysis (DFA) on the principle components scores precludes statistical determination of significant differences in chemical signatures at the latter two APECs (see comment on statistical tests above). There were also concerns regarding the ability of multivariate analyses to discriminate sources. The principal components analysis was restricted to PCDD/Fs as this was the only group of consistently detected chemicals. Yet, the different PCDD/F congeners may have had a common source. The consultants indicate that Agent Orange formulations contain predominately 2,3,7,8-TCDD as the PCDD/F impurity, yet they did not provide evidence for the presence or absence of other PCDD/F congeners in this and other herbicide formulations applied within the RTA. If all PCDD/F congeners originated from the same source and these were the only congeners included in the multivariate analysis, the analysis would not be able to distinguish different sources within the RTA. In this case, inclusion of ubiquitous tracer chemicals such as PCBs may have been helpful to locating areas of chemical enrichment in the RTA that are not associated with chemical focussing processes on site.	See above comments
	3.3f.7 The analysis of discrete samples within APECs showing elevated PCDD/F concentrations suggest considerable heterogeneity of soil PCDD/F concentrations. APEC #2 was unique in the number of discrete samples with PCDD/F concentrations above soil quality guidelines, however, it is difficult to understand why soil concentrations were so heterogenous (CV = *5.2)* given that herbicides would have been applied to these study plots in a relatively uniform manner. The consultant should comment on this, especially with respect to APEC #2.	See above comments
	3.3f.8 There was little discussion in the report regarding contaminant transport mechanisms. One weakness of the study was the failure to determine soil organic carbon content and to jointly analyze PCDD/F data on a dry weight basis and on an organic carbon normalized basis. If heterogeneity of PCDD/F distribution in soil was shown to be decreased by OC normalization this would suggest that air deposition of PCDD/Fs represent a potential source of dioxins to the RTA. If heterogeneity of PCDD/Fs is increased by OC normalization, this could suggest evidence of point sources. Finally, the inability to document PCDD/F soil residues in reference areas outside of the RFA (even if this only reflects literature review data) further confounds identification of possible dioxin sources and environmental transport mechanisms within the RTA.	See above comments
	3.3 f. 9 There is agreement with the statement provided on page 144 section 8.2.1.12: 'Overall, the APECs where PCDD/F exceeded CCME SQG of 4 pg TEQ/g should not be cause for extreme control measures at this point. Rather, they point to the need for further assessment....' However, there is a need to quantify total TEQs (not just those associated with PCDD/F) at the designated PCDD/F hotspots and in randomly selected composite samples from other APECs to provide a better risk assessment. After all, the study identified that the major contributor to PCDD/Fs was OCDD that was not anticipated to be an important impurity of herbicide formulations. The consultants interpret this to be a result of preferential degradation of 2,3,7,8-TCDD over OCDD, yet other alternate hypotheses are equally plausible. It may be that non-herbicide sources of PCDD/Fs have contributed to observed enrichments, in which case other contaminants such as PCBs, PAHs and mercury might also be enriched. Once total TEQ's have been determined, the soil TEQ5 measured within the RTA could be better interpreted in the context of other contaminated sites (for example the lakewide TEQ for Lake Ontario Sediments exceeds 100 pg TEQ/g, well above any of the TEQ5 measured for the RFA (Marvin et al 2002 JGLR 28:43 *7-450;)*.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
3.4 Sampling and Analysis: As par of a separate contract, the Consultant is required to manage coordinate analytical testing with an accredited laboratory. This may consist of the following:	3.4.1 It is not known whether the Jacques Whitford company has their own analytical chemical laboratory and could have done these analyses if time permitted. To meet the time constraints, it was good they could make arrangements with a number accredited laboratories. With this approach, they could select the most competent labs for the various types of chemistry.	Jacques Whitford does not own or operate its own analytical chemical laboratory. This element of the project was contracted separately through Defence Construction Canada (DCC) to RPC laboratories. Results were then communicated from the lab directly to Jacques Whitford and not the government.
