DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE, INDIANA 47522-5001

IN REPLY REFER TO

5090
Ser 095/0079
14 APR 2000

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane) submits two copies of the Statistical Evaluation Report for ground water monitoring rounds one through four at the Ammunition Burning Grounds as enclosure (1). Provided as enclosure (2) are two copies of the sample calculation for the statistical analysis report.

The signature page for the Quality Assurance Project Plan for ground water monitoring at the Subpart X units is submitted as enclosure (3). The permit required Certification Statement is provided as Enclosure (4).

NAVSURFWARCENDIV Crane point of contact is Mr. Thomas J. Brent, Code 09510, telephone 812-854-6160.

Sincerely,

James M. Hunsicker
Director, Environmental
Protection Department
By direction of the Commander

Encl:
(1) Statistical Evaluation Report
(2) Sample Calculation
(3) Quality Assurance Project Plan Signature Page
(4) Certification Statement

Copy to:
ADMINISTRATIVE RECORD
SOUTHNAVFACENGCOM (Code 1864) (w/o encl)
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TTNUS (Ralph Basinski) (w/o encl)

Statistical Evaluation Report for Ammunition Burning Grounds Rounds 1 through 4

Naval Surface Warfare Center Crane Division Crane, Indiana

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0038

March 2000

Encl (1)

030008/P

STATISTICAL EVALUATION REPORT
FOR
AMMUNTION BURNING GROUNDS
ROUNDS 1 THROUGH 4

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0038

MARCH 2000

PREPARED UNDER THE SUPERVISION OF:

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1.0 GROUND WATER STATISTICAL METHODOLOGY

The Naval Surface Warfare Center (NSWC) Crane conducts open burning treatment of hazardous waste munitions/explosives at the Ammunition Burning Grounds (ABG). Open burning of hazardous waste munitions/explosives is subject to ground water monitoring requirements described in and RCRA regulations 40 CFR 264.97 and 40 CFR 264.98 Subpart F. NSWC Crane has developed a Ground Water Monitoring Plan. This plan describes the ground water monitoring at the ABG including the statistical evaluation. Section 10 of the Ground Water Monitoring Plan describes procedures for determining statistically significant increases for monitored parameters in downgradient wells.

Four rounds of ground water monitoring have been conducted at the ABG. Statistical evaluations have been conducted. This report describes the results of the statistical evaluation. Since the quantity of upgradient data was limited (only one upgradient well), it is not possible to run the Shapiro-Wilk "W-Test," as identified in the Ground Water Monitoring Plan. A non-parametric statistical evaluation was performed, and is discussed in Sections 1.1 and 1.3, below.

Table 1 contains a summary of the results of the analyses at each monitoring well (upgradient and downgradient) at the ABG for Monitoring Event #4 (September 1999). This table lists the concentrations of each constituent for which analysis was performed and the detection limit for each constituent that was not detected.

Table 2 presents the descriptive statistics summary for all constituents over the last four rounds of sampling. The frequency of detection, range of detections, average of detections, and location of the maximum detection for each constituent is shown on this table.

Figures 1 and 2 are tag maps showing the locations with statistically significant exceedences, the parameters exceeded, and their concentrations. These tag maps include chlorinated solvents and explosive degradation products that were not analyzed in the upgradient well. None of these would be expected to be found in the upgradient well.

1.1 BASIC APPROACH OF THE COMPARISON OF DOWNGRADIENT WELLS TO THE UPGRADIENT WELL

The downgradient data was compared to upgradient data using a non-parametric Analysis of Variance (ANOVA) analysis. No correction for seasonal variability was required since all wells at the facility should be affected similarly by such variability. The statistical methods described in this report were used to

determine if the concentrations of constituents detected in downgradient wells are statistically significantly different from those detected in samples from the upgradient well.

The ANOVA technique was the basic approach used to compare data from upgradient and downgradient monitoring well locations. The ANOVA technique is used to test whether there is statistically significant evidence of contamination. There are two types of ANOVA: parametric and non-parametric. The parametric ANOVA methods make two important assumptions: 1) the data residuals are normally (or lognormally) distributed, and 2) the group variances are homogeneous. Only one well at the ABG is upgradient of the potential source of contamination. Therefore, there is an insufficient quantity of upgradient data to test these assumptions. As a result, the standard parametric ANOVA analysis (the "Shapiro-Wilk W Test" described in the Ground Water Monitoring Plan) cannot be used.

