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September 5, 2006

Project Number G00200

Mr. James Colter
Remedial Project Manager
NAVFAC Midlant Environmental
1530 Gilbert Street Building N-26
Room 3208
Norfolk, Virginia 23511

Reference: CLEAN Contract No. N62472-03-D-0057
Contract Task Order No. 043

Subject: Final Background Soil Investigation Report
NUSC Disposal Area, SA-08
Naval Station Newport, Newport, Rhode Island

Dear Mr. Colter:

Enclosed you will find four copies (two CD and two paper copies) of the Final Background Soil Investigation Report for the NUSC Disposal Area, located at the Naval Undersea Warfare Center, which is part of the Naval Station Newport, Newport, Rhode Island.

The report was prepared based on the draft provided April 2006, and revised in accordance with responses to comments. Comments on the Draft were received from USEPA on May 9, 2006 and from RIDEM on June 2, 2006. Responses to these comments were provided on June 28, 2006. RIDEM provided comments to the response package on July 25, 2006. Final responses to these comments are enclosed as part of this transmittal.

In accordance with the task order, copies of the report and the new response summary have been provided to the persons on the distribution list below for their records.

If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Heather M. Ford
Project Manager

HMF/rp

Enclosures

c: K. Keckler, USEPA (w/encl. – 2 paper, 2 CD)
P. Kulpa, RIDEM (w/encl. – 2 paper, 2 CD)
C. Mueller, NAVSTA (w/encl. – 1 paper, 2 CD)
NAVSTA repositories c/o C. Mueller, NAVSTA (w/encl. – 4 CD)
J. Stump, Gannett Fleming (w/encl. – 1 paper, 1 CD)
J. Trepanowski/G. Glenn, TtNUS (w/o encl.)
S. Parker, TtNUS (w/encl. – 1 paper, 2 CD)
File G00200-3.2 (w/o encl.) File G00200-8.0 (w/encl. – 1 CD)

Response to Correspondence from RIDEM 7/25/06
Draft Background Soil Investigation Report,
Site 8, NUSC Disposal Area
Original Comments Dated June 2, 2006

1. General Comment

Please be advised that background studies are limited to metals.

Response: The comment is noted. It is our understanding that previous versions of RIDEM regulations allowed the adjustment of cleanup criteria for metals by conducting background studies, However, RIDEM should be aware that EPA and Navy policies allow for background evaluations be conducted for anthropogenic chemicals such as PAHs and pesticides. Therefore, the Navy opted to identify PAH and pesticide concentrations in the background areas as well. This data may be used in the future to continue to gain understanding as to anthropogenic contaminants in the region.

Evaluation of Response

The Navy acknowledges that RIDEM regulations does allow for modification to cleanup standards for metals. This was the intent of the comment.

Final Response: Comment noted. Specific discussions on how the background values will be used are anticipated in regards to the NUSC RI report.

2. General Comment

The report has produced a table containing the range, arithmetic and geometric average for arsenic in different soil types. Please indicate whether the proposed background concentration is the range, arithmetic, geometric average or some other value

Response: The report notes that the background data set was developed to allow comparison of site data to background data, and to be incorporated into a base wide background data set. Rather than set a single background value for any specific chemical constituent for this site specifically, any and all statistics developed from the background data groups should be available for different comparisons, and specific comparisons should be made as appropriate to the ends that are being tested. Thus, the response to the comment is all these values are pertinent to the comprehensive understanding of background conditions.

Evaluation of Response

It appears that the Navy feels that all of these values should be considered in the background analysis and at this time the Navy has not selected a particular value. The Office of Waste Management concurs that the background values for a particular metal lies within the ranges in the report (with the understanding that for certain metals these ranges will have to be modified to address concerns broached in the comments below). As a particular value each metal has not been selected at this time, the Office of Waste Management will withhold concurrence until such time that he Navy proposes a value for review and approval.

Final Response: Comment is noted. Refer to the final response to Comment 1, above.

3. General Comment

The executive summary focuses on arsenic. Please indicate whether arsenic is the only metal that the Navy is seeking a background value for. If the Navy is seeking a background value for more than one metal please provide a table with these metals and the associated background values.

Response: The executive summary focuses on arsenic because it is the metal that is more consistently found above the RIDEM direct exposure criteria not only at NUSC, but at many sites on Aquidneck Island. It appears that this has come to RIDEM's attention as well, since 7 of the 18 comments on the subject report focus on the evaluation of the arsenic data. However, other chemical constituents were analyzed and the background conditions for any and/or all chemical constituents measured may be used at some point during the RI/FS process to qualify data, risk, design and construction considerations, etc.

Evaluation of Response

Again it appears that the Navy will select a particular background value, as or when found to be necessary during the RI/FS process. Accordingly, the Office of Waste Management will withhold concurrence until such time that he Navy proposes a value for review and approval.

