UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
JOHN F. KENNEDY FEDERAL BUILDING
BOSTON, MASSACHUSETTS 02203-0001

September 4, 1996

Mr. Philip Otis
U.S. Department of the Navy
Northern Division - NAVFAC
10 Industrial Highway
Code 1811/PO - Mail Stop 82
Lester, PA 19113-2090

Re: EPA Comments on the Draft Final Feasibility Study (FS), Site 09-Allen Harbor Landfill, dated July 1996, at the former Naval Construction Battalion Center (NCBC), Davisville, Rhode Island

Dear Mr. Otis:

Pursuant to § 7.6 of the NCBC Federal Facility Agreement (FFA), the Environmental Protection Agency's (EPA) has reviewed the above referenced documents. Please find our comments enclosed.

On July 31, 1996, EPA commented on the Navy's Sampling Strategy to start design of a long-term groundwater monitoring plan. We feel that the implementation, during the Site 9 design phase, of such a strategy will provide us with the needed data to resolve the outstanding technical issues on this site. EPA is prepared to discuss the sampling plan comments, if needed, so that the Navy can start implementation this fall in anticipation of a low groundwater table.

However, there still remains an issue of objectivity that the EPA, RIDEM and Navy need to resolve before we can move further along in the remedy selection process. The Navy's insistence in exaggerating the benefits of Alternative 2 (Soil Cap) at the expense of Alternatives 3 (Multimedia Cap) & 4 (Multimedia Cap with Vertical Barriers) will only cause confusion to the public and must be clarified prior to finalization of the RI/FS process.

Due to the need for an objective document to present to the public, we feel the Navy should submit a response to comments and a revised redlined draft version of the FS that fully addresses the enclosed comments. Accordingly, I recommend that we meet to discuss these comments and the Navy's written responses at a BCT meeting soon in attempt to reach resolution on this subject of objectivity. I have reserved a conference room at EPA in Boston beginning at 10 am on September 19, 1996 in anticipation of your attendance.

EPA New England looks forward to working with the Navy and RIDEM toward remedy selection for this site. If you have any questions about this letter please call me at (617) 573-5736.

Sincerely,

Christine A.P. Williams
Remedial Project Manager
Federal Facilities Superfund Section

Enclosure

cc: Richard Gottlieb, RIDEM
Walter Davis, CSO
Tim Prior, USF&WL
Ken Finkelstein, NOAA
Andy Beliveau, EPA
Bill Brandon, EPA
Jean Choi, EPA
Bob DiBiccaro, EPA
Ed Hathaway, EPA
Jayne Michaud, EPA
Mary Sanderson, EPA
Howard Cohen, RIEDC
Marilyn Cohen, ToNK
George Horvat, Dynamac
Jim Shultz, EA Eng.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

General Comments:

1. Numerous entries in the text of the document indicate that ground water "may not" be a significant to ecological risks identified in Allen Harbor media. The RI results and ground water modeling are listed as the basis for these statements. Although, strictly speaking, this is factually correct, it is important to point out that the RI results and modeling results which are based on them are, practically speaking, limited to the source area (i.e. the landfill footprint). The projections and inferences made from this data may or may not be representative of actual downgradient ground water and sediment conditions (i.e. beneath the harbor). In this respect, constant repetition of the phrase "may not" is biased and can not be supported by EPA at this time. Describing the current situation as "inconclusive" would result in a more objective presentation until the additional downgradient data is obtained.

2. In several places in the report, the text states that the soil cap option (Alternative 2) may meet the relevant and appropriate portions of RCRA if federal and state regulatory agencies "agree" that the results of ground water modeling and pre-design sampling indicate that ground water migration from site 09 is not a risk to public health and the environment. EPA objects to this wording since EPA believes that the Soil Cap would not meet ARARs and because the wording implies that regulatory acceptance rather than technical adequacy is the Navy's goal for Site 9 - Groundwater Remediation. EPA will base its ground water containment decision-making on a cogent technical presentation once it is available. Currently the downgradient database is incomplete, and as such the modeling based on this database may not be accurate. Presumably the Navy will update the ground water modeling if the new data from the pre-design investigation suggests that this is warranted. It is unclear from this language whether or not this specific step is planned.

3. The text frequently uses adjective such as "significant" when referring to the potential contribution of ground water to downgradient receptors. This usage should be defined at an appropriate location in the report, such as, above AWQC or the amount of groundwater contamination which causes sediment concentrations above ERLs.

4. EPA has commented extensively on the redlined Proposed Plan (PP) for this site. Please see the comment letter from Christine Williams to Phil Otis dated August 29, 1996 for additional suggestions on rewording the subtly biased statements contained in both the FS and the PP.

5. The EPA received the revised RI for Site 9 after this FS and has not yet completed its review, therefore, some statements made in this FS concerning the RI may be commented on in this document. The Navy should incorporate those applicable statements in the revision of the RI.

6. In addition, the following issues noted in previous comments have not been sufficiently addressed: 1. Quantification of contaminant mass leaving the site for each alternative. 2. Expected risks based on quantified mass of contaminant discharging from the site. However, since the Navy is doing additional studies at the toe the quantification may change. EPA expects the Navy to address these issues after the additional studies are performed.

Specific Comments:

7. Page ES-4, second paragraph, last sentence; the maximum concentration of chemicals in the Allen Harbor Watershed were all found at or near the landfill. Revise the sentence to read, "Based on maximum concentration of chemicals, the landfill was identified as a major source of the ecological risk in the Allen Harbor Watershed."

8. Page ES-5; The use of the language, "..due to uncertainties associated with the model input assumptions and a lack of downgradient subsurface data,.." effectively describes the deficiencies in the current database which preclude making any firm conclusions regarding the ground water contribution to downgradient receptors. This language should be inserted in the many other areas of this report which touch on this subject (see General Comment 1, above).

9. Page ES-6; The list of baseline remedial actions should include or make reference to the pre-design investigation downgradient ground water and sediment sampling program.

10. Page ES-6, fourth paragraph; the triggers for additional remedial action will have to be determined prior to ROD signature. If the next phase of sediment analysis and modeled concentrations of contaminants found in the undisturbed zone below Allen Harbor result in surface sediment concentrations at or above the NOAA ERMs, EPA may require the Navy to install groundwater containment as was evaluated in Alternative 4.