The Wilcoxon Rank-Sum test (also known as the Mann-Whitney U test) was employed as the non-parametric ANOVA for comparing the downgradient wells to the upgradient well. Because this technique looks at the relative ranks of the results rather than their values, it is a qualitative (rather than quantitative) test, and not subject to the same reliance on distribution and variance that the parametric test is dependent on.

1.2 LIMIT OF DETECTION / FIELD DUPLICATES

In the chemical analysis of environmental samples, some analytes may be present at concentrations that are below the sample quantitation limit (SQL) of the analytical procedure. These results are generally reported as "not detected" (rather than zero), and the appropriate limit of detection is given. The amount of data that are below the detection limit plays an important role in selecting the method of addressing the limit of detection problem. The nondetects found at the ABG site have been replaced with the SQL divided by two prior to statistical analysis. Clearly, if all the observations were nondetect results, no statistical analysis was warranted. In addition, field duplicate results were averaged and counted as one sample for use in statistical analysis.

1.3 PARAMETRIC ANOVA: THE WILCOXON RANK-SUM TEST (AKA MANN-WHITNEY U TEST)

When data from multiple downgradient wells are being compared to a single upgradient well and a non-parametric test is needed (i.e., the population is not normally or lognormally distributed), the Wilcoxon Rank-Sum test (also known as the Mann-Whitney U test) should be employed (EPA, 1993). In general, the Wilcoxon Rank-Sum test should be employed whenever the proportion of nondetects is greater than 15% (but less than 90%). However, in order to provide valid results, the Wilcoxon Rank-Sum test should

not be used unless the downgradient and upgradient well have been sampled at least 4 times. The following equations present a step-by-step procedure for conducting the Wilcoxon Rank-Sum test.

The null hypothesis (H_0) that is tested is:

H_0 *The downgradient concentration IS NOT higher than the upgradient concentration.*

The alternate hypothesis (H_A) is:

H_A *The downgradient concentration IS higher than the upgradient concentration.*

If H_0 is rejected, then H_A is accepted. If H_0 is not rejected, the data set is consistent with the H_0 distribution.

Step 1. Combine the upgradient and downgradient data and rank the ordered values from 1 to N. Assume there are n downgradient samples and m upgradient samples so that N = m + n.

Step 2. Compute the Wilcoxon statistic W:

$$W = \sum_{i=1}^{n} E_i - \frac{1}{2} n(n+1)$$

where Ei are the ranks of the downgradient samples (Large values of the statistic W give evidence of contamination in downgradient wells).

Step 3. Compute an approximate Z-score. To find the critical value of W, a normal approximation to its distribution is used. The expected value and standard deviation of W under the null hypothesis (i.e., no contamination exists) are given by the formulas

$$E(W) = \frac{1}{2} mn; \qquad SD(W) = \sqrt{\frac{1}{12} mn(N+1)}$$

An approximate Z-score for the Wilcoxon Rank-Sum test may be calculated by the following equations:

$$Z = \frac{W - E(W) - \frac{1}{2}}{SD(W)}$$

The factor of 1/2 in the numerator serves as a continuity correction since the discrete distribution of the statistic W is being approximated by the continuous normal distribution. If n,m > 10 and ties are present, an adjustment to the approximate Z-score must be made:

$$Z_{RS} = \frac{W - E(W) - \frac{1}{2}}{S'D(W)}$$

$$\text{where: } SD'(W) = \left(\frac{mn}{12} \left[N + 1 - \frac{\sum_{j=1}^{g} t_j (t_j^2 - 1)}{N(N-1)} \right] \right)^{\frac{1}{2}}$$

g = the number of tied groups and tj is the number of tied data in the jth group.

Step 4. For a one-tailed 95% confidence level test for H_O versus the, reject H_O and accept HA if $Z_{ADJUSTED} > Z_{0.95} = +1.96$.

1.4 DISCUSSION

A total of 60 constituents were detected in the downgradient wells at the ABG during the last 4 quarters of sampling. Of these, 12 compounds were not sampled for in the upgradient well. These were:

- the volatile organics 1,2-dichloroethane, carbon tetrachloride, and chloroform
- the energetics MNX and TNX
- the miscellaneous parameters carbon dioxide, dissolved oxygen (Hach field kit), ferrous iron (field), nitrate (field), nitrite (field), sulfide, and sulfide (field).