Final Response: Comment is noted. Refer to the final response to Comment 1, above.

4. General Comment

Please provide a table, with the following information, for <u>each</u> metal that the Navy is seeking a background concentration for:

Sample result arranged in ascending order for the particular soil type (for example for Se soils the Navy would list all the sample results for arsenic in ascending order for this soil type).

Descriptive statistics for each contaminate and each soil type, typically place below abovementioned soil types, (for example, below the list of arsenic sample results for Se soil would be the range, medium, mode, mean, standard deviation, kurtosis, skew, etc).

Non Descriptive Statistic for each contaminates and each soil type, typically below the abovementioned descriptive statistics. The sample value obtained and the critical value for each test must also be included in this table, (for example, below the descriptive statistics for arsenic for Se soil would be the results of the test for normality, outliers test, etc (critical values and sample values, as well as a statement indicating the significance of being above or below the critical value for a particular test.)

Response: Regarding the first portion of the comment, the Navy is not currently seeking a single background value for any analyte (refer to the response to comment 2, above). Regarding the remainder of the comment, rearranging the data tables, the statistical analysis and testing spreadsheets for all the analytes would result in an extensive revision and lengthening of the report. Since the Navy is not seeking a state-approved background value for all these analytes, the report will not be revised to provide this information.

However, since the discussion subject at the current time is the elevated concentrations of arsenic at this site, providing the summaries described above for arsenic will be provided as requested. This will be provided in a new Appendix E of the report. Existing evaluations will remain as previously published.

Evaluation of Response

The Navy has reiterate its position that they are not seeking a single background value for any particular contaminate at this time. However, since the discussion topic at this time is arsenic they have provided the rearranged tables.

Final Response: Comment is noted. No further action is required.

6. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-3.

This section of the report notes that the Sample 06 (arsenic concentration 71 ppm) has been identified an outlier by the statistical test. The report should also note that inclusion of this value results in a non normal distribution, which does not allow for the use of parametric test.

Response: Table 4-9 indicates that, before considering removal of the candidate arsenic outlier at 71.7 mg/kg, the arsenic data set for Non-Hydric Soil Type Se acceptably matches the shape of a lognormal distribution (W-score 0.9162, critical value 0.905), but does not have a normal distribution (W-score 0.5162, critical value 0.905). Table 4-14 reveals that, after removal of the candidate outlier, the lognormal fit is slightly better (W-score 0.963, critical value 0.901), but the normal fit now also matches acceptably (but not as good as the lognormal fit). This is to be expected with outlier removal, since lognormal distributions are necessarily skewed with a tail reaching out to include a few data points at much higher or lower concentrations. It will be noted in the report that this precludes background tests that require the assumption of normality (parametric tests)

Evaluation of Response

RIDEM's calculation for log normality generates different sample values and critical values. Please indicate what significance level was employed. In addition, in order to verify that the same data is being used please list the sample number and the actual value for each sample, which were used in the calculation.

Final response: Table 4-9 provides the results for the Shapiro Wilk test run on the non-hydric Se soil entire data set with a significance level of 0.05. The duplicates were averaged before running calculations. Table 4-14 provides results for the Shapiro Wilk test (alpha of 0.05) using this data set minus the 71.7 candidate outlier. The arsenic data points used were as follows:

SO11: average of 3.3 (positive) and (3.9/2) (non-detect)
SO16: 3.9
SO17: 5.8
SO18: 5.8
SO12: 6.4
SO04: 7.7
SO01: 7.8
SO03: 8.6
SO07: average of 9.1 and 10.7 (both positive)
SO19: 9.2
SO05: 9.5
SO15: 11
SO10: 11.2
SO14: 11.2
SO13: 12.2
SO09: 12.6

SO08: 13.2
SO02: 16.3
SO20: 23.5
SO06: 71.7

7. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-3.

The report notes that the concentration of arsenic observed in sample 06 is almost twice the magnitude of the second highest observed arsenic concentration and 4 times the 75 quintile of the combined data set. Further, it is noted that the value is a J value due to iron interferences. The report also notes that probable source for this high result is use of pesticides. The Office of Waste Management agrees that the arsenic concentration observed in this sample does not represent natural background conditions.

Response: The report does not state that the probable source for the high arsenic result is the use of pesticides, it states "it is conceivable that use of arsenic containing pesticides or herbicides may have contributed to regional background conditions", a statement that has a completely different meaning. The paragraph concludes that this sample was retained for use in the final background data set.

Additionally, the comment implies that use of pesticides resulted in an unacceptable condition. RIDEM should be aware that contaminant concentrations present as a result of the use of pesticides in accordance with the manufacturers' instructions do not constitute a release. This input would be considered an anthropogenic condition, and part of background. This will be clarified in the revised report.