3.4a **Propose the parameters for analysis. A laboratory that** is **certified and accredited by CAEAL for the parameters tested must conduct all analysis.**	3.4a.1 The list of parameters for analysis was clearly stated in the report.	Comment only – No action required
	3 .4a.2 The list of analytes chosen for chemical analysis was based on pre-evaluation of the types of herbicide formulations applied within the RTA with consideration for active ingredients and trace impurities which could exhibit high persistence and bioaccumulation potentials. The analytical packages developed for different herbicides and trace impurities (Table *5-1)* was appropriate for the objectives of the project.	Comment only – No action required
	3.4a.3 Additional parameters such as ubiquitous pollutants not present within herbicide formulations would have been highly beneficial to the interpretation of results as their inclusion would have allow better distinction between within RTA-sources from long- range transport processes. Example chemicals would include PCBs and PAHs. Also, the failure to measure soil and sediment total organic carbon content represents a critical missing parameter for assessing the fate and possible source delineation of PCDD/Fs.	Comment only – No action required
3.4b Provide detailed records of the sample collection process, total number of samples collected and which subsequent samples were submitted for analysis shall be kept and provided in the report;	3 .4b.1 The records of sample locations, numbers taken, and numbers analyzed were good.	Comment only – No action required
	3.4b.2 An important omission, at least in the body of the report, was the sample volume sizes for water samples, surface soil samples, core soil samples and plant tissue samples. The volumes that were subsequently extracted would also be very important to include. This information is required to assess their limits of detection.	See above comments
	3.4b.3 The detailed records of samples collected, along with maps of locations sampled, total number of samples collected and composited have been presented very clearly. A summary of samples analysed is provided in Table *5-5.*	Comment only – No action required
	3.4b.4 The consultants provided a very thorough overview of the sampling design, number of samples collected, rational and means by which various discrete samples were composited and numbers/rational for samples that were submitted for laboratory analysis. The information is presented in several tables and detailed for each APEC are provided in Chapter 7.0.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
3.4c Establish appropriate Quality Assurance (QA)/Quality Control (QC) procedures for sampling and analysis to ensure accuracy and precision of results. Sample analysis shall follow appropriate standard analytical practices including confirmatory samples.	3.4c.1 The system of collecting and using field blanks, field duplicates, lab duplicates, purchased reference samples and spiked reference samples appeared to be very adequate for QA and QC requirements.	Comment only – No action required
	3.4c.2 The QA/QC program is detailed in Section 6. Appropriate field blanks, trip blanks and duplicates were obtained and analyzed. The accuracy and precision of the analytical methods and the analyses were performed.	Comment only – No action required
	3.4c.3 Laboratory QA!QC protocols are documented in Chapter 6.0. The text describes the collection of field duplicates and blind submission of field duplicates to analytical laboratories, spiking of samples with isotopic labelled surrogate standards to determine % recoveries for each sample analysis, use of matrix blanks, field blanks, trip blanks, rinsate blanks and standard reference materials to check for analysis accuracy. The numbers of QA/QC samples analysed in conjunction with sample batches are documented (Table 6- 1).	Comment only – No action required
	3.4c.4 There was an adequate description of the evaluation of SRIvI data in that the consultant described the use of control charts and Westgard rules to trigger a non-compliance report for sample batches that could potentially fail QA/QC. However, rules used to trigger failure of QA/QC for other parameters are not stated in the report. For example, % recovery data for surrogate standard spikes are collected for each blank, sample and SRM and summarized in the data tables of Appendix H. However, the report does not indicate what the acceptable range is for % recoveries. Having went through EPA method 1613B, it became apparent that recoveries in the range of 17% to 185% are acceptable (variable range for individual PCDD/F congeners) according to the method. There is a need to include a description of acceptable and non-acceptable recovery ranges in the Tables associated with Appendix H to appropriately evaluate these criteria.	The % recovery for surrogate spikes and the remaining information asked in this comment are routinely checked by RPC, the analytical laboratory. Their internal QA/QC checks are performed in this manner and only data that meets their CAEAL protocols is reported to the consultant.