11. Page ES-6, last paragraph; Alternative 2 does not meet ARARS. Disposal and investigative information support the conclusion that materials sufficiently similar to currently regulated hazardous wastes to were disposed of in the landfill such that the federal and state hazardous waste landfill closure regulations are considered relevant and appropriate to the response action. Testing of the soils indicate that on-site soils fail TCLP for lead and cadmium resulting in characteristic wastes being left within the Waste Management Unit. Site investigations reveal that ground water is contaminated due to the Navy's land filing activities and at least 75% of the waste is above the water table. The concentrations of hazardous substances in the leachate seeps are toxic to the ecological receptors which results in an unacceptable ecologic risk. Ecological risks due to surface soil and sediment exposures and food chain uptake models are also unacceptable. Base line human health risks due to dermal, ingestion and inhalation from the current and future expected use of recreational exposures to surface soils are within the risk range

and below a HI of 1. RME Shell fish ingestion exposure pathway risks were above the risk range (2×10^{-3}) and had a HI above 1 (20). Average and RME residential groundwater ingestion exposure pathways were above the risk range (6×10^{-3}, 3×10^{-1}) and had an HI over 1(9,20). EPA uses the technical guidance document "Final Covers on Hazardous Waste Landfills and Surface Impoundments" (EPA/530-SW-89-047, July 1989) as the technical reference for the design of a hazardous waste landfill cover. Alternative 2 does not conform to these requirements. Alternative 2 does not conform to the State hazardous waste landfill closure requirements nor does it conform to the State Solid Waste closure requirements.

Revise the last paragraph to read, "Alternatives 3 and 4 which were retained through detailed analysis will achieve RAOs, meet ARARs, and be protective of human health and the environment. Alternative 2 and the No Action Alternative were also retained through detailed analysis but these alternatives will not met ARARs. While Alternative 2 will achieve some RAOs it will not be as protective of human health and the environment as Alternatives 3 & 4."

12. Page ES-7, ¶ 1; this paragraph implies that only the No Action Alternative would require a 5 year review. However, any selected capping remedy will require a 5 year review.

13. Page ES-7, Alternative 2-Soil Cap, third and fourth sentence, also Chapter 4, section 4.4.2.2, Compliance with ARARs, and Chapter 5, section 5.2, Compliance with ARARS, page 3; the soil cap does not meet ARARs. If the EPA were to grant an ARAR waiver, it would be for the relevant and appropriate portions of the statute, but the cap would not meet the ARAR the ARAR would be waived. The portion of the laws that are not either applicable or relevant and appropriate to the site are not ARARs.

Revise the third and fourth sentences page ES-7 and the third paragraph, first sentence on page 5-3, to read as one sentence, such as, "A soil cap would not meet RCRA "C" or "D" ARAR, however the federal and state agencies may issue an ARAR waiver if the Navy can provide sufficient justification to meet ARAR waiver requirements of NCP (40 CFR 430(f)(1))."

See PP cmt # 49. (49. Page 22, ¶ 3.8.2, line 11: Delete sentence which begins " A waiver can be . . . " and insert the following sentence: In order for a federal ARAR waiver to be granted by EPA, the Navy would have to demonstrate that it meets the ARAR waiver requirements of NCP (40 CFR 430(f)(1)).)

14. Page ES-7, Alternative 2, additional last sentence and Chapter 5, section 5.3, Long-Term Effectiveness and Permanence, page 4 ; add the following,

"One concern with Alternative 2 is the increased maintenance costs associated with the

heterogeneous vegetation on the cap. The Navy will have to provide a higher skilled labor force to remove specific species of deep rooted plants and other species which are undesirable and to plant desirable vegetation that will deter erosion. Mowing can be accomplished with a lower skilled labor force and therefore at a lower cost. Also the heterogeneous vegetation (shrubs) will impede inspections. Mowed vegetation will not impede such inspections.

"While the evapotranspiration approach may be practical in the western U.S. where rainfall is less than 20 inches per year, it is unlikely to be effective in areas of high infiltration, such as the Northeast where annual precipitation is greater than 40 inches per year, and in areas that experience spring thaw. The cap significantly differs from standard solid waste and hazardous waste covers in that it is designed to allow for saturation of the soil cover. Most solid waste and hazardous waste covers are designed to maximize run-off and minimize infiltration and head over the barrier layer. Saturated soils are inherently less stable and more erosive than well drained soils. The ET cover design could result in cap and slope failure and would require a vigorous, and therefore more costly operation and maintenance program to monitor the slope conditions and vegetation. "

15. Page ES-7; ¶ 2; See general comment 2, above.

16. Page ES-8, ¶ 1; See general comments 1 and 3, above.

17. Page ES-8, ¶ 1; the risks are not low to moderate. The risks exceed acceptable threshold criteria. The statement "..., it is uncertain whether minimization of infiltration of the site will reduce the low-to-moderate risk..." should be changed to "..., it is uncertain whether minimization of infiltration of the site will reduce risks below the acceptable threshold criteria...".

18. Page ES-8, ¶ 1, last sentence; the statement "One concern with Alternative 3 is the elimination of natural habitat that would be caused by the necessary maintenance of a mowed grass environment on the multimedia cap" is deceiving. There are many advantages to placing the Alternative 3 type of cap on the landfill and none of those are provided in this summary. The Alternative 3 cap also protects against the loss of additional habitat and reduced habitat quality resulting from the migration of compounds from the landfill into the harbor. It is recommended that this statement be removed.

19. Page ES-8, ¶ 2; See general comments 1 and 3, above.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

20. Page ES-8, last paragraph, last sentence; this sentence should be removed. The term "permanent" is a relative term. Nothing is permanent given enough time for degradation. However, given the typical 30-year time period usually considered for costing of remedial alternatives, then the vertical barrier can be considered permanent. The placement of this sentence at the end of this summary gives the appearance that the Navy is biased against this alternative.

21. Page 1-3; ¶2; Typo. "standard operating procedures"

22. Page 1-3; ¶2; Is the reader to infer that the practice of burning flammable wastes has resulted in minimal introduction of these substances into the landfill ? EPA's experience at other sites suggests that burning of liquid wastes still may result in substantial quantities in the site subsurface. For example, at military Fire Training Areas a 50 % infiltration rate of the fuels ignited on the surface is often used as a means of estimating subsurface residuals.