Evaluation of Response

Please be advised that RIDEM does not concur with the exemption for a release noted above.

Final Response: Comment is noted. Further discussions on this issue may be warranted, depending on the findings of the investigations conducted.

8. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-3.

Please be advised that the concentration at Sample 06 indicates that it should not be used in the background analysis. Therefore, please remove this value from the assessment and all subsequent statistical tests must be performed without this data point.

Response: As noted in the first full paragraph on Page 4-14 of the draft report, arsenic and iron have a correlation coefficient is 0.96, which indicates arsenic concentrations increase with iron due to adsorption capacity of iron in the soil. Based on the soil conditions found in this area, the iron is clearly a natural feature, a result of mineral leaching and bedding over time as soils have developed. The sample in question shows the highest concentration of iron and thus the highest concentration of accumulated arsenic. Therefore sample SO-06 is not an anomaly, it is just the high end of the sample group. Additional discussion on origins of arsenic and iron will be added to the revised report.

Evaluation of Response

The response focuses on the correlation to iron not the actual concentration of arsenic, which reflects a release.

Final Response: The comment is noted. The response describes a correlation of elevated iron to elevated arsenic, which is further indication that the arsenic is a natural element in the soil at the concentrations measured. It is clear that RIDEM considers this presence of arsenic a release as stated in their evaluation to the response on comment 7, above. Additional information will be provided in the report, but it would appear unhopeful that agreement can be reached on this point.

9. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-4, Paragraph 2.

This section of the report deals with Sample 25 and the fact that the observed concentration makes it a potential outlier. The report notes that the average concentration for this sample was 23.1 ppm. This concentration reflects an averaging of the duplicate samples, which were collected at this location. The concentration of the duplicate s0 25 was 10.3. and 32.3 ppm respectively. This translates into a relative percent difference of 103 percent, which is beyond acceptable QA/QC protocol. As such, both data points must be rejected and all subsequent statistical test and must be performed without these two data points.

Response: The data validation process noted the RPD >50% for this field duplicate pair for arsenic, iron, lead, and manganese. Under the USEPA validation guidelines used for this project, standard practice in this situation is to qualify the values with a J and not reject the values. This approach is appropriate because adequate consideration must be given to the variability in the soil matrix.

Evaluation of Response

The Navy states that if the relative percent difference is above fifty percent the approach is to labeled the value as J and used the data. One also has to consider the magnitude of the difference. A relative percent difference of 103 % is high and is not acceptable. Accordingly both data points must be rejected. The Navy may elect to perform this analysis without these points, even though it will translate into not having twenty samples.

Final Response: The relative percent difference of 103% does not in itself provide justification for rejection of the data point, because adequate consideration must be given to the variability in the soil matrix.

10. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-5, Paragraph 1.

This section of the report notes that the high concentration of arsenic observed in sample 20 (23.5 ppm) is attributable to the high iron concentration in this sample 23,500 ppm. The concentration of arsenic observed in sample 10 was 11.3 ppm. The concentration of iron observed in this same sample was 23,800 ppm, higher than that observed in sample 20. In essence despite the essentially equivalent iron concentration the arsenic concentration is approximately one half. As such, the iron concentration does not appear to be the culprit for the high arsenic concentration. It is more likely that the high arsenic observed in this location reflects use of pesticides or other materials.

Response: Figure D-1 in Appendix D provides an assessment of the use of sample SO-20 in the correlation of arsenic to iron. It is noted on the right margin that within the Se soil data set, correlation of iron to arsenic in the data set would actually drop if this sample were removed from the mix. This observation indicates the value of evaluation of data points as a group and not individually.

Evaluation of Response

The response focuses on the correlation to iron not the actual concentration of arsenic which reflects a release.

Final Response: Please refer to the response to comment No. 8, above.

12. Section 4.2.3, Examination of Extreme Values and Outliers
Arsenic
Page 4-5, Paragraph 1.

Please be advised that the concentration at Sample 20 indicates that it should not be used in the background analysis. Therefore, please remove this value from the assessment and all subsequent statistical test and must be performed without this data point

Response: As noted in the first full paragraph on Page 4-14 of the draft report, arsenic and iron have a correlation coefficient is 0.96, which indicates arsenic concentrations increase with iron due to adsorption capacity of iron in the soil. This means that if high iron is present in a soil sample, arsenic would have accumulated within that soil regardless of it's origin. There is no justification for elimination of sample SO-20.

Evaluation of Response

See response to comment 10.

Final Response: Please refer to the response to comment No. 8, above.