	3.4c.5 Similarly, the acceptable concentration of PCDD/Fs in blank samples should have definite trigger points that would initiate failure of QA!QC. EPA Method 1613B specifies these general criteria in the range of 1-10 pg/g depending on the PCDD/F congener. EPA Method 1613B also specifies 'If any 2,3,7,8-substitutded CDD/CDF (Table 1) is found in the blank at greater than minimum levels (Table 2) or one third the regulatory compliance level, whichever is greater....'. Based on data of maximum detected values of PCDD/F in Laboratory Soil/Sediment Blanks (Table H-19), one or more of the blanks should have failed the 1/3 compliance rule and necessitated a re-analysis. The PCDD/F TEQ for the maximum detected Soil/Sediment blank value was 3.3 pg TEQ/g based on data presented in Table H- 19 and applying congener specific TEF values of Table 8-3 which approaches the TEQ guideline of 4 pg/g. The consultants should review high blank concentrations and check that blank PCDD/F did not exceed the 1/3 compliance rule.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
	3.4c.6 The data tables indicate that data were blank-corrected prior to calculating concentrations. The blank correction methodology is not specified (again, a problem with not including analytical SOP's with this report). The electronic database provides the fields 'CorrectedSubtractedBlankValue' and 'SubtractedBlankValue'. It is not apparent what these fields mean and there are no annotations to define these terms. Finally, some concentration values reported in the data tables of Appendix G are less then the minimum reported detection limits specified in Table H-b of Appendix H. E.g. a number of soil 2,3,7,8-TCDD concentrations in soil samples are reportedly at 0.01 pg/g while the minimum detection limit for the method is reported as 0.03 pg/g. The electronic database provides qualifiers and it became apparent that several congeners had PCDD/F concentrations below MDL's, yet numerical values equal to the MDL are indicated in the data fields and hardcopy data reports of Appendix G. Only after thorough review of the electronic data did it become apparent that PCDD/F TEQ5 values were being generated by replacing Non-Detected data with MDLs in some cases. This manufactured data then presumably gets built into the summary statistics e.g. mean APEC TEQ values. There is no place in the text that qualifies which TEQ5 include MDL substituted data. The consultants should review the analytical data reports and ensure that data are appropriately censored according to the method detection limits and flagged in the corresponding hard copy data report tables as well as in summary statistics presented throughout the report.	See above comments
	3.4c.7 The data on SRMs and general observation of sample recoveries suggest good accuracy and repeatability of the analytical methods for PCDD/Fs. Based on data reported in Appendix H, there appears to be a high degree of confidence in the analytical integrity of sample analysis for the samples with high PCDD/F concentrations (e.g. above 9 pg TEQ/g), but there are questions about some of the results demonstrating lower concentration values owing to issues with blanks, blank correction and substitution of non-detected data with MDL values as described above.	See above comments
3.4d Provide analytical results in data tables including comparison to applicable regulatory criteria and previous analytical results. Historical results for all parameters that exceeded guidelines must be reviewed in light of new guidelines. DND shall be contacted as soon as analytical results are received and interpreted by the consultant for further discussion.	3 .4d.1 The presentation of the analytical results in tables and graphs and comparisons with regulatory criteria was clear.	Comment only – No action required
	3.4d.2 Some PCDD/F concentrations reported in Appendix G are clearly lower than the detection limits reported in Appendix H. For example, Table H-27 states that the minimum detection limit of 2,3,7,8-TCDD in soil was 0.01 pg/g. Table G-2 reports a value of 0.005 pg/g for sample A2-S1SS-2. It is not clear if half the minimum detection limit is being used as a finite value for non-detected samples. This should be explained clearly.	See above comments
	3.4d.3 Units for soil concentrations in Tables (e.g. Table G2) of Appendix G have an incorrect table heading in terms of the units for PCDD/F concentrations. It is assumed that all results are reported in pg/g and not in mg/Kg.	Agree. These changes have been made in the final report