The Wilcoxon Rank-Sum test was performed on the remaining 48 constituents detected in the downgradient wells at the ABG site. It was determined that the downgradient concentrations were statistically higher than the upgradient to a 95% confidence level (5% level of significance) for trichloroethene (TCE), barium (total) and barium (dissolved). In fact, only one of the other 45 parameters (dissolved oxygen, which is not a potential contaminant) showed statistically significant downgradient concentrations relative to the upgradient concentrations at a much more rigorous 20% level of significance. The results of the Wilcoxon Rank-Sum tests (also known as the Mann-Whitney U test) can

be found in Table 3. A sample calculation showing the determination of the 95% UCL and the Wilcoxon Rank-Sum test is presented as an attachment to this report.

This report includes mean concentrations and 95% UCLs of each chemical for the upgradient and downgradient wells for the four most recent quarters (quarters 1, 2, 3, and 4) which may be found in Table 2. Future annual reports will include a trend analysis showing moving averages that will be compared to moving averages from the previous quarters. Graphical representations of these trends comparing upgradient versus downgradient concentrations for constituents which have been shown to be statistically higher than the upgradient concentration will be presented.

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TABLE 1

AMMUNITION BURNING GROUND
ANALYTICAL RESULTS FOR MONITORING EVENT #4
PAGE 1 OF 2

cation	03B02	03B04	03C02P2	03C02P2	03C03	03C03	03C04	03C07	03C08P2	03C09P2	03C10	03C11	03C12	03C15	03C17	03C20	03C25	03C26	03C27	03C30	BLANK	BLANK	BLANK	CRB	SPRING A	SPRING C	SPRING C
aquifer	ALLUVIUM	ALLUVIUM	BEECH CREEK	BEECH CREEK	BEAVER BEND	BEAVER BEND	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK							
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	SW	SW	SW	SW
nsample	AB023A99	AB043A99	AC02P23A99	AC02P23A99-D	AC033A99	AC033A99-D	AC043A99	AC073A99	AC08P23A99	AC09P23A99	AC103A99	AC113A99	AC123A99	AC153A99	AC173A99	AC203A99	AC253A99	AC263A99	AC273A99	AC303A99	TB09079901	TB09099901	TB09139901	ACRB3A99	ASPA3A99	ASPC3A99	ASPC3A99-D
sample	AB023A99	AB043A99	AC02P23A99	FD09079901	AC033A99	FD09119901	AC043A99	AC073A99	AC08P23A99	AC09P23A99	AC103A99	AC113A99	AC123A99	AC153A99	AC173A99	AC203A99	AC253A99	AC263A99	AC273A99	AC303A99	TB09079901	TB09099901	TB09139901	ACRB3A99	ASPA3A99	ASPC3A99	FD09139901
sacode	NORMAL	NORMAL	DUP	DUP	DUP	DUP	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	DUP	DUP
sample_dat	8/9/1999	9/8/1999	9/7/1999	9/7/1999	9/11/1999	9/11/1999	9/11/1999	9/11/1999	9/12/1999	9/11/1999	9/8/1999	9/10/1999	9/8/1999	9/8/1999	9/9/1999	9/14/1999	9/10/1999	9/12/1999	9/8/1999	9/10/1999	9/7/1999	9/9/1999	9/13/1999	9/13/1999	9/13/1999	9/13/1999	9/13/1999
duplicate				AC02P23A99		AC033A99																					ASPC3A99
Volatile Organics (ug/L)																											