13. Section 4.2.4, Statistical Constrains to identify Sub Groups by Soil Type
Page 4-26, Whole Section.

Sediment samples were taken at two different locations SD 1-10 immediately up gradient of the site and SD 11-20 approximately 1200 feet up gradient of the site. A review of the concentrations of the contaminants detected in these sub groups indicate that the groups are different. Further, it does not appear that the contaminants observed at SD 11-20 affect the contaminant distribution at SD 1-10. Therefore, as the two subgroups are different and do not influence each other, the contaminant distribution in SD 1-10 which is closer to the site, should be used as the background samples.

Response: The comment indicates that RIDEM conducted either qualitative or quantitative evaluation of the two groups of data to arrive at the observation that the groups are different. It was requested on 6/12/06 that RIDEM provide any information to the Navy and USEPA on the analysis used to draw the conclusion that the two sediment subgroups are different. However RIDEM has not provided any further information as of the date of this letter. Since no reason has been given to separate the data sets, no revision on this point is anticipated. If a technical argument is made to separate the data groups, the Navy will certainly consider that argument.

Evaluation of Response

Recommend that the Navy evaluate the data and perform a Students t test.

Final Response: The sediments from locations 1 to 10 were compared to the sediments from locations 11 to 20, which represent two sections of the stream, as shown on Figure 3-2 of the report. Tables showing this comparison are attached to this letter. There was not statistical difference in metals concentrations (1-10 > 11-20 or 11-20 > 1-10, either one). There is a slight statistical difference for the PAH data.

14. Section 4.2.4, Statistical Constrains to identify Sub Groups by Soil Type Page 4-26, Whole Section.

A review of the contaminants distribution between sediment samples SD1-10 and SD11-20 indicates that they are different and should be treated as such in the statistical analysis.

Response: Please refer to the response to Comment no. 13 above.

Evaluation of Response

See evaluation to comment 13 above.

Final Response: Please refer to the response to comment No. 13 above.

Table Temp-2

Statistical Comparison of Background Hydric Soil Type Se,
Pathway Samples 11 -20 Versus Pathway Samples 1 - 10
Background Soil Inv stigation, NUSC Disposal Area
NUWC, Middletown, Rhode Island