23. Chapter 1, Page 6, section 1.2.3.2, first paragraph, last sentence; revise the sentence as was requested in EPA comment # 35 on the draft FS and in comment # 34 of the June 6, 1996 letter on RI/FS response to comments. The term "artificially-elevated" exposure concentration data is not acceptable to EPA. The unfiltered seep samples were used with correct laboratory methodology and the ecological exposures were correctly investigated. The ecological receptors do not filter groundwater prior to ingesting it. Therefore, the data should stand as is and not be qualified by the term "artificially -elevated". Revise the sentence in question to read, "Unfiltered seep samples were used for chemical analysis in the RAPS I ."

It would be necessary to provide considerable further justification in order to demonstrate that the filtered seep samples would have been the correct samples to have used. For example, in ground water sampling, filtering has been de-emphasized due to the advent of low-flow techniques. The reason for this is considerable research which suggests that depending on the filter size used, certain constituents are favored at the expense of others. Has the Navy evaluated the constituents favored by the Whatman 4 filter in relation to the COCs at Allen Harbor ?

24. Page 1-8; ¶ 5; What specific data "gaps" are referred to ?

25. Page 1-9; Perhaps some additional climatological data such as hurricane and flood magnitude and frequency data can be added here since, further on in the text, the merits of the various alternatives are subjected to considerable qualitative discussion concerning their respective abilities to withstand such events.

26. Chapter 1, Page 9, Section 1.3.2, first sentence

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

It is recommended that the statement "... 12 miles wide and with up to 12,000 ft. of accumulated sediment deposited within this feature..." be changed to "... 12 miles wide and extending to a depth of approximately 12,000 ft." As it is written it implies that there are presently 12,000 ft. of soft sediment in Narragansett Bay, which is not possible. The accumulated sediments are actually of Pennsylvanian age and were compacted into rock long before the formation of Narragansett Bay.

27. Page 1-13, ¶ 2; Please quantify "slightly higher"; the reference point is presumably the low tide levels ?

28. Page 1-13, ¶ 2; On what basis are the K values from Layer 2 determined to be "uniform" ?

29. Page 1-13, ¶ 3; Why were the last 2 sentences removed ? This text provides support to the conceptual model of the ground water proximal to the site shoreline, and therefore should be included for the readers consideration.

30. Page 1-13, ¶ 5; Please briefly describe how the reported leakance values were assigned.

31. Page 1-14, ¶ 2; The statement that VOC are present in "isolated areas" rather than as "extensive elongated plumes," is misleading. As pointed out in earlier EPA comments, it is difficult to determine the true axial length of the "plumes" as there are currently no monitoring wells downgradient of the landfill footprint. In fact, the entire landfill area would more appropriately be described as the "source area". In this context the "isolated" areas of VOC become a function of the scale of investigation which currently contains enough detail to distinguish contaminant zonation (i.e. 'hotspots') in the source area, yet offers very little information on the downgradient extent of any plumes. Concentration gradient information, although limited, does suggest that contaminant plumes do extend eastward beyond the landfill.

Also relevant to the "source input" is the fact that high concentrations of VOC in ground water suggest that residual DNAPL is contained within the aquifer pore spaces in limited areas of the subsurface. This condition effectively allows for an on-going source despite the lack of recent "input".

32. Chapter 1, Page 14, last paragraph, last sentence
For clarity, it is recommended that the actual chlorobenzene calculated pore water concentration be provided as well.

33. Page 1-18, ¶ 1; Note: due to variability in contaminant response to filter mesh size, filtering may or may not be effective in simulating actual dissolved concentrations.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

34. Page 1-18, second paragraph, first sentence
The maximum and average depth of "deep" sediment porewater samples should be provided in this sentence. The amount of deep sediment data are very limited and this fact should be exemplified. As currently presented, it appears that sufficient deep sediment data points are available and none indicate a problem. However, the actual number of data are limited, and of those, their depth is relatively shallow and not truly representative of sediment and pore water deeper than a few feet.

35. Page 1-19, ¶ 5; The fact that source area concentrations (i.e. within the landfill) are much higher than those suggested from the limited data in the intertidal and subtidal zones is not particularly enlightening. Generally, this would be expected, and as such does not go particularly far in demonstrating the significance of ground water relative to contaminant transport.

36. Page 1-20, ¶ 2; It should be pointed out that conclusions concerning ground water, based on the current database, are hampered by the extremely limited data set from the down gradient (i.e. harbor) areas.

37. Page 1-20, Section 1.4.2, fourth sentence; the words "...may be a minor contributor to the low-to-moderate ecological risk reported..." should be removed from this sentence, and replaced with "may be a contributor to the ecological risk reported..."

38. Page 1-21, second complete paragraph, last sentence; allowing Layers 1 and 2 to discharge directly to Allen Harbor is not necessarily that conservative. It is highly likely that these layers do in fact discharge directly to Allen Harbor. The primary question is where in Allen Harbor the water discharges. If it discharges close to the landfill then there is less distance and time for dilution to occur prior to discharge so the resulting concentration would be higher. Therefore, a conservative assumption would be to allow the model to discharge water from Layers 1 and 2 at or very near the shore of the landfill.

39. Page 1-21, ¶3; The Navy's modeling has been very useful in advancing the conceptual model of contaminant fate and transport at Site 09. However, the example cited only considers VOCs which is one of many classes of COCs. Further limitations are discussed below in the context of Section 1.4.2.2.

40. Page 1-22, Section 1.4.2.2, general comment; As pointed out in previous EPA comments, the physical processes active in the sediment/surface water part of the system may be quite different than those operating in the "aquifer". It is essential that the Navy addresses this issue (during the design phase) in a more deliberate manner, which considers the interaction of ground

water, surface water and sediments as one system for all expected types of contaminants. Specifically, the Navy needs to examine processes other than partitioning which may be having an effect on the fate and transport of certain contaminants. For example, build-up of metals in sediments may not be solely a function of partitioning. Rather, simple oxidation/precipitation of dissolved metals occurring in a reduced state (e.g. within a leachate plume) may occur as the dissolved plumes discharge into relatively more oxygenated surface waters/sediments. Such phenomena would not necessarily be explained by partitioning theory, and further, may be in operation despite low concentrations of dissolved metals in ground water. In other words, metals may have the potential to accumulate in the sediments over time, perhaps even if ground water concentrations are on average below MCLs or other screening criteria such as AWQCs. A cumulative mechanism of this type is not addressed by the current approach. Further, partitioning or precipitation of trace metals to sediments does not necessarily represent permanent removal from the system. The Navy will need to evaluate this and/or other potential fate and transport mechanisms in the context of the upcoming work plan.