Review Criteria	Review Comment	Jacques Whitford Response
	3.4d.4 Analytical results are reported in data tables in Appendix G of the report. In many cases the units of measurement are in error, or at least deemed to be in error due to conflict of units presented in the electronic database and hardcopy. For example, Table G-2 reports the soil PCDD/F concentrations are expressed in mg/kg which is one million fold higher than reported in the electronic database (pg/g). It is suspected the pg/g unit is the correct one. There is also no indication as to whether the data are reported in wet weight or dry weight, although reporting the data on a dry weight basis is more standard. For sediments, Table G-8 reports the analytical units as pg/L but the electronic database reports the units as pg/g. Again, it is suspected that the pg/g designation is the correct one. For water, Table G-14 identifies the units of measurement as pg/L which is consistent with the electronic database, however, the TEQ values for water are reported in pg TEQ/g whereas the text and electronic database reports the water TEQ in units of pg TEQ/L. These inconsistencies in unit reporting need to be fixed. Hard copy data tables should flag (e.g. bold or italic font) any values where the MDL was substituted for true analytical values. TEQ calculations should also flag values where MDL substitutions contributed to the TEQ value.	Agree. These changes have been made in the final report
	3.4d.5 All analytical data are compared with regulatory criteria. Exceptions include failure to account for regulatory guidelines available for tetrachlorobenzenes andpentachlorobenzenes in water and use of a less stringent probable effects level screening criteria for PCDD/Fs in sediment rather than the interim sediment quality guideline. The text should be modified to incorporate these exceptions; however, it will not substantially alter the interpretation of the data.	Agree. These changes have been made in the final report
3.5 Data Interpretation: Based on the results of the environmental field investigation program, the Consultant shall confirm the presence or absence of environmental impacts. The consultant shall (if required):		
3.5a Use the CCME criteria as well as other relevant and applicable federal, provincial and municipal guidelines to evaluate the results of the chemical analyses;	3.5a.1 CCME criteria and other provincial criteria are presented in the report. The COPC concentrations have been compared to the regulatory criteria where applicable for specific media.	Comment only – No action required
	3.5a.2 Data were compared to CCME environmental quality criteria as well as provincial guideline for available analytical parameters. There are some concerns regarding the comparison of TEQ values to guidelines when the TEQ5 include manufactured data e.g. substitution of non-detected values with the MDL. TEQ values reported in the text and data tables that include MDL estimators should be flagged using bold or italics font.	See above comments

Review Criteria	Review Comment	Jacques Whitford Response
3.5b Submit electronic data in a flat file format with the following fields: Chain of Custody, Number, Lab ID, Sample ID, Date sampled, Date tested, Matrix, Result, MDL, Units, Parameter description, Laboratory parameter code (if used by the lab), Additional fields: Sampling method, Sampler, and Report Number. If further information regarding file format is required by the lab, then questions should be directed to the DND project manager. Station Names for new sample location shall be approved by the DND Project Manager prior to use;	3.5b.1 Protocols for sample handling have been stated and they are adequate.	Comment only – No action required
	3.5b.2 All of the above fields appear to be available in the electronic database although not within a single query table. The biggest problem has to do with the inconsistenciesbetween hard copy data report tables and electronic report tables. Areas of confusion in this regard include: appropriate units of measurement and whether a datum refers to a true analytical value or an MDL substituted value. There are also many inconsistencies in data reported in the hard copy tables and electronic database.	Jacques Whitford does not believe that there are inconsistencies with the actual values reported in the database and the report. Rather that it was an issue of units reported for some parameters in the Appendix G. These have been corrected in the final report.