Name of Test / Question Posed: / Assumptions Valid / Test Criterion		Detection Freq: Z or Fisher / Pathway 11-20 Freq. > Pathway 1-10 Freq.? / #ND & Pos >=5 or use Fisher / P value <= 0 025 ?				Upper Ranks / Majority are Pathway 11-20? / # Pathway 11-20 (s) in Top r / P<=0 025 that #s>=k				Mann-Whitney/Gehan / Ranks of Pathway 11-20 > Pathway 1-10? / <40% ND or use Gehan / P value <=0 025 ?				Student's or Satterthwaite T-test / Pathway 11-20 Mean > Pathway 1-10 Mean ? / #s>2,#b>2,>=85% Pos, both norm/log / t-Value > t-Table					Bartlett's Test for Equal Standard Deviations / Pathway 11-20 Standard Deviation =Pathway 1-10 Std.Dev.? / #s>2,#b>2, Pathway 11-20 & Pathway 1-10 both normal or both lognorm / F-Value<=F-Table (Students T) If not, Satterthwaite						
Conclusion: Pathway 11-20 > Pathway 1-10?	YN	Pathway 1-10 Freq	Pathway 11-20 Freq	P Value	YN	r	k	P Value	YN	P Value	Test	Used	YN	Pathway 1-10 Mean@	Pathway 11-20 Mean@	t Value	t Table	YN	Pathway 1-10 Distnb	Pathway 11-20 Distnb	Std Dev Pathway 1-10@	Std Dev Pathway 11-20@	F Value	F Table	YN
Substance																									
Aluminum	N	10/10	10/10		NA	3	2	0 5000	N	0 6474			N	13700	13000	-0 4578	2 1009	N	normal	normal	3730	3410	0 0669	3 8499	Y
Antimony	NA	0/0	1/5		NA				NA				NA		3 86			NA							NA
Arsenic	N	10/10	10/10		NA	8	6	0 0849	N	0 1207			N	15 9	19 8	1 3124	2 1009	N	normal	normal	5 01	7 82	1 6468	3 8499	Y
Barium	N	10/10	10/10		NA	4	4	0 0433	N	0 1724			N	66 7	100	1 4189	2 2010	N	normal	normal	25 3	70 3	7 7513	3 8499	N
Cadmium	NA	0/10	1/10	0 5000	N				NA				NA		0 381			NA							NA
Chromium	N	10/10	10/10		NA	4	4	0 0433	N	0 0929			N	19 6	27 9			NA	normal	lognor					NA
Cobalt	N	10/10	10/10		NA	10	7	0 0894	N	0 1628			N	15 2	19 5	1 2383	2 1788	N	normal	normal	4 52	9 81	4 7037	3 8499	N
Iron	N	10/10	10/10		NA	4	3	0 2910	N	0 3388			N	28800	30300	0 5035	2 1009	N	normal	normal	7380	6200	0 2578	3 8499	Y
Lead	Y	10/10	10/10		NA	8	7	0 0099	Y	0 0445			N	63 1	121	2 1383	2 2281	N	normal	normal	21 6	82 6	12 3422	3 8499	N
Magnesium	N	10/10	10/10		NA	16	8	0 7090	N	0 7865			N	2990	2830			NA	nonpar	normal					NA
Manganese	N	10/10	10/10		NA	11	7	0 1849	N	0 2603			N	2530	3520	0 9605	2 1009	N	normal	normal	1650	2820	2 3514	3 8499	Y
Nickel	N	10/10	10/10		NA	6	5	0 0704	N	0 2363			N	22 6	25 4	0 7433	2 1009	N	normal	normal	5 39	10 6	3 6311	3 8499	Y
Vanadium	N	10/10	10/10		NA	6	4	0 3142	N	0 6043			N	29 1	28 1	-0 2758	2 1009	N	normal	normal	7 32	9 49	0 5702	3 8499	Y
Zinc	Y	10/10	10/10		NA	6	6	0 0054	Y	0 0521			N	158	229	1 5791	2 2010	N	normal	normal	52 3	132	6 5082	3 8499	N
4,4'-DDD	N	10/10	9/10	1 0000	N	12	8	0 0849	N	0 1365			N	19 2	26 1			NA	lognor	normal					NA
4,4'-DDE	N	10/10	10/10		NA	5	3	0 5000	N	0 5453			N	90 1	87 8	-0 0994	2 1009	N	normal	normal	51 4	51 6	0 0001	3 8499	Y
4,4'-DDT	N	10/10	9/10	1 0000	N	14	7	0 6858	N	0 8793			N	71 1	56 3	-0 9136	2 1009	N	normal	normal	36 8	35 9	0 0058	3 8499	Y
Alpha-Chlordane	N	10/10	10/10		NA	3	3	0 1053	N	0 2135			N	30 9	49 6	1 4047	2 1788	N	normal	normal	18	38	4 4253	3 8499	N
Aroclor-1260	N	10/10	6/10	1 0000	N	2	2	0 2368	N	0 8659	Gehan	Test	N	54 8	47 6			NA	normal	normal					NA
Dieldrin	N	10/10	10/10		NA	6	5	0 0704	N	0 1282			N	71	104	1 3087	2 1009	N	normal	normal	43 3	66 5	1 5208	3 8499	Y
Endosulfan Sulfate	N	0/10	4/10	0 0433	N	4	4	0 0433	N				NA		5 95			NA							NA
Endrin Ketone	N	2/10	2/10	0 7090	N	1	1	0 5000	N	0 4785	Gehan	Test	N	3 66	3 85			NA	lognor	lognor					NA
Gamma-BHC (Lindane)	N	0/10	1/10	0 5000	N	1	1	0 5000	N				NA		1 8			NA							NA
Gamma-Chlordane	N	10/10	10/10		NA	2	2	0 2368	N	0 2850			N	22 7	33 2	1 1803	2 1604	N	normal	normal	12 3	25 2	4 0286	3 8499	N
2-Methylnaphthalene	N	4/10	3/10		NA				NA	0 7450	Gehan	Test	N	17 4	13 5			NA	lognor	nonpar					NA
Acenaphthene	N	8/10	7/10	0 8483	N	12	7	0 3250	N	0 7017			N	45	30 1			NA	lognor	normal					NA
Acenaphthylene	Y	6/10	10/10	0 0433	N	14	10	0 0054	Y	0 0004	Gehan	Test	Y	17 1	50 9			NA	lognor	nonpar					NA
Anthracene	N	9/10	10/10	0 5000	N	11	8	0 0349	N	0 1034	Gehan	Test	N	124	183			NA	lognor	lognor					NA
Benz(a)anthracene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0105			Y	456	1110			NA	lognor	normal					NA
Benzaldehyde	N	7/10	7/10	0 6858	N	5	3	0 5000	N	0 4836	Gehan	Test	N	222	181			NA	nonpar	normal					NA
Benzo(a)pyrene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0128			Y	547	1440			NA	lognor	normal					NA
Benzo(b)fluoranthene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0128			Y	982	2510			NA	lognor	normal					NA
Benzo(g,h,i)perylene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0117			Y	599	1570	2 9525	2 1788	Y	normal	normal	419	955	5 2526	3 8499	N
Benzo(k)fluoranthene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0142			Y	336	876	2 9469	2 1788	Y	normal	normal	227	532	5 5869	3 8499	N
Bis(2-ethylhexyl) Phthalate	Y	0/10	8/10		NA	8	8	0 0004	Y				NA		2290			NA							NA
Butyl Benzyl Phthalate	N	1/10	6/10	0 0286	N	5	4	0 1517	N	0 0296	Gehan	Test	N	191	409			NA	nonpar	nonpar					NA
Carbazole	Y	7/10	8/10	0 5000	N	10	8	0 0115	Y	0 0092	Gehan	Test	Y	130	198			NA	nonpar	normal					NA
Chrysene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0171			Y	745	1910			NA	lognor	normal					NA
Dibenz(a,h)anthracene	Y	9/10	10/10	0 5000	N	9	8	0 0027	Y	0 0095			Y	87 3	336	3 4881	2 2281	Y	normal	normal	54 6	219	13 0584	3 8499	N
Fluoranthene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0156			Y	1080	2660			NA	lognor	normal					NA
Fluorene	N	8/10	8/10	0 7090	N	12	8	0 0849	N	0 4251			N	55 2	63 3			NA	lognor	lognor					NA
Hexachlorobenzene	NA	0/10	1/10		NA				NA				NA		11 2			NA							NA
Indeno(1,2,3-cd)pyrene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0086			Y	433	1210	3 1664	2 1788	Y	normal	normal	317	711	5 0820	3 8499	N
Naphthalene	N	6/10	4/10		NA				NA	0 8870	Gehan	Test	N	60	14 7			NA	nonpar	lognor					NA
Phenanthrene	Y	10/10	10/10		NA	10	8	0 0115	Y	0 0480			N	637	1070			NA	lognor	normal					NA
Phenol	N	4/10	6/10	0 3281	N	7	5	0 1749	N	0 1844	Gehan	Test	N	19 4	17 4			NA	nonpar	lognor					NA
Pyrene	Y	10/10	10/10		NA	9	8	0 0027	Y	0 0142			Y	1200	2850			NA	lognor	normal					NA