41. Page 1-24; ¶ 1; The conclusions expressed here should be tempered with the fact the their basis is a mere two data points.

42. Page 1-24, ¶ 2, 1st sentence; change the text from "...based on the location of MW09-05S near the shoreline indicating that shallow ground water..." to read, "...based on the location of MW09-05S near the shoreline assuming that the shallow ground water..."

43. Page 1-26, ¶ 1; One would also expect ground water discharge to be greatest nearest the shoreline. On this basis the Navy's conclusion that the PAH distribution is primarily due to erosion, although potentially correct, is not conclusive.

44. Page 1-28, ¶ 2; The impact to sediments is not discussed.

45. Page 1-28, last ¶; Please include the number of data points which are available proximal to the landfill (i.e. the number of data points used for this decision).

46. Page 1-36; last bullet; See general comment 1.

47. Page 2-5; Description of the upcoming pre-design sampling is well-written, but it would also be useful to include more detail either here or in another appropriate section of the text concerning what specific actions will be taken and when they will be taken (i.e. sequence relative to other remedial actions).

48. Page 2-6, ¶ 2; See previous comment on this issue in the E.S.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

49. Page 2-6, Section 2.4 PRGs

The last sentence of this paragraph refers to FDA and RIDOH levels for shellfish tissue PRGs, yet the referenced Table 2-3 does not cite any State values. EPA's previous comments on the use of an FDA action level as a PRG remain the same; specifically, FDA values are not used as PRGs because they are not intended for specific sites at which recreational fishing occurs, and FDA levels may be based on economic considerations.

Given that PRGs should reflect the baseline risk assessment and site-specific characteristics, the following average and RME risks are associated with the proposed PRG (FDA value) of 86 mg/kg arsenic in fish tissue:

Average:	8e-04
RME:	3e-02

These values are above the state and federal target risk levels. At a risk of 1e-04, the concentration in fish tissue would be approximately 11 mg/kg.

This report should discuss a risk-based value for arsenic in fish **and** discuss the basis of the FDA action level of 86 mg/kg arsenic in shellfish. Specifically, discuss the population that the FDA value is intended to protect, whether it is freshwater-based or marine, the assumed consumption rate and how that compares to the assumptions in the baseline risk assessment. This report should also compare the State Action Levels to the FDA levels.

50. Page 2-7; ¶ 1; When is the toxicity testing to be done ?

51. Page 2-7, ¶ 4; Please briefly list the specific "Allen Harbor receptors". Please see also general comment 1, above.

52. Page 2-8; ¶ 4 (strike-out); Why was this text removed ? This information suggests that a soil cap (Alternative 2) is not appropriate from the standpoint of leachate control. EPA believes that the Soil Cap will not be appropriate for leachate control.

53. Page 2-8, last ¶; "Significant contributor" needs further definition.

54. Page 2-10, last ¶, The following sentence should be moved to the end of the paragraph for clarity: " Consequently, ...for further consideration."

55. Page 2-12, Section 2.7.3; It is unclear why the last sentence was stricken out. It should be

retained as a means of introducing the subsequent sections on vertical barriers.

56. Page 2-13, 1st bullet; Please see general comment 2.

57. Page 2-13, first bullet, Implementability, last sentence; it is unclear why the highly improbable agreement, by the state and federal agencies that ground water does not pose a risk to human health and the environment, has any bearing on the **implementability** of a soil cap. This sentence should be removed. Ladwin inp.

58. Page 2-13, second bullet, Effectiveness, third sentence; it is unclear why a clay cap is very susceptible to erosion and a soil cap is not. This sentence implies a bias toward the preference for a soil cap. Greater explanation should be provided regarding the increased erosion potential of a clay cap over a soil cap. In fact, a clay cap will be even more resistant to erosion because of the adhesive nature of clay particles. However, the clay cap must be sufficiently thick, such that plant roots, and frost, do not completely penetrate to the bottom and allow for increased rain infiltration rates. The ET cap in Appendix C utilizes a clay layer to provide for the lower permeability suggested.

59. Page 2-14, ¶ 6; Please provide a reference for the landfill gas study.

60. Page 2-14, first bullet, Effectiveness; a concrete cap would also require periodic maintenance as cracks appeared. The expansion joints in concrete are present in order to allow for cracks to preferentially form in areas, however, cracks do form and would require sealing.

61. Chapter 2, Page 15, "Multimedia Cap", first sentence; EPA does not "typically" recommend a RCRA "D" cap for containment of hazardous wastes. Revise the first sentence to read, "For the containment of hazardous wastes, EPA typically recommends a four or five-layered cap system, a RCRA Subtitle "C" cap, consisting of an upper vegetative layer with an underlying drainage layer covering a low-permeability layer, a gas venting layer, if needed, and a bedding layer over the hazardous waste."

62. Page 2-17, ¶ 3; The sheet pile technology should be retained as part of the groundwater containment technology in Section 2.7.5.2 until the results of the pre-design investigation are available. It is.

63. Page 2-18; 1st bullet; The text implies that the "coastal environment" would make routine excavation activities inordinately difficult. Is this really the case ? There is now and will be in the future, good land access to the site since the Navy has agreed to preserve Sanford Road as part of the proposed remedy as has been requested by the Town of North Kingstown.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

64. Page 2-18, last bullet; EPA would dispute the Navy's conclusion that there are no identifiable 'hotspots'. Further, the text makes no mention of the central portion of the site (MW-7 area) where substantially elevated concentrations of CVOC in ground water, which is suggestive of residual DNAPL, were identified in localized areas. The Navy may want to retain this technology until the results of the design phase investigations are evaluated since the possibility exists that a more active ground water source control may need to be implemented in the future and if the FS evaluates a technology, the Navy can "pull" from the administrative record to develop an Explanation of Differences (ESD) rather than having to do the FS process all over again.

65. Page 2-19, last ¶, The concern of the role of Allen Harbor as acting as a "constant head water source" also suggests that this feature plays a key role relative to ground water discharge.

66. Page 2-20, 21 & 22, Ground water extraction technology. We disagree that ground water extraction and refuse wells would not be effective or implementable at this site. It is very likely that a sufficient volume of water could be drawn from these wells to inhibit ground water flow from the landfill to the harbor. The cost of this option may be relatively high, but to eliminate these options from consideration based on the rationale that they would not be effective or implementable is incorrect. It is recommended that these options be retained for further consideration in the detailed analysis. The Navy may also want to retain these technologies since the possibility exists that a more active ground water source control may need to be implemented in the future and if the FS evaluates a technology, the Navy can "pull" from the administrative record to develop an Explanation of Differences (ESD) rather than having to do the FS process all over again.

67. Page 2-21, 2nd bullet; Pending the results of the pre-design investigation, EPA would dispute the assertion that plumes are not present at Site 09.

68. Page 2-23, ¶ 2; Silt should be included as an "keyed" layer for the vertical barriers (see 1st bullet, this page).

69. Page 2-26; ¶ 5; Couldn't UVB be considered an essentially "passive" technology ?

70. Page 2-27; 2nd bullet; The implementability discussion for the reactive wall does not appear to be constrained by depth within the ranges required at this site. By inference one could reason that, also using sheet piles, a recovery trench could be constructed below the 30 "limit" mentioned on page 2-22.

71. Page 2-27, last ¶; Another limitation, which is not mentioned in the discussion, is the

potential negative influence of contaminants transported by ground water discharge into the "clean" sediment.

72. Page 2-32, ¶ 3; It is appropriate to mention the potential beneficial aspects of created wetlands, but the contaminant attenuation functions listed here can not be verified in any accurate way until the results of the "pre-design investigation" are available.

73. Page 3-1; Section 3.1; The list of RAO's needs to mention the potential inclusion of additional ground water control mechanisms pending the results of the "pre-design investigation".

74. Page 3-2, first paragraph after bullets, and Page 6, Section 3.2.2.1, first paragraph The evapotranspiration cover, although efficient in dry climates, does not necessarily enhance evapotranspiration in wetter climates. Essentially, the ET cover is merely a soil cap which, because of the design, increases the rainwater runoff. However, it does not increase evapotranspiration over the soil cap presently on the landfill, and should not be presented as such. (See EPA comments on Appendix C)

75. Page 3-7, ¶ 1; See general comment 2, above.

76. Chapter 3, page 7 section 3.2.2.2, Implementability; remove the last sentence since this section is not about ARAR compliance. See also previous comments on this issue in the E.S.

77. Page 3-8; ¶ 1; Please provide a numerical estimate of infiltration reduction so that the reader can preform a direct comparison with the other alternatives.

78. Page 3-11, first complete sentence; please refer to the previous comment on the Executive Summary on Page ES-8 in last paragraph and last sentence regarding the term permanent, and change text in the same manner.

79. Page 4-5; please indicate whether or not the cost estimates here (and for other alternatives) are based on using the "clean borrow material" or the excavated harbor sediments.

80. Page 4-7; ¶ 3; has the Navy specifically (e.g. relative contribution) quantified the risks from these "other" sources? Is this discussed in detail in another document ? If so, please provide reference.

81. Page 4-8, ¶ 1; please provide the percentage of reduction that the "8-in." represents.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

82. Page 4-8, second paragraph, last sentence; it is not clear why creation of wetlands along the site shoreline will improve the quality of existing wetland resources. This should be explained.

83. Page 4-9, ¶ 1; please see general comment 1, above.

84. Page 4-9, ¶ 1; Why was this material stricken out ? Removing it takes attention away from the leachate generation/ ground water issue.

85. Chapter 4, page 9, section 4.4.2.2; see previous comments on this issue in the E.S.

86. Chapter 4, page 10, section 4.4.2.3; Alternative 2 would not eliminate the long-term risks of potential contact with groundwater, the cap does not contain nor cleanup groundwater. Revise the first sentence in this paragraph to state, "Alternative 2 would eliminate the long-term risks of contact with surface soil and would reduce the long-term risks associated with exposure to sediment but would not reduce the long-term risks of groundwater exposures."

87. Chapter 4, page 10, section 4.4.2.3; EPA does not agree that the soil cap will not erode as much due to the cap settlement. The soil cap does not have the strength of a double barrier cap since the soils are not as strong as the geomembrane. The vegetative layers in both caps may create disturbed soils for enhanced root growth.

88. Chapter 4, page 10, section 4.4.2.3 and Chapter 5, section 5.3; Please clarify the term "self-renewing" as it applies to the soil cap in the text. If the Navy means that since the plants will have enhanced root growth due to slight disturbances in the vegetative layer and an erosion channel would not be created, then this could be applied to all the other alternatives also. The grasses and legumes on the double barrier caps of Alternatives 3 & 4 would act in the same way. The existing landfill contains many naturally occurring plants that may be holding some of the soils together, however, without the Navy doing the maintenance required to stop erosion, the landfill has eroded into the harbor and created some of the resulting risks to human health and the environment.

89. Chapter 4, page 10 and 11, section 4.4.2.3; The Navy has neglected to point out the downside of having heterogeneous vegetation on the landfill cover and the downside of have saturated soils year round on the landfill. See previous comment on the E.S. and add appropriate language here in this section.

90. Page 4-10, ¶ 3; Typo. "Phase II and Phase III RI." Also, it should be added in this place, that another purpose of the additional sampling is to ascertain whether or not ground water migration is an issue and if this requires additional remedial actions.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

91. Page 4-12, ¶ 1; See previous comment, page 4-7, ¶ 3.

92. Chapter 4, section 4.4.2.6, page 14, last sentence; the EPA may not approve the construction of a soil cap because it does not meet the threshold criteria of meeting ARARs and providing the best possible balanced protection for the human health and the environment, not only due to the fact that it is not an "impermeable" barrier. Please revise the sentence to read, "Federal and state regulatory agencies may not approve the construction of a soil cap because the Administrative Record shows that the soil cap does not meet the threshold criteria of protection of human health and the environment and compliance with ARARs."