1,1,1-TRICHLOROETHANE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHANE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				25	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BENZENE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CARBON TETRACHLORIDE	0.3 U	0.3 U			0.3 U	0.3 U	0.3 U				1.4	0.3 U	0.3 U				0.3 U				0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CHLOROETHANE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	0.3 U	0.3 U			0.3 U	0.3 U	0.3 U				1.9	2.1	0.3 U				0.3 U				0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CIS-1,2-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	14	0.5 U	0.5 U	8.5	0.5 U	0.5 U	0.5 U	77	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
ETHYLBENZENE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
METHYLENE CHLORIDE	1 U	1 U			1 UJ	1 UJ	1 UJ				1 U	1 UJ	1 U				1 U				1 U	1 U	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ
TETRACHLOROETHENE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOLUENE	0.5 U	0.5 U			0.5 U	0.5 U	0.5 U				0.5 U	0.5 U	0.5 U				0.5 U				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	7.2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	10	10	0.5 U	0.5 U	0.5 U	4.3	63	170	61	2300	21	0.5 U	0.5 U	3400	0.5 U	8.9	4.2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VINYL CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
XYLENES, TOTAL	1 U	1 U			0.5 U	0.5 U	0.5 U				1 U	1 U	1 U				1 U				1 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dissolved Gases (ug/L)																											
ETHANE	0.091	0.046			0.005 U	0.005 U	0.005 U				0.005 U	0.005 U	0.005 U				0.044							0.006	0.005 U	0.005 U	0.005 U
ETHENE	0.028	0.005 U			0.005 U	0.005 U	0.005 U				0.005 U	0.005 U	0.005 U				0.005 U							0.005 U	0.005 U	0.005 U	0.005 U
METHANE	7.4	7.2			0.37	0.31	1.8				0.095	0.051	0.08				43.6							9	0.048	0.059	0.07
Energetics (ug/L)																											
1,3,5-TRINITROBENZENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	6.7 J	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
1,3-DINITROBENZENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
2,4,6-TRINITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	1.8	0.31 U	0.4 U
2,4-DIAMINO-6-NITROTOLUENE	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				0.49 U	0.51 U	0.75 U				0.79 U							0.52 U	0.87 U	0.31 U	0.4 U
2,4-DINITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
6-DIAMINO-4-NITROTOLUENE	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				0.49 U	0.51 U	0.75 U				0.79 U							0.52 U	0.87 U	0.31 U	0.4 U
-DINITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.94	0.58 J	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
2-AMINO-4,6-DINITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	2.1 J	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	12	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	2.1	0.31 U	0.4 U
2-NITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
3,5-DINITROANILINE	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				0.49 U	0.51 U	0.75 U				0.79 U							0.52 U	0.94	0.31 U	0.4 U
3-NITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
4,4'-TN-AZOXY	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				0.49 U	0.51 U	0.75 U				0.79 U							0.52 U	0.87 U	0.31 U	0.4 U
4-AMINO-2,6-DINITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.4 J	3.9 J	0.31 U	1.3 J	0.56 J	0.75 U	1.4 U	1.4 U	19	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	4.9	0.31 U	0.4 U
4-NITROTOLUENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
HMX	0.3 U	0.64 U	29	27	0.70 U	0.48 U	1.5 U	5.3 J	31	2.9	6.8	5.4	38	1.4 U	1.4 U	26	0.79 U	0.61 U	0.86 U	0.25 U				3.4	31	0.51	0.54