3.5c Interpret the data to determine and identify the environmental impacts; and	3.5c.1 There was little discussion of "environmental impact" on vegetation or non-target organisms other than humans. Other than physical characterization of sampling sites and data on residues of COPC, no additional data on vegetation of other non-target organisms was collected that would permit the identification of environmental impacts.	This was not within the Scope of Work
	3.5c.2 The concentrations of COPCs in different media were presented in a detailed manner. These have been compared to background area levels and to regulatory criteria. Multivariate analyses (e.g. principal component analyses) were performed to identify the degree of similarity and differences in the PCDD/F congener patterns at different locations of the site. The report concludes that further sampling for COPCs other than PCDD/Fs are not required. Further sampling of PCDD/F may be required depending on exposure-based on soil quality objectives and for a better characterization of impacts on ecological receptors (vegetation and small animals) may be required.	Comment only – No action required
	3.5c.3 The report provides as detailed as possible an interpretation of the spatial extent of soil herbicide/herbicide impurity contamination within the RTA. Environmental impacts were interpreted in light of the number of samples that exceed environmental quality objectives and spatial extent of guideline exceedances. The consultants are appropriately cautions concerning conclusions about human risk related to areas having somewhat elevated soil PCDD/Fs and provide recommendations to develop site specific human and ecological soil quality objectives that better incorporate actual exposure conditions on site.	Comment only – No action required
3.5d Prepare scaled drawings of the site showing analytical results and indicating the areas of environmental impacts.	3.5d.1 Good maps were provided to indicate the precise location of samples with higher PCDD/F residues.	Comment only – No action required

Review Criteria	Review Comment	Jacques Whitford Response
	3.5d.2 Detailed drawings of the areas and locations sampled are presented. Soil samples that provided the highest concentrations in a sampling area were shown in the drawings. Data tables clearly list the concentrations obtained for each sample analyzed.	Comment only – No action required
	3.5d.3 The consultants provided a very extensive summary of analytical data in GIS-format. Detailed GIS-maps of all sampling sites and APEC sampling zones are provided. Further, several GIS-maps are presented that yield different levels of data interpretation to include categorization of total TEQ ranges within sampled APECs and individual sectors within each APEC containing one or more discrete samples having total TEQ values above environmental quality guidelines.	Comment only – No action required
3.6 Evaluation and Recommendations: Based on the results, the Consultant shall make recommendations including:	3.6.1 It is clearly stated in the SOW (No.10, page 3) that the consultant is required to conduct and Environmental Site Investigation (ESI) of the Range and Training Area (RTA) at CFB Gagetown. It is very clear that they have done this.	Comment only – No action required
	3.6.2 In the SOW (No. 17, pages *5* and 6), it is stated that the consultant shall "on the basis of results from the ESI confirm the presence or absence of environmental impacts and shall (if required) interpret the data to identify the environmental impacts. Was there a high priority to confirm the presence or absence of environmental impacts? It appears that this was a low priority at this stage because there was no plan to collect and compare data on the occurrence of vegetation or other non-target organisms in sprayed areas compared to non-sprayed, background areas. Clearly, there was a goal of DND to have a major environmental impact on the vegetation to reduce fire risks in live fire areas (SRIA). Beyond these and related impacts, what other environmental, as compared to human health, impacts is DND concerned about?	Comment only – No action required
	3.6.3 Section 9 of the report provides recommendations based on interpreted results. The main recommendations, to focus on areas showing elevated soil Total TEQ values and perform a more detailed human health and ecological risk assessment in these areas appears to be warranted based on the field sampling results and data interpretation. There is agreement with the recommendation to examine for PCDD/F bioaccumulation in soil invertebrates to verify the lack of dioxin bioavailability suggested by the vegetation sampling efforts. The authors should consider re-analyzing some of the samples of other contaminant classes such as PAHs, PCBs (including *mono-ortho* and coplanar PCB5) or OC pesticides to provide better estimates of total TEQ5 and to establish whether areas of PCDD/F enrichment are correlated with enrichment of other contaminants likely to have multiplelong range sources.	See above comments
Section 4.0 Declarative Statements	Declarative statements by each of the peer reviewers are provided indicating that they have contributed to, reviewed and agree in principle with the consensus statements outlined in the consolidated peer review report.	