Notes

Units are mg/kg for inorganics, ug/kg for organics

A statistical significance level (P value) of 0 025 is used for all tests that directly compare Pathway 11-20 to Pathway 1-10 Soil A two-sided significance level of 0 1 is used for Bartlett's test for equal variance

For each test, a YES or NO decision is presented only if all assumptions are met The overall decision (is Pathway 11-20 > Pathway 1-10) for each chemical appears at the left and is based on four criteria

(1) Overall decision is YES if any one of the Mann-Whitney/Gehan, Upper Ranks Test, or T-Test is YES, regardless of other test results

(2) Overall decision is NO if at least one of Mann-Whitney/Gehan, Upper Ranks Test, or T-Test is NO, and none of the aforementioned tests are YES

(3) Overall decision is YES/NO if Z/Fisher Test is YES/NO, respectively, and other tests are NA Z-test is treated as lowest priority since it relies on detection frequency, not magnitude of results

(4) Overall decision is NA if all tests are NA (Might occur if too few detections to be capable of detecting a statistically significant difference even if one exists)

* Very low frequency of detected values and all were just above the detection and reporting limits, which interferes with the power of statistical tests to detect a significant difference between groups

Abbreviations

# NDs or # Pos	Number of non-detected (ND) or positive (Pos) results in data set, not including rejected data or blank-qualified data
# s or # b	Number of Pathway 11-20 (s) or Pathway 1-10 (b) samples, not including rejected data or blank-qualified data
s = b	Standard deviation of Pathway 11-20 results must not be different from the standard deviation of Pathway 1-10 results
P value	Probability or significance level is defined as the chance of a false positive If P <= 0 025 then test determines Pathway 11-20 > Pathway 1-10 with 95 % confidence
% ND	Mann-Whitney test used if < 40% of data Non-Detected and detect limits uniformly below the range of positive values If not, the Gehan Test is used
@	For the t-test, the arithmetic mean and standard deviation of un-transformed data are shown in every case, since the t-test cannot be run if site and background do not both match a normal distribution
r,k	The upper ranks test calculates the probability that k or more samples from the top r ranks of the combined Pathway 11-20 and Pathway 1-10 data set are comprised of Pathway 11-20 data if both populations are in fact equal

Table Temp-1

Statistical Comparison of Background Hydric Soil Type Se, Pathway Samples 1 -10 Versus Pathway Samples 11 - 20
Background Soil Investigation, NUSC Disposal Area
NUWC, Middletown, Rhode Island