MNX	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				3	0.51 U	0.75 U				0.79 U							0.52 U	2.4 J	0.31 U	0.4 U
NITROBENZENE	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
NITROCELLULOSE	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U				1000 U	1000 U	1000 UR	1000 U
NITROGLYCERIN	3 U	6.4 U	9.5 U	4.8 U	7 U	4.8 U	15 U	2.3 U	7.9 U	3.1 U	4.9 U	5.1 U	7.5 U	14 U	14 U	11 U	7.9 U	6.1 U	8.6 U	2.5 U				5.2 U	8.7 U	3.1 U	4 U
PETN	1.5 U	3.1 U	4.7 U	2.4 U	3.5 U	2.4 U	7.4 U	1.2 U	3.9 U	1.5 U	2.4 U	2.5 U	3.7 U	6.7 U	6.7 U	5.2 U	3.9 U	3 U	4.2 U	1.2 U				2.6 U	4.3 U	1.5 U	2 U
PICRIC ACID	1 U	1 U			1 U	1 U	1.1 U				1 U	1 U	1 U				1 U							1 U	1 U	1 U	1 U
RDX	0.3 U	0.64 U	17	16	0.70 U	0.48 U	1.5 U	21	86	130	100	25	28	1.4 U	1.4 U	170	0.79 U	0.8	0.86 U	0.25 U				3.8	120	0.72	0.77
TETRYL	0.3 U	0.64 U	0.95 U	0.48 U	0.70 U	0.48 U	1.5 U	0.23 U	0.79 U	0.31 U	0.49 U	0.51 U	0.75 U	1.4 U	1.4 U	1.1 U	0.79 U	0.61 U	0.86 U	0.25 U				0.52 U	0.87 U	0.31 U	0.4 U
TNX	0.3 U	0.64 U			0.70 U	0.48 U	1.5 U				0.49 U	0.51 U	0.75 U				0.79 U							0.52 U	0.87 U	0.31 U	0.4 U
Total Metals (ug/L)																											
ANTIMONY	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
ARSENIC	10.3	6.3	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1	2.2	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
BARIUM	88.0	95.0	105	105	42.3	43.7	30.5	31.9	81.8	15.2	46.6	23.1	96.9	25.1	13.2	30.4	16.8	41.6	33.0	17.2				158	142	70.2	68.9
BERYLLIUM	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
CADMIUM	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
CHROMIUM	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U				5.6 U	5.6 U	5.6 U	5.6 U
COBALT	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U				3.3 U	3.3 U	3.3 U	3.3 U
COPPER	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	4.9	2.2 U	30.1	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U				2.2 U	2.2 U	2.2 U	2.2 U
IRON	12100	6790			111 U	111 U	190				111 U	111 U	111 U				201							517	111 U	118	111 U
LEAD	1.1 UJ	1.1 UJ	4.0 J	1.1 UJ	1.1 U	1.1 U	1.1 U	8.3	1.1 U	1.1 U	1.1 UJ	1.1 U	1.1 UJ	1.1 UJ	1.1 U	1.1 U	1.1 U	1.1 U	1.1 UJ	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
MANGANESE	1210	1760	16.7 U	16.7 U	16.7 U	16.7 U	908	16.7 U	16.7 U	30.9	16.7 U	16.7 U	16.7 U	36.2	140	16.7 U	29.7	20.1	16.7 U	26.7				362	16.7 U	16.7 U	16.7 U
MERCURY	0.20 U	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.20 U	0.2 U	0.20 U	0.20 U	0.2 U	0.2 U	0.2 U	0.2 U	0.20 U	0.2 U				0.2 U	0.2 U	0.2 U	0.2 U
NICKEL	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U				11.1 U	11.1 U	11.1 U	11.1 U
SELENIUM	1.1 U	1.1 U	3.1	2.0	1.1 U	1.1 U	2.3	1.8	2.6	2	3.0	4.4	1.2	2.0	1.3	1.3	1.1 U	1.3	1.1 U	1.1 U				1.1 U	1.6	1.1 U	1.2
SILVER	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U				3.3 U	3.3 U	3.3 U	3.3 U
THALLIUM	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
TIN	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U				11.1 U	11.1 U	11.1 U	11.1 U
VANADIUM	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U				2.2 U	2.2 U	2.2 U	2.2 U
C	11.1 UJ	13.4 J	193 J	11.1 UJ	11.1 U	11.1 U	11.1 U	33.9	11.1 U	11.1 U	11.1 UJ	11.1 U	11.1 UJ	11.1 UJ	11.1 U	11.1 U	11.1 U	11.1 U	20.6 J	11.1 U				11.9	11.1 U	11.1 U	11.1 U
.ssolved Metals (ug/L)																											