93. Chapter 4, section 4.4.2.7, Cost; the Navy should include more inspections for the soil cap due to the need for maintenance of the correct species on the cap and the saturated soils that could quickly erode down to expose the waste. The cost per inspection should also be higher since the Navy will have to hire more skilled labor to determine the appropriate types of vegetation to be removed from the cap. The length of each inspection will have to be necessarily longer since the trees, shrubs and vines that may be naturally established on the cap will be more difficult to trudge through than a mowed field.

94. Chapter 4, section 4.5.1.1, Multimedia Cap and Figure 2-2; EPA does not use the term geocomposite to describe the flexible membrane liner (FML) or the geomembrane liner (GM) that should be included in the design of a RCRA "C" cap. Please change the term to either a FML or a GM. The second half of the low permeability layer that is required in the design of a RCRA "C" cap is the low permeability soil layer or an equivalent geocomposite clay liner (GCL). Please change both the text and the figure to be consistent with EPA requirements.

95. Chapter 4, section 4.5.1.1, Multimedia Cap; the HPDE liner noted in the second paragraph has not been approved by EPA. See above comment for revision.

96. Chapter 4, section 4.5.1.1, Multimedia Cap, page 16; 12" will most likely be needed for the vegetative layer at the site.

97. Chapter 4, section 4.5.1.1, Multimedia Cap, page 16, last sentence; please add this same sentence to the section 4.4.1.1, Soil Cap, page 6, as it pertains to both types of caps.

98. Page 4-17; ¶ 4; Please provide a numerical estimate of infiltration reduction so that the reader can preform a direct comparison with the other alternatives. Also, please provide the percentage of reduction that the "14-in." represents.

99. Chapter 4, section 4.5.1.1, Multimedia Cap, page 18, last paragraph; the "chain link" fence

could be a cedar panel stockade fence. The Navy may not need to provide any type of fence around the entire landfill, if the Navy can increase the number of inspections to keep burrowing animals off the cap or provide a burrowing animal barrier above the geomembrane. The Navy may just fence the areas around the gas vents so that the exposure to off-gasses are minimized and so that the Base Reuse Plan requirements for conservation/recreation future use of the site could be more easily attained.

100. Chapter 4, section 4.5.2.1, Overall Protection of Human Health and Environment, page 18, last sentence; either remove the last sentence or add it to all the alternatives since the Navy will have to selectively plant the caps under any alternative, the "natural" habitat will not be attained for any of the alternatives. The "edge" habitat created with the grassy cap under alternatives 3 & 4 creates a needed wildlife habitat for the Allen Harbor Watershed. The closest large grassy edge habitat is over at the old CED Area near building 224. The area is fenced off from the Snake Pit Area, the Landfill and the Calf Pasture Point Area so that wildlife movement is restricted. The Navy should consider Alternatives 3 & 4 as a plus for the creation of edge habitat.

101. Page 4-19; ¶ 1; It is implied that the RIDEM regulations provide an exception for landfills within flood plain areas. Provide the reference.

102. Page 4-20, ¶ 1; Please provide a reference for the landfill gas study. Since this study did not evaluate the extremely high levels of vinyl chloride detected from some samples during the Phase III RI, what is the Navy's plan to address this issue?

103. Chapter 4, section 4.5.2.3, Long-Term Effectiveness and Permanence, page 20, first full paragraph, last sentence; Revise the sentence to read, "Repair of the cap liners is possible, but may require additional effort due to the need to excavate to inspect and repair the materials, however, the geomembrane will tend to add strength to the landfill capping system and minimize the damage due to cap settlement."

104. Page 4-20, ¶ 2; Whether or not the effort needed to repair RCRA C cap liners is "substantial" is somewhat subjective.

105. Page 4-21, ¶ 2, Please see general comment 1, above.

106. Page 4-24, ¶ 4; Indicate how far into the silt the sheet pile will extend.

107. Page 4-26, ¶ 1, Please see general comment 1, above.

108. Page 4-28, ¶ 2; Please provide a reference for the landfill gas study. See comment above

on this issue.

109. Page 4-29, ¶ 2; The text is overly negative in tone. There are the same uncertainties with the other cap, and for that matter just about any other remedy.

110. Chapter 5, page 2, section 5.1 Overall Protection of Human Health and the Environment; see previous comments on this issue in the E.S. and the comments concerning these issues in the PP comments.

111. Page 5-2, second paragraph, and Chapter 5, Page 3, first paragraph; It is recommended that the comment regarding the negative impact of a mowed-grass environment be removed (see previous comment - *Executive Summary, Page ES-8, first paragraph, last sentence*).

112. Page 5-2; ¶ 2; See general comment 1, above.

113. Page 5-3, ¶ 1; The potential reduction of the ground water level in the waste following implementation of a multi-media cap should be included. Also, see general comment 1, above.

114. Page 5-3, ¶ 3; See general comment 2, above.

115. Chapter 5, page 3, last sentence; remove this sentence and the last sentence of the previous paragraph on page 2. See previous comments on this issue in the E.S.

116. Chapter 5, section 5.2, Compliance with ARARs; Alternative 2 will not meet ARARs. See previous comments on this issue in the E.S. and comments on the similar section of the PP.

117. Page 5-4, ¶ 5, See general comment 1, above.

118. Chapter 5, section 5.3, Long-Term Effectiveness and Permanence, page 4; while the design life of the cap may only be 30 years, the Navy is reminded that the geomembranes recommended by EPA for use as a liner in landfills do not biodegrade readily. While no liner can be thought of as a permanent barrier to the infiltration and seepage of hazardous substances, a geomembrane will protect the groundwater from the migration of hazardous substances found in this landfill much better than an evapotranpiration cap. Revise the second sentence in the last paragraph to read, "However, due to the inevitable degradation of the artificial cap materials, which will not be permanent, the permanence of Alternative 3 may be similar to the permanence of Alternative 2, if the geomembrane becomes deteriorated."

119. Chapter 5, section 5.3, Long-Term Effectiveness and Permanence, page 5; The statement

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

"Under each alternative, shallow ground-water COC concentrations are expected to be substantially reduced..." is incorrect. None of the alternatives will reduce concentrations. The alternatives will only limit the migration potential of COCs. Revise the last sentence in the top paragraph and the second sentence in the second paragraph of page 5 to read, "Only if the results of the additional sampling conclude that Site 09 is ***not*** contributing to the harbor sediment COC concentration through the ground-water pathway, Alternatives 2, 3, & 4 can be considered to be similarly effective in protecting human health and the environment because each of the alternatives will control the only COC Migration Pathways (site erosion and surface soil runoff)."

120. Page 5-5 ¶ 2; Text should discuss leachate generation, which would be much greater under Alternative 2.

121. Page 5-5, ¶ 3; There is too little time-series ground water data from which to base any conclusion as to whether ground water migration is ongoing. Residual DNAPL could be acting as a long-term source.

122. Page 5-5, last ¶; See general comment 1, above.

123. Page 5-6, last ¶; The ground water monitoring network will have to be expanded to included downgradient areas.

124. Chapter 5, Page 7, first sentence; revise the sentence so that it reads, "Construction of a soil cap and riprap revetment under Alternative 2 is technically implementable, however federal and state regulatory agencies may not approve the construction of a soil cap a Site 09 because it does not meet the threshold criteria."

125. Table 2-1, chemical Specific ARARs and TBCs for Site 09; change the status of the state sediment water quality regulation for water pollution control to be "applicable".

126. Table 2-3; EPA did not agree to remove the sediment PRGs from this table. Please provide justification as to why the Navy indicates that the sediment at the toe of the landfill will be removed in the body of the FS but does not indicate a PRG for the sediment.

127. Table 2-4 and Table 2-5; if the Navy has decided to include both shallow and deep ground water in one RAO for groundwater, the Navy must indicate that the RAO is to "Prevent both ecological and human exposures to groundwater" not just human exposure, since the seeps were found to be toxic to the ecological receptors and since according to table 5-28 of the redlined draft final RI for Site 9, the groundwater can be potentially impacting the sediments.

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

128. Table 2-5; the strike out verbiage of "the control of ground water migration, restrictions of the future use of ground water and reduction of leachate generation" must be added to the overall ground water RAO, since both shallow and deep groundwater RAOs were consolidated the General Response Actions should also be consolidated.

129. Table 3-1, Action-Specific ARARs for Alternative 2: Soil Cap;

1. change status for the Clean Water Act to relevant and appropriate and change the action to be taken to state "AWQC will be applicable to remedial alternatives which involve discharges to surface water."

2. change the action taken to meet ARAR for RCRA Subtitle C Requirements to "Substantive RCRA requirements will not all be met".

3. Change the action taken to meet ARAR for Subpart N to "Cap design, cap maintenance, and closure/post closure substantive requirements will not be met."

4. Change the action to be taken for final covers to "Cap design will not meet these requirements."

5. Change the status of Clean Air Act from To Be Determined to Applicable.

6. Change the LDR Status from To Be Determined to Applicable.

7. Change the action to meet ARAR for section 10 of the RI Haz. Waste regulations to "substantive portions of this section will not be met."

8. Change the action to be taken to meet ARAR for section 14.12 of the RI Solid Waste regulations to "Design of the final landfill cover will not meet regulations."

130. Tables 3-2, Action-Specific ARARs for Alternative 3: Multimedia Cap and 3-4, Action Specific ARARs for Alternative 4: Multimedia Cap and Vertical Barriers;

1. Change the action to be taken to meet ARAR for the Final Covers to "Cap design will conform to these standards."

2. change status for the Clean Water Act to relevant and appropriate and change the action to be taken to state "AWQC will be applicable to remedial alternatives which involve discharges to surface water."

EPA Review of Redlined Draft Final FS for Site 9, Allen Harbor Landfill, dated July 1996

3. Change the LDR Status from to be determined to applicable.

131. Table 4-2; see previous comments on this issue. The costs for maintenance for the soil cap should be higher due to previously related concerns.

132. Figure 1-4; Two adjacent wells are designated as 9-MW09S.

133. Figures 4-1 and 4-2; The water table beneath the landfilled area is shown to be considerably below the level of the fresh water wetland west of the site. Is the wetland expected to dry up ?

EPA Review of the Navy Report on the Evapotranspiration Cover for Site 09 - FS Appendix C

The following assess the advantages/disadvantages that the ET Cover may have relative to the Resource Conservation and Recovery Act (RCRA) C cap. The conclusion drawn from our review is that the ET Cover is essentially a grass-vegetated soil cap and is not as effective as a RCRA C cap for decreasing infiltration. Alternative designs for the ET cap may have a clay layer present, and it is primarily the presence (or absence) of this clay layer that determines the magnitude of expected rainwater infiltration. When the clay layer is not included in the cap design, the reduction in infiltration is minimal. The clay layer increases surface runoff, and to a lesser extent, evapotranspiration. The presence of the clay layer increases evapotranspiration by decreasing the infiltration rate so that plants have additional time to make use of the rainwater. The use of two different grass varieties showed *no effect* on the predicted reduction of infiltration. It should be noted, however, that transpiration rates vary widely among plant species, growth forms, and communities, and the model used in this analysis may not be sensitive to such floristic variables. The documentation in Appendix C does not cite studies of the effects of types of vegetation on evapotranspiration rates in New England that would support use of the technology. The technology appears to be most appropriate in semiarid or subhumid regions.

Assuming that the models were designed and applied appropriately (backup details were not presented), the Navy's conclusion that the ET cover will reduce infiltration of rainwater through the landfill is correct, relative to that presently occurring. However, the magnitude of the reduction is not as significant as that provided by a RCRA C cap which, based on calculations done in the past, can be considered to reduce infiltration by 95 percent to 99 percent. Table 2 in the memorandum shows that the ET Cover does not reduce infiltration as significantly as a RCRA C cap. Review of Table 2 is summarized as follows:

- Navy calculated that approximately 17 inches of rainwater infiltrates into the waste if the landfill is left in its present state (see row titled Rainbow, RI Indigenous Soil, Existing Cover Using Warm-Season Grass). Using a Single Layer ET Cover with Warm-Season Grass and a Rainbow Soil, approximately 15 inches water would percolate into the waste. This is only a reduction of **12 percent**. Using a Single Layer ET Cover with Warm-Season Grass and a Bridgehampton Soil resulted in a reduction of deep percolation from 17 inches to 12 inches or approximately **29 percent**. *It should be noted that it appears Navy used different amounts of rainfall for the different soil types. For the Rainbow, RI Indigenous Soil 0 percent Rock, the total rainfall is 47 inches (i.e., PRK+Q+ET) and, for the same soil but 10 percent Rock, the total rainfall is 48 inches. For the Rainbow Soil Single Layer ET Cover, the total rainfall is 45 inches. This should be clarified.*

- Navy calculated that approximately 6 to 7 inches of water would percolate into the fill if a clay layer is incorporated into the various Multiple Layered ET Covers Using Warm-

Season Grass. This results in an approximate reduction of **65 percent** to **59 percent**, respectively, if it is assumed that 17 inches percolates without the ET Cover.

Therefore, the greatest reduction in deep percolation achieved with the ET Cover is approximately 65 percent, in contrast with the 95 percent to 99 percent reduction expected to be achieved by the RCRA C cap.

Based on the Navy memorandum, the primary reason the ET cover reduces infiltration is because of increased runoff due to the presence of a clay layer (refer to Table 2 in the memorandum). For example, when the present day conditions were evaluated (Rainbow, RI Indigenous Soil, 10 percent rock), the runoff is 6 inches, and the evapotranspiration is 25 inches (total rainfall is 48 inches). When a Multiple Layer ET Cover with three soil layers and Warm-Season Grass was evaluated, the runoff is 14 inches and the evapotranspiration is 28 inches, irrespective of the relative thickness of the cover layer (i.e., the silt layer). This indicates that 73 percent of the total reduction in infiltration is a result of increased runoff, and only 27 percent is due to increased evapotranspiration, both of which are solely attributed to presence of a 1-foot layer of clay. It should be kept in mind that the effectiveness of the ET Cover has been modeled using literature values and only limited site-specific data. The model has not yet been compared to site measured infiltration/ET/runoff balances for existing conditions at Site 09 and conclusions based on these models may change if site specific data are included.

In addition to our conclusions drawn above, other issues were identified regarding the ET Cover as follows:

Except for regional rainfall data, the calculations and modeling conducted for this study were not based on site-specific data. If the ET Cover were to actually be used at Site 09, it is recommended that site-specific data be gathered to calibrate/run the models, such as:

- Percolation rates for soils presently onsite
- Percolation rates for the proposed soil types by on-site pilot testing
- Site-specific vegetative cover, floristic data, and evapotranspiration rates
- Measurements of existing versus proposed root depths

- The Navy report does not demonstrate that the vegetation they propose (i.e., Warm- or Cool-Season Grass native to more arid zones of the Western United States) would provide any greater benefit (via increased evapotranspiration) than that provided by the native vegetation presently growing on the landfill.

The majority of the locations where the ET Cover has been tested and/or utilized has been in areas west of the Mississippi River. The climate in these locations can be significantly

different than that in New England. The temperatures at many of the locations of the tested ET Covers are, on an average, higher than those in New England. This can cause a significant increase in evaporation from the soil and in transpiration from vegetation, both of which are temperature-dependent.

In summary, the ET Cover would not be as efficient in reducing landfill leachate as a RCRA C cap. Additionally, if a clay layer is included in the design, then the ET Cover would be more effective than a soil cap that does not include a clay layer, but still not as effective as a RCRA C cap.

EPA Review of Redlined Draft Final FS for Site 9, Appendices D and E, Allen Harbor Landfill, dated July 1996

1. *Appendix D, Page 1, Section D.1, second paragraph, second to last sentence*
Some recharge will occur through the Resource, Conservation, and Recovery Act (RCRA) Subtitle C cap, and even though the volume is small, a non-zero number should be presented.

2. *Appendix D, Ground-Water Flow Simulation for Landfill Capping Alternatives*
HELP Model Listings: Both listings indicate essentially no runoff, even though the final cap will have a slope. Has the modeler properly taken the final contours of the proposed cap into account? Understating the runoff may increase the apparent effectiveness of a proposed capping alternative.

3. *Appendix E, Landfill Cap Slope Stability Analysis*, Page E.2
The total unit weight used for the revetment stone (Soil Type No. 2 in the PCSTABL model) was based on Rhode Island Coastal Resources Management Program requirements that stone revetments have a minimum unit weight of 165 lbs./ft^3. Does the Rhode Island Coastal Resources Management Program requirement pertain to the total unit weight of the revetment layer (γ_t), to the dry unit weight of the revetment layer (γ_d), or to the unit weight of the individual stones that make up the layer (γ_s)? If it pertains to γ_t or γ_s, then the unit weight of Soil Type No. 2 is incorrect.

4. *Appendix E, Landfill Cap Slope Stability Analysis*, Page E.2
The statement is made in the middle of the page that the "interface friction angles are product dependent". During the design phase, the Navy should research additional products that have different interface friction angles that would create a more stable slope. The Navy should also investigate additional engineering controls to create a more stable design.

5. *Appendix E, Landfill Cap Slope Stability Analysis*, Page E.3
A comparison between the potential slope angles and the interface friction angles between the multimedia cap components indicates that the multimedia cap will may (sic) not be stable at a slope of 3.5:1 and higher. The 3.5:1 slope mentioned implies a Factor of Safety of 1.0, and does not consider the effect of pore pressures in the cap layers, which would further reduce the Factor of Safety.

6. *PCSTABL input, SOIL CAP (2 feet thick and 4 feet thick)*

Soil Type 2: Check total unit weight (see comment above)

Soil Type 3: The reported friction angle of 42 degrees for the mixed fill in the landfill should be verified by laboratory tests on representative samples before designing the final slope geometry.

Soil Type 6: The design engineer should demonstrate that the reported friction angle of 14 degrees and cohesion intercept of 3,000 psf correspond to the stress levels expected following construction. Use of inappropriately high soil strength parameters can artificially limit the depth of the circles in the search process and produce erroneous and unsafe results.

The limitations imposed on the initiation and termination points for each potential failure surface may overly constrain the search process and produce erroneous and unsafe results.

7. *PCSTABL input, SOIL CAP (4 feet thick)*

Soil Type 4: The reported friction angle of 0 degrees and cohesion intercept of 0 psf disagrees with the input for the previous analysis and appears erroneous.