Name of Test:	Delection Freq: Z or Fisher				Upper Ranks				Mann-Whitney/Gehan				Student's or Satterthwaite T-test					Bartlett's Test for Equal Standard Deviations						
Question Posed:	Pathway 1-10 Freq. > Pathway 11-20 Freq.?				Majority are Pathway 1-10?				Ranks of Pathway 1-10 > Pathway 11-20?				Pathway 1-10 Mean > Pathway 11-20 Mean ?					Pathway 1-10 Standard Deviation =Pathway 11-20 Std Dev.?						
Assumptions Valid	#ND & Pos >=5 or use Fisher				# Pathway 1-10 (s) in Top r				<40% ND or use Gehan				#s>2,#b>2,>=85% Pos, both norm/log					#s>2,#b>2, Pathway 1-10 & Pathway 11-20 both normal or both lognorm						
Test Criterion	P value <= 0 025 ?				P<=0 025 that #s>=k				P value <=0 025 ?				t-Value > t-Table					F-Value<=F-Table (Students T) If not, Satterthwaite						
Conclusion: Pathway 1-10 > Pathway 11-20? YN																								
Substance	Pathway 11-20 Freq	Pathway 1-10 Freq	P Value	YN	r	k	P Value	YN	P Value	Test	Used	YN	Pathway 11-20 Mean*	Pathway 1-10 Mean*	t Value	t Table	YN	Pathway 11-20 Distrib	Pathway 1-10 Distrib	Std Dev Pathway 11-20@	Std Dev Pathway 1-10@	F Value	F Table	YN
Aluminum	10/10	10/10		NA	14	8	0 3142	N	0 3811			N	13000	13700	0 4578	2 1009	N	normal	normal	3410	3730	0 0669	3 8499	Y
Arsenic	10/10	10/10		NA	16	8	0 7090	N	0 8939			N	19 8	15 9	-1 3124	2 1009	N	normal	normal	7 82	5 01	1 6468	3 8499	Y
Barium	10/10	10/10		NA	14	7	0 6858	N	0 8462			N	100	66 7	-1 4189	2 2010	N	normal	normal	70 3	25 3	7 7513	3 8499	N
Chromium	10/10	10/10		NA	12	6	0 6750	N	0 3031			N	27 9	19 6			NA	lognor	normal					NA
Cobalt	10/10	10/10		NA	15	8	0 5000	N	0 8551			N	19 5	15 2	-1 2383	2 1788	N	normal	normal	9 81	4 52	4 7037	3 8499	N
Iron	10/10	10/10		NA	1	1	0 5000	N	0 6884			N	30300	28800	-0 5035	2 1009	N	normal	normal	6200	7380	0 2578	3 8499	Y
Lead	10/10	10/10		NA	14	7	0 6858	N	0 9622			N	121	63 1	-2 1383	2 2281	N	normal	normal	82 6	21 6	12 3422	3 8499	N
Magnesium	10/10	10/10		NA	13	8	0 1749	N	0 2362			N	2830	2990			NA	normal	nonpar					NA
Manganese	10/10	10/10		NA	8	4	0 6750	N	0 7636			N	3520	2530	-0 9605	2 1009	N	normal	normal	2820	1650	2 3514	3 8499	Y
Nickel	10/10	10/10		NA	16	9	0 2910	N	0 7864			N	25 4	22 6	-0 7433	2 1009	N	normal	normal	10 6	5 39	3 6311	3 8499	Y
Vanadium	10/10	10/10		NA	12	7	0 3250	N	0 4251			N	28 1	29 1	0 2758	2 1009	N	normal	normal	9 49	7 32	0 5702	3 8499	Y
Zinc	10/10	10/10		NA	16	8	0 7090	N	0 9555			N	229	158	-1 5791	2 2010	N	normal	normal	132	52 3	6 5082	3 8499	N
4,4'-DDD	9/10	10/10	0 5000	N	16	8	0 7090	N	0 8794			N	26 1	19 2			NA	normal	lognor					NA
4,4'-DDE	10/10	10/10		NA	11	6	0 5000	N	0 4848			N	87 8	90 1	0 0994	2 1009	N	normal	normal	51 6	51 4	0 0001	3 8499	Y
4,4'-DDT	9/10	10/10	0 5000	N	8	6	0 0849	N	0 1366			N	56 3	71 1	0 9136	2 1009	N	normal	normal	35 9	36 8	0 0058	3 8499	Y
Aldrin	0/10	1/10	0 5000	N	1	1	0 5000	N				NA		4 51			NA							NA
Alpha-Chlordane	10/10	10/10		NA	16	8	0 7090	N	0 8078			N	49 6	30 9	-1 4047	2 1788	N	normal	normal	38	18	4 4253	3 8499	N
Aroclor-1260	6/10	10/10	0 0433	N	11	8	0 0349	N	0 1513	Gehan	Test	N	47 6	54 8			NA	lognor	normal					NA
Dieldrin	10/10	10/10		NA	12	6	0 6750	N	0 8870			N	104	71	-1 3087	2 1009	N	normal	normal	66 5	43 3	1 5208	3 8499	Y
Endrin Ketone	2/10	2/10	0 7090	N	4	2	0 7090	N	0 5645	Gehan	Test	N	3 85	3 66			NA	lognor	normal					NA