TABLE 1

AMMUNITION BURNING GROUND
ANALYTICAL RESULTS FOR MONITORING EVENT #4

ocation	03B02	03B04	03C02P2	03C02P2	03C03	03C03	03C04	03C07	03C08P2	03C09P2	03C10	03C11	03C12	03C15	03C17	03C20	03C25	03C26	03C27	03C30	BLANK	BLANK	BLANK	CRB	SPRING A	SPRING C	SPRING C
aquifer	ALLUVIUM	ALLUVIUM	BEECH CREEK	BEECH CREEK	BEAVER BEND	BEAVER BEND	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK	BEECH CREEK							
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	SW	SW	SW	SW
nsample	AB023A99	AB043A99	AC02P23A99	AC02P23A99-D	AC033A99	AC033A99-D	AC043A99	AC073A99	AC08P23A99	AC09P23A99	AC103A99	AC113A99	AC123A99	AC153A99	AC173A99	AC203A99	AC253A99	AC263A99	AC273A99	AC303A99	TB09079901	TB09099901	TB09139901	ACRB3A99	ASPA3A99	ASPC3A99	ASPC3A99-D
sample	AB023A99	AB043A99	AC02P23A99	FD09079901	AC033A99	FD09119901	AC043A99	AC073A99	AC08P23A99	AC09P23A99	AC103A99	AC113A99	AC123A99	AC153A99	AC173A99	AC203A99	AC253A99	AC263A99	AC273A99	AC303A99	TB09079901	TB09099901	TB09139901	ACRB3A99	ASPA3A99	ASPC3A99	FD09139901
sacode	NORMAL	NORMAL	DUP	DUP	DUP	DUP	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	DUP	DUP
sample_dat	9/9/1999	9/9/1999	9/7/1999	9/7/1999	9/11/1999	9/11/1999	9/11/1999	9/11/1999	9/12/1999	9/11/1999	9/8/1999	9/10/1999	9/8/1999	9/8/1999	9/9/1999	9/14/1999	9/10/1999	9/12/1999	9/8/1999	9/10/1999	9/7/1999	9/9/1999	9/13/1999	9/13/1999	9/13/1999	9/13/1999	9/13/1999
duplicate				AC02P23A99		AC033A99																					ASPC3A99
ANTIMONY, FILTERED	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
ARSENIC, FILTERED	10.9	6.4	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.2	2	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
BARIUM, FILTERED	91.3	107	105	105	49.7	45	31.7	32.9	89.6	15.3	44.0	27	99.6	24.9	13.8	34.4	18.1	47.3	33.2	73				158	154	71.8	72.2
BERYLLIUM, FILTERED	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
CADMIUM, FILTERED	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
CALCIUM, FILTERED	47300	29500	119000	122000	1430	1470	147000	97100	119000	76800	99300	237000	106000	105000	204000	92200	104000	106000	57100	52800				48100	71800	58800	57700
CHROMIUM, FILTERED	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	7.6	5.6 U	5.6 U	5.6 U	7.3	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U	5.6 U				5.6 U	5.6 U	5.6 U	5.6 U
COBALT, FILTERED	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U				3.3 U	3.3 U	3.3 U	3.3 U
COPPER, FILTERED	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	4.2 J	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U				2.2 U	2.2 U	2.2 U	2.2 U
LEAD, FILTERED	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
MAGNESIUM, FILTERED	5920	4150	17600	17700	1110 U	1110 U	193000	46000	41300	14900	12300	121000	7510	43800	196000	31100	59600	55700	3030	33300				9090	15800	12200	12100
MANGANESE, FILTERED	1250	1730	16.7 U	16.7 U	16.7 U	16.7 U	102	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	35.7	130	16.7 U	23.8	20.7	16.7 U	16.7 U				356	16.7 U	16.7 U	16.7 U
MERCURY, FILTERED	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U				0.2 U	0.2 U	0.2 U	0.2 U
NICKEL, FILTERED	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	24	13.1	15.6	11.1 U	11.1 U	33.4	11.1 U	11.1 U	30.7	11.1	15.7	12.9	11.1 U	11.1 U				11.1 U	11.1 U	11.1 U	11.1 U
POTASSIUM, FILTERED	1350	1110 U	2930	2950	1190	1300	3220	3500	26800	1450	1130	4770	2160	2110	3300	2130	2640	3110	1400	3630				2320	2780	1240	1180
SELENIUM, FILTERED	1.1 U	1.1 U	3.3	2.8	1.1 U	1.1 U	2.6	2	1.8	1.6	4.2	3.4	1.3	2.2	1.3	1.1 U	1.1 U	1.2	1.2	1.1 U				1.1 U	1.1	1.1 U	1.1 U
SILVER, FILTERED	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U				3.3 U	3.3 U	3.3 U	3.3 U
SODIUM, FILTERED	9560	5790	33800	32800	221000	235000	51100	22400	19000	4810	7660	88400	12900	25400	119000	12700	66100	18500	5720	80700				6370	11400	6710	6590
THALLIUM, FILTERED	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U				1.1 U	1.1 U	1.1 U	1.1 U
TIN, FILTERED	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U				11.1 U	11.1 U	11.1 U	11.1 U
VANADIUM, FILTERED	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U				2.2 U	2.2 U	2.2 U	2.2 U
ZINC, FILTERED	11.1 U	11.1 U	32.2	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	61 J	11.1 U	11.1 U	11.1 U	14 J	14.6 J	11.1 U	11.1 U	11.1 U				11.1 U	32.8 J	11.1 U	11.1 U
Miscellaneous (mg/L)																											
ALKALINITY (MG/L)	129	80.8	235		338	347	343	295	290	149	170	244	158.8	255	353	198	328	301	116.4	229				167	158	165	136
BICARBONATE ALKALINITY (MG/L)	129	80.8	235		338	347	343	295	290	149	170	244	158.8	255	353	198	328	301	116.4	229				167	158	165	136
CARBON DIOXIDE (MG/L)	120	60	113.8		33.0	34.1	106	NA	NA	NA	101	131	63.6	NA	NA	NA	93	NA	NA	NA				38.3	37.9	39.8	40.7
CARBONATE ALKALINITY (MG/L)	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0
CHLORIDE	4	1	77	73	1	1	6	8	13	5	8	46	34	4	3	5	2	3	3	2				6	11	4	4
ANIDE	0.005 U	0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U				0.005 U	0.005 U	0.005 U	0.005 U
DISSOLVED OXYