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GENERAL COMMENTS

Comment 1:

Overview: Year 3 monitoring results continue to demonstrate the effectiveness of the Area A Landfill cap in limiting the mobility of COPCs to groundwater and surface water. In groundwater, no organic compounds were detected in exceedance of either primary or secondary monitoring criteria. The majority of the exceedances detected are for the primary criterion for arsenic. The geochemical evaluation appears to indicate that the dredged material wells see a rather unique porewater environment that shows no discernible relationship to the groundwater elsewhere in the Area A system. Exceedances in surface water include two relatively low-level detections of phenanthrene (at 0.4 J and 0.5 micrograms per liter, compared to the primary monitoring criterion of 0.3 micrograms per liter), but are primarily inorganics (arsenic, copper, lead, zinc). Many of the metals exceedances in surface water apparently are associated with particulates, as they often do not appear in the corresponding filtered samples.

Response:

Comment noted. The Navy agrees with the EPA's overview of the information.

Comment 2:

VOC detection in groundwater: The report notes that there was a detection of xylene at 2WMW42DS in Round 9 (1/11/02), the first detection of a VOC in the monitoring program. Beginning with Round 10, VOC analyses were dropped from the program. Since the xylene detection in Round 9 was very low, at 0.6 J microgram per liter (below the reporting limit given for the "non-detects" at all other wells, 1 U microgram per liter), it is unclear whether it is from analytical uncertainty or sample contamination. Furthermore, although the report notes (p. 4-3, §4.2.1) that no applicable monitoring criteria had been established for xylenes, some perspective is given by the drinking-water standard of 10,000 micrograms per liter. To ensure that VOC concentrations remain at acceptable levels. EPA recommends that VOCs should be retained in the analyte list for future rounds.

Response:

Disagree. The marginal detection of xylene during Round 9 does not warrant re-instituting analysis of samples for VOCs. This statement is supported by the following information. Xylene was only detected once above detection limit in 89 samples collected from downgradient dredge spoil monitoring wells. Xylene was not detected above detection limit (1 U microgram per liter) in the sample collected from well 2WMW42DS during the subsequent sampling event (Round 10 – March 21, 2002).

EPA Rebuttal:

The original comment suggested that a detection of xylene at 2WMW42DS in Round 9 (Nov 02) argues for reinstatement of VOC analyses, that were dropped following Round 9. Navy responds that the detection does not warrant additional VOC analyses because it represents a single detection in 89 samples from the downgradient dredged spoil wells, and xylene was ND in the well of concern in the following round. It is agreed that the xylene detection at 2WMW42DS is not a concern. In addition to the arguments advanced by Navy, it is noted that the detection under discussion (0.6 J microgram per liter) was below the reporting limit given for all other analyses (1 U microgram per liter), so could very well be ascribed to analytical uncertainty or to sample contamination. The reinstatement of VOC analyses was considered by Navy and the response is appropriate.

Resolution:

VOC analyses will not be reinstated into the monitoring program.

Comment 3:

Development of conceptual geochemical and hydrologic models: EPA previously suggested that site-specific data be used to construct a conceptual model for the Area A Landfill groundwater geochemistry, and to show how the data support the assertion that the landfill poses minimal threat of impact to the wetlands area on the north side. In spite of minor issues with the groundwater analytical results (e.g., turbidity problems, possible analytical interference from high TDS content, etc.), the conceptual geochemical model is consistent with both the site stratigraphy and the inferred groundwater flow field. Characteristics of the dredged material, composed of fine-grained Thames River sediments, include: low hydraulic conductivity, high organic carbon content, anerobic conditions, and elevated levels of trace metals within the sediments because of either sorption onto clay mineral surfaces or precipitation as sulfide phases. In such an environment, a number of complex geochemical processes may affect the mobility of arsenic and other redox-sensitive elements. Given a relatively small data set, and with some qualifications of the data, it is not reasonable to verify all of the mechanisms that may be operating to control trace metal distributions and concentrations; but key processes have been identified and discussed within a plausible and defensible conceptual geochemical model.

Response:

Comment noted. The Navy agrees with the EPA's interpretation of the conceptual model.

Comment 4:

Conclusions and recommendations are sound. The recommendations proposed at the

end of this report seem reasonable, especially with respect to dropping sulfate and other analytes. Because the geochemical modeling provides a reasonably thorough assessment of the major controls on groundwater chemistry beneath the Area A landfill, dropping sulfate, COD, and TOC will not result in the loss of critical information. The continued monitoring of other key analytes (e.g., chloride, alkalinity) should reveal any significant (but unanticipated) changes in groundwater composition.

Response:

Agree. Future groundwater and surface water samples, collected under the Area A Landfill Groundwater Monitoring Program, will not be analyzed for sulfate, COD, or TOC.

Comment 5:

Implications for the long-term monitoring program: The supplemental geochemical investigation makes the case that the dredged material pore water is not participating actively in the local groundwater flow system, or at least is doing so only at very slow rates. Among the most compelling evidence is the observation that the dredged material pore water retains strong signatures of the seawater (e.g., high chloride and sodium) that was placed with the sediment, indicating that "flushing" of the dredged materials by the local, fresh-water hydrological system is occurring exceedingly slowly. This picture is also supported by the measured hydraulic conductivities (both horizontal and vertical) for the dredged material, which indicate that this unit is an aquaclude relative to the fill and alluvium. For this reason, the relevance of the dredged material wells to the landfill cap performance monitoring appears to be much less than believed at the time that the monitoring program was designed. Monitoring-well coverage of the dredged material is quite extensive (ten wells along the downgradient edge of the landfill cover), and now appears to be somewhat out of balance with the significance of this hydrostratigraphic unit. In contrast, the underlying alluvium currently has very little monitoring coverage and could be a major conduit for groundwater flow at the basin scale, flowing to the northwest toward the Area A Downstream watercourses. EPA recommends that the overall balance of the long-term monitoring program be reviewed in the future, with a possible reduction in the sample coverage of the dredged material wells and addition of coverage of the alluvium (e.g., add 2LMW29A to the routine monitoring program, and consider installation of at least one more well in this unit). This could result in a substantial savings in sampling and analytical costs over the long-term, with no loss of information critical to assessment of the performance of the remedy.

Response:

Agree with clarification. The Navy was aware that the alluvium was more permeable and the more likely medium for groundwater transport from the Area A Landfill based on the results of the groundwater modeling study conducted for the site during the remedial design. The draft monitoring program proposed by the Navy focused on the alluvium unit; however, based on EPA's insistence, the monitoring program was changed to focus on downgradient dredge spoil. The

current downgradient dredge spoil wells were installed as a result of EPA's comments.

The Navy suggests the following changes to the monitoring network for the Area A Landfill site:

(1) Regarding the existing downgradient dredge spoil monitoring well and staff gauge network, the following recommendations are made. Monitoring wells 2WMW38DS, 2WMW39DS, 2WMW41DS, 2WMW45DS, and 2WMW47DS should be eliminated from the monitoring program. These wells have either been poor groundwater producers that are difficult to sample, have not shown any significant contamination, or are close to other dredge spoil wells. The staff gauges that are currently sampled along with these wells (SG-18, SG-22, and SG-24) should also be eliminated from the monitoring program. The remaining dredge spoil wells (2WMW40DS, 2WMW42DS, 2WMW43DS, 2WMW44DS, and 2WMW46DS) and staff gauges (SG-19, SG-20, SG-21, and SG-23) should continue to be sampled because they provide reasonable downgradient coverage and/or there have been low-level hits of PAHs in the staff gauges previously.

(2) As far as additional alluvium monitoring wells, the Navy proposes to sample monitoring well 2LOW1D, which is the deepest and most downgradient alluvium monitoring well located within the limits of the Area A Landfill. Monitoring of this well should provide the best indication of contaminant migration within the alluvium. It will be necessary to verify the condition and usefulness of the well prior to including it in the monitoring program because it has not been sounded or sampled since the cap was installed at the site. Assuming the wells can be used, it is recommended that this well be sampled for four rounds, concurrent with the monitoring program, and the results should be qualitatively compared to the results from 3MW37S and 3MSP01 to show similarities in analytical and water quality data. It is recommended that this well not be used in the quantitative evaluation of the monitoring results since it is located within the limits of the Area A Landfill and is not useful for showing downgradient compliance. If there are no significant signs of contamination in the well and groundwater quality is similar to downgradient alluvium groundwater, it is recommended that 2LOW1D should then be eliminated from the program, since the downgradient monitoring locations (3MW37S and 3MSP01) will provide sufficient coverage for compliance monitoring.

(3) The current monitoring program includes several downgradient monitoring locations that provide reasonable coverage of the potential discharge locations for the alluvium. Monitoring wells 3MW37S (alluvium) and 3MW12D (bedrock) are part of the monitoring program and are located just downgradient of the Area A Landfill and dike. In addition, the seep sample location 3MSP01 is included in the monitoring program and it is located adjacent to 3MW37S. Therefore, it does not appear that additional downgradient monitoring locations are required in the Area A Downstream.

Once agreed upon, these recommendations will be incorporated into the latest Groundwater Monitoring Plan for the Area A Landfill (Volume II of the Operations and Maintenance Manual).

EPA Rebuttal:

The original comment noted that, given what is now known about transport processes in the neighborhood of the Area A Landfill, the balance of monitoring wells in the long-term monitoring program should be reviewed. Navy's response proposes changes that are generally well motivated. In particular, Navy recommends:

- *Eliminate dredged-spoil wells 2WMW38DS, 2WMW39DS, 2WMW41DS, 2WMW45DS, and 2WMW47DS.* This action is endorsed. These wells have been shown to monitor a local environment in the dredged spoil that shows no discernible impact of the landfill. Furthermore, these wells are redundant, in that there are five additional dredged-spoil wells that Navy proposes to leave in the LTM program. The five wells proposed for elimination can be dropped without loss of useful data for monitoring the effectiveness of the site remediation.

- *Add monitoring well 2LOW1D for four rounds of sampling in order to address the concern for lack of well coverage in the alluvium.* This well location appears to be well chosen to monitor for potential impacts of the landfill on groundwater in the conductive alluvium. It is toward the downgradient (northern) end of the landfill. According to the response, the recommended well has the deepest screen among downgradient wells within the landfill footprint. The rationale for choosing a deep screen should be provided. Is this simply to assure that the well is screened within the alluvium? If the alluvium is sufficiently thick here, and if there is an existing well screened in the uppermost portion of the alluvium, that may be a worthwhile sampling target, because one might expect landfill influences to be detected first in the shallowest "fast" material. Are there available estimates of the vertical hydraulic gradient in the vicinity of 2LOW1D? The Navy should ensure that the well does not sample groundwater discharging upward from underlying bedrock. Navy recommends sampling the added alluvium well (2LOW1D or whatever well is agreed upon) for four rounds, and, if it shows "... no significant signs of contamination ...," that it be dropped from the monitoring program. EPA believes that that decision should await review of analytical results and regulator approval, rather than being determined by a pre-set criterion. Even if clean, this well might still be regarded as a viable "sentry" for the penetration of landfill impacts into the deeper alluvium.

- *Retain 3MW37S (alluvium), 3MW12D (bedrock), and 3MSP01 (seep) for coverage of the downgradient domain.* It is agreed that these locations provide adequate coverage to monitor for downgradient impacts of the landfill. No additional wells are indicated in the downgradient area at this time.

Resolution:

Monitoring wells 2WMW38DS, 2WMW39DS, 2WMW41DS, 2WMW45DS, and 2WMW47DS will be eliminated from the monitoring program.

Monitoring wells 2LOW1D and 2LMW29A are the only existing wells installed in the alluvium within the footprint of the Area A Landfill. Well 2LOW1D is located near the downgradient edge of the landfill and screened beneath approximately 10 feet of dredge spoil from elevation 60.74 to 55.74 with 2 feet of the screen in dredge spoil and 3 feet in alluvium. Well 2LMW29A is located near the upgradient edge of the landfill and screened beneath approximately 1 foot of dredge spoil from elevation 75.41 to 70.41 with all 5 feet of the screen in alluvium. Based on previous investigations conducted by the Navy in support of the landfill cap design, there is typically an upward flow gradient from the bedrock to the alluvium in the vicinity of the landfill. Based on this information, neither well is optimal for the monitoring program. Therefore, the Navy recommends sampling both wells for one round to determine the geochemical conditions present in each well and to determine if any contaminants of concern are present in the alluvium groundwater. The new information will be used along with the each well's physical data to select the most appropriate well for the monitoring program. The selected monitoring well will be included in the monitoring program as long as it continues to provide useful information.

Downgradient monitoring wells 3MW37S (alluvium) and 3MW12D (bedrock) and seep sample location 3MSP01 will remain in the monitoring program.

SPECIFIC COMMENTS

Comment 1: p. 2-4, §2.2.4

The significant contrast in horizontal hydraulic conductivities between the alluvium and the dredged material (~100X) and the large anisotropy found for the dredged material (KH/KV ~ 37) support the interpretation of the dredged material as a confining unit, and are consistent with the geochemical indicators of minimal exchange with actively recharging groundwater.

Response:

Comment noted. The Navy agrees with the EPA's interpretation of the data.

Comment 2: Table 3-1, §2

Monitoring well 2LMW20S is described in the table as being screened in the fill/alluvium. The interpretive cross-section shown in Figure 4-8 shows the bottom of the well screen penetrating a thin layer of dredged material, although the majority of the screen is shown in the fill. Is the figure accurate? This may be relevant to the detection of arsenic at this well in one round above the primary monitoring criterion. Arsenic was detected at 5.6 micrograms per liter in Round 11. This is the only arsenic exceedance in groundwater other than in the dredged material. I note that ORP was at a minimum in this sampling round for this well (-200 mV, compared to a range from -114 to +81 mV in previous rounds), and that iron was high (15.9 mg/L); results for the filtered sample were similar. While the arsenic exceedance may be from a drop of ORP (possibly associated with lower water levels, shallower hydraulic gradients, and lower groundwater fluxes due to a relatively dry year), dissolution of iron oxyhydroxides, and mobilization of sorbed arsenic, it is entirely plausible that this process could mobilize and release arsenic within the fill and/or alluvium.

Response:

Agree with clarification. Figure 4-8 shows the latest interpretation of the available geologic information. Based on the boring log for 2LMW20S and the likely method used to deposit the dredge spoils, it is probable that a thin layer of dredge spoil is present in this location; however, the boring log is not clear on this issue. Table 3-1 will be amended to indicate that the screened formation for 2LMW20S includes Fill/Alluvium/Dredge Spoil.

Comment 3: Table 4-2, §4

The detection limits achieved by the laboratory are sometimes above the lowest monitoring criteria for a number of elements. For example, in the Round 10 analysis for

2WMW40DS, arsenic is reported as undetected (U) at a detection limit of 6.5 micrograms per liter, which is above the primary monitoring criterion of 4 micrograms per liter. For this reason, the "non-detect" is not shown in bold in the table, while in rounds 9 and 11, detections of the same order (5.9 and 8.6 J micrograms per liter, respectively) are shown as exceedances. It is not known whether arsenic was in exceedance of the primary monitoring criterion in Round 9. The table would be more informative if some notation (e.g., grey shading) for analyses whose detection limits are higher than the corresponding monitoring criterion were established, indicating possible exceedances that could not be quantified. Cadmium and copper revealed a similar problem.

Response:

Agree with clarification. These potential exceedances will be called out in the text versus on the table, as requested by the EPA, in future reports. For reference, this approach was taken in the Draft Year 1 Annual Groundwater Monitoring Report for the Goss Cove Landfill (March 28, 2003). No changes will be made to the subject report.

Comment 4: Table 4-2, §4

Table 4-2 reports total zinc in 2WMW46DS at 166 micrograms per liter. Zinc was not detected in the filtered sample from this monitoring well, at 3.78 U micrograms per liter (in App. G in the Round 9 monitoring report), and turbidity is reported at 70 NTU. However, arsenic, iron, and manganese are all essentially the same in the filtered/unfiltered pair. Iron concentrations were 946 and 698 micrograms per liter, for the unfiltered and filtered analyses, respectively, suggesting that this apparently elevated zinc value is not associated with particulates. Zinc is not detected in the filtered/unfiltered pairs from the subsequent sampling rounds, at detection limits that vary from 5.7 to 22.2 micrograms per liter. It is likely that this single analysis is an analytical artifact, arising either from spectral interference due to the high TDS content of this sample, or some other, unidentified cause. What other plausible explanations exist?

Response:

Agree with clarification. The EPA's interpretation of the results is plausible. A similar set of total and dissolved zinc results were recorded at this well during Round 3 (146/8.2J micrograms per liter). The turbidity reading was also similar (71 NTU). Data validation procedures were not able to identify the cause of the difference. The Navy does not know of any other plausible explanations.

Comment 5: Figure 4-6, §4

Monitoring well 2LMW29A, located on the northwestern geochemical transect, is labeled 2LMW29DS on this figure. Please correct.

Response:

Agree. Figure 4-6 will be changed to show the correct monitoring well identification (2LMW29A).

Comment 6: p. 5-2, §5.1

While the conclusion in the first bullet is almost certainly correct, the point deserves an expanded discussion. Cadmium exceedances were observed at 2WMW38DS and 2WMW47DS; chromium exceedances at 2WMW21DS and 2WMW44DS; copper exceedances at 2WMW38DS; and a zinc exceedance at 2WMW46DS. If the same mechanisms that control arsenic concentrations in dredged material pore water are also expected to control cadmium, chromium, copper and zinc concentrations, this should be discussed briefly, perhaps in Section 4.5.4, with a recap in Section 5.1.

Response:

Disagree with clarification. The focus of the geochemical investigation conducted by the Navy was arsenic because arsenic has been consistently detected above the primary monitoring criteria. The inorganics mentioned in the comment have been detected at higher concentrations in the downgradient dredge spoil wells, but their concentrations have been generally insignificant when compared to the primary criteria and background concentrations. Therefore, even though cadmium, chromium, copper, and zinc could be associated with iron oxyhydroxide or iron monosulfide minerals that are likely part of the dredge spoil and these inorganics could be released, along with arsenic, if they become unstable and dissolve, it does not seem necessary to elaborate on this fact in the report.

EPA Rebuttal:

The original comment asked for an expanded discussion of the implications of the supplemental geochemical study (targeted specifically at arsenic) for other trace metals. Navy's response discounts the importance of this, noting that "...concentrations have been generally insignificant when compared to the primary criteria...." While it is agreed that the draft document meets its principal goal of addressing arsenic, there is some merit in expanding that goal, particularly in view of the new primary monitoring criteria for the Area A Landfill (Draft Groundwater Monitoring Plan, Operation and Maintenance manual Volume II), as discussed in the teleconference on the Groundwater Monitoring Plan on 6/3/03. In particular, EPA comments on the O&M Manual noted that the proposed, more stringent, primary criteria for many trace metals will bring some elements into exceedance that previously were not. For example, the existing primary criterion for cadmium is 6 micrograms per liter; the proposed new criterion is 0.25 micrograms per liter; the maximum observed in Rounds 9 to 11 is

2.15 micrograms per liter. Similarly, the existing primary criterion for copper is 48 micrograms per liter; the proposed new criterion is 4.8 micrograms per liter; the maximum observed in Rounds 9 to 11 is 7.3 micrograms per liter. Thus, Navy's response to this comment will no longer be true if the proposed revisions to the primary criteria are adopted. It would then be in Navy's best interest to expand the discussion of the implications of the arsenic investigation for other trace metals in the dredged spoil. Such a development could support future discussions of exceedances of monitoring criteria that may have a straightforward explanation that is unrelated to landfill impacts.

Resolution:

The Navy will add text about the additional trace metals (cadmium, chromium, copper, and zinc) and their relationship to the dredge spoils into Sections 4.5.4 and 5.1 of the report as requested in the original comment.

Comment 7: p. 4-20, §4.5.2

This section summarizes the major chemical characteristics of local groundwater, in a well-organized fashion that groups wells according to the horizons in which they are completed: bedrock, alluvium, clean fill/dredged material, landfill/dredged material, and dredged material. In addition, Thames River water is included for comparison. Overall, groundwater in the area appears to be dominated by sodium chloride and calcium carbonate chemistry, consistent with the origin of the dredged material sediments and the signature of Thames River water. Plots of sodium vs. chlorine and calcium vs. alkalinity show highly linear correlations.

Response:

Comment noted.

Comment 8: p. 4-22, §4.5.3

The calculation of saturation indices (SIs) was a critical step in identifying phases that may affect trace metal concentrations. In particular, it is important to note that the PHREEQCI results indicate the stability of ferric oxyhydroxide (FeOOH) in groundwater from bedrock, alluvium, and fill, yet conditions within the dredged materials are variable and PHREEQCI indicates that this phase may be either precipitating or dissolving in this environment. As noted in previous review comments, the presence of hydrous ferric oxide (HFO) plays a major role in sequestering arsenic and other trace metals, through sorption onto active sites on the oxide surface. Where redox conditions favor the precipitation of HFO, trace metals are removed from the aqueous phase. When ORP decreases, the HFO surface dissolves and sorbed constituents are released into solution. In addition to calcite, were any other carbonate phases considered? With the high alkalinities observed in the groundwater data, it is possible that some carbonate phases are contributing to the trace element behavior by precipitation of Fe or Mn solids

(e.g., FeCO3 or MnCO3), although relatively little is known about the sorption of arsenic onto carbonate surfaces.

The data indicate an approximate association of dissolved arsenic with barium. Why might these elements be related? Is it possibly from a Ba-carbonate (or Ba-sulfate) formation? Were any Ba phases predicted by PHREEQCI?

Computational results also confirm the stability of solid-phase FeS at very low ORPs (usually in the range below about -300 mV) in the wells completed in the dredged materials (e.g., 2WMW40 – 47DS). Although the mechanism is not as well-studied as that for sorption onto HFO surfaces, it is known that iron sulfides also sorb arsenic (and other trace metals). There is an 'optimal' ORP where neither HFO precipitation nor Fe-sulfide formation is occurring, in which aqueous concentrations of arsenic and other sorbates are at maxima.

As discussed in the text on pages 4-23 and 4-24, the calculated ORP is expected to differ from field measurement, and will differ depending on which redox couple is used (as demonstrated clearly by results shown in Table 4-14); it should be noted that the Eh values from all of the redox pairs that were reported are internally consistent.

Because dissolved iron and arsenic do not appear to be correlated, the reductive dissolution of hydrous ferric oxide (HFO) and/or the precipitation and subsequent oxidation of FeS and release of sorbed arsenic cannot be either confirmed or ruled out. It is highly likely that any signal that might derive from reactions involving dissolved iron may be obscured by a number of possible sampling and analytical problems – e.g., changes in redox conditions during and possibly even after sampling; field data sheets indicate severe turbidity problems, some of which may be from rapidly-changing ORP conditions during sample collection, and resulting precipitation of Fe and Mn. In addition, it is possible that results are biased because of spectral interferences during analysis by ICP (inductively-coupled plasma atomic emission spectroscopy) owing to the high TDS content of the samples. The round 11 data show a qualitative association between iron and arsenic, and one can only speculate on the mechanism(s) responsible, mainly because only six values for arsenic (three of which are below the current MCL of 10 micrograms per liter) were reported above the analytical detection limit. Qualitatively, the data are consistent with the interpretation that iron and arsenic are associated: the sample with the highest dissolved arsenic (42 micrograms per liter) also reported the highest level of dissolved iron (100 mg/L).

Response:

<u>Paragraph 1</u>

The PHREEQCI model automatically calculates the saturation indexes (SIs) for mineral phases for which the user inputs solution data and there is available thermodynamic data in the database. As a result, for the model runs at Area A Landfill, both siderite (FeCO3) and rhodocrosite (MnCO3) were considered by the model. With one exception (well 2LMW32F) wherein the iron and manganese content of the groundwater were very high, model results indicate

that groundwaters are undersaturated with respect to these two mineral phases.

Paragraph 2

The association between dissolved arsenic and barium is problematic. Again, barium mineral phases (either carbonate or sulfate) would be examined by PHREEQCI. The SI for witherite (BaCO3) is consistently very negative therefore unlikely to precipitate. The SI calculated for barite (BaSO4) on the other hand is usually slightly negative but often near zero with the sample from well 2WMW40DS exhibiting an SI slightly positive (0.27). However, there does not appear to be any correlation between the concentration of dissolved arsenic and the saturation index for a barium mineral. Calculated SIs for selected minerals are provided in the table below.

PHREEQCI Saturation Index for Selected Minerals – Area A Landfill Groundwater				
Well ID	Rhodocrosite ($MnCO_3$)	Siderite ($FeCO_3$)	Barite ($BaSO_4$)	Witherite ($BaCO_3$)
4MW1S	-4.40	-4.05	-0.16	-5.94
2LMW29A	-1.76	-1.36	-0.27	-5.87
2LMW32B	-2.38	-3.70	-0.09	-5.72
2LMW32DS	-0.31	-1.59	-0.63	-3.70
2LMW32F	0.94	1.71	-0.52	-1.94
2LMW7D	-1.86	-0.56	-0.28	-5.29
2LMW7S	-1.29	-0.70	-1.25	-4.32
2WMW21S	-0.66	-1.23	-1.10	-3.84
2WMW40DS	-0.90	-0.50	0.27	-3.76
2LMW20S	-0.97	-0.02	-0.52	-4.85
2WMW46DS	-1.13	-2.53	-0.75	-3.01

Paragraphs 3 through 5

Comments noted.

Comment 9: p. 4-22, §4.5.3

The conceptual geochemical model is consistent with both the underlying stratigraphy and the observed groundwater chemistry. The conclusions proposed in this section are based on a number of complex processes but supported with site-specific data. It is clear that oxidation and reduction of iron and manganese play a key role in controlling trace element concentrations, and there is little indication that the landfill has impacted either the redox conditions or naturally-occurring trace metal concentrations.

The contrast between the composition of the dredged material groundwater and waters from the other hydrostratigraphic units is distinct. Owing to limitations of the size of the groundwater data set and possible uncertainties, EPA explored other interpretations that

could be derived from the data, including an examination of the major-element chemistry via Piper diagrams. These plots are a simple, graphical method of displaying major-element chemistry in a manner that permits rapid, visual assessment of groundwater data. Two ternary diagrams are constructed, one with cations (Ca+2, Mg+2, Na+ + K+) and the other with anions (Cl-, SO4-2, HCO3- + CO3-2), and the points are projected onto a diamond-shaped field representing the six major components. Waters that are compositionally similar will plot as a cluster of points. Alternatively, mixing of two end-member compositions can be easily ascertained, as samples of intermediate compositions plot along a straight line between the end-members.

Piper diagrams show that the "upgradient" or background wells (bedrock wells 4MW1 and 2LMW32B, and 2LMW20S) have major-element compositions that differ from each other and are also different from the dredged material wells. However, all the dredged material wells are tightly clustered in the six-component field of the Piper diagram, indicating that their compositions are similar. Moreover, the "reference" well 2WMW21S, presumed to be unimpacted by the landfill, plots in the same part of the diagram as the other dredged material wells. This observation suggests that the groundwater in the dredged material downgradient of the landfill retains the chemical signature of its origin in a marine environment, and that the landfill has not appreciably altered this composition. These observations, based on the major-element chemistry, are consistent with the conceptual model presented in Section 4.

Response:

Comments noted.

EPA Rebuttal:

The original comment provided some additional insight into the hydrogeochemical "facies" present in Area A Landfill groundwater. In particular, the comment pointed out that the dredged-spoil wells (including 2WMW21S, the "reference" well believed to be removed from potential landfill impacts) all fall tightly within a group on a Piper diagram, distinct from the upgradient wells. This result is consistent with the conclusion reached in Navy's supplemental arsenic geochemistry study to the effect that the dredged-spoil wells sample a unique geochemical environment that is not discernibly impacted by the landfill. Navy agrees with the comment. It is noted here that this comment takes on added importance in view of the proposed changes to the monitoring network (see General Comment 5). That is, the major-element chemistry lends added support to the argument that the dredged-spoil wells do not monitor groundwater that is measurably affected by the landfill, and that monitoring well coverage of this material is excessive. The major-element chemistry suggests that the 10 wells presently set in this domain are largely redundant, and supports the proposal to drop 5 of the wells from the LTM program.

Resolution:

Comment noted. Five of the dredge spoil monitoring wells will be dropped from the monitoring program (see Resolution to General Comment 5).