Gamma-Chlordane	10/10	10/10		NA	6	3	0 6858	N	0 7401			N	33 2	22 7	-1 1803	2 1604	N	normal	normal	25 2	12 3	4 0286	3 8499	N
2-Methylnaphthalene	3/10	4/10		NA	2	2	0 2368	N	0 2861	Gehan	Test	N	13 5	17 4			NA	nonpar	lognor					NA
Acenaphthene	7/10	8/10	0 5000	N	4	4	0 0433	N	0 3251			N	30 1	45			NA	normal	normal					NA
Acenaphthylene	10/10	6/10	1 0000	N	10	2	0 9995	N	0 9995	Gehan	Test	N	50 9	17 1			NA	nonpar	normal					NA
Anthracene	10/10	9/10	1 0000	N	4	2	0 7090	N	0 9097	Gehan	Test	N	183	124			NA	lognor	lognor					NA
Benz(a)anthracene	10/10	10/10		NA	16	7	0 9567	N	0 9905			N	1110	456			NA	normal	lognor					NA
Benzaldehyde	7/10	7/10	0 6858	N	2	2	0 2368	N	0 5491	Gehan	Test	N	181	222			NA	lognor	nonpar					NA
Benzo(a)pyrene	10/10	10/10		NA	14	6	0 9296	N	0 9884			N	1440	547			NA	normal	lognor					NA
Benzo(b)fluoranthene	10/10	10/10		NA	15	7	0 8483	N	0 9884			N	2510	982			NA	normal	lognor					NA
Benzo(g,h,i)perylene	10/10	10/10		NA	15	7	0 8483	N	0 9895			N	1570	599	-2 9525	2 1788	N	normal	normal	955	419	5 2526	3 8499	N
Benzo(k)fluoranthene	10/10	10/10		NA	16	8	0 7090	N	0 9871			N	876	336	-2 9469	2 1788	N	normal	normal	532	227	5 5869	3 8499	N
Butyl Benzyl Phthalate	6/10	1/10	0 9985	N	3	1	0 8947	N	0 9743	Gehan	Test	N	409	191			NA	nonpar	nonpar					NA
Carbazole	8/10	7/10	0 8483	N	1	1	0 5000	N	0 9898	Gehan	Test	N	198	130			NA	lognor	nonpar					NA
Chrysene	10/10	10/10		NA	15	7	0 8483	N	0 9844			N	1910	745			NA	normal	lognor					NA
Dibenz(a,h)anthracene	10/10	9/10	1 0000	N	16	8	0 7090	N	0 9914			N	336	87 3	-3 4881	2 2281	N	normal	normal	219	54 6	13 0584	3 8499	N
Dibenzofuran	0/10	1/10	0 5000	N	1	1	0 5000	N				NA		158			NA							NA
Fluoranthene	10/10	10/10		NA	15	7	0 8483	N	0 9859			N	2660	1080			NA	normal	lognor					NA
Fluorene	8/10	8/10	0 7090	N	5	4	0 1517	N	0 6044			N	63 3	55 2			NA	lognor	normal					NA
Indeno(1,2,3-cd)pyrene	10/10	10/10		NA	15	7	0 8483	N	0 9923			N	1210	433	-3 1664	2 1788	N	normal	normal	711	317	5 0820	3 8499	N
Naphthalene	4/10	6/10		NA	4	4	0 0433	N	0 1298	Gehan	Test	N	14 7	60			NA	lognor	nonpar					NA
Phenanthrene	10/10	10/10		NA	1	1	0 5000	N	0 9591			N	1070	637			NA	normal	lognor					NA
Phenol	6/10	4/10	0 9106	N	1	1	0 5000	N	0 8156	Gehan	Test	N	17 4	19 4			NA	lognor	nonpar					NA
Pyrene	10/10	10/10		NA	15	7	0 8483	N	0 9871			N	2850	1200			NA	normal	lognor					NA

Notes

Units are mg/kg for inorganics, ug/kg for organics

A statistical significance level (P value) of 0 025 is used for all tests that directly compare Pathway 1-10 to Pathway 11-20 Soil A two-sided significance level of 0 1 is used for Bartlett's test for equal variance

For each test, a YES or NO decision is presented only if all assumptions are met The overall decision (is Pathway 1-10 > Pathway 11-20) for each chemical appears at the left and is based on four criteria

(1) Overall decision is YES if any one of the Mann-Whitney/Gehan, Upper Ranks Test, or T-Test is YES, regardless of other test results

(2) Overall decision is NO if at least one of Mann-Whitney/Gehan, Upper Ranks Test, or T-Test is NO, and none of the aforementioned tests are YES

(3) Overall decision is YES/NO if Z/Fisher Test is YES/NO, respectively, and other tests are NA Z-test is treated as lowest priority since it relies on detection frequency, not magnitude of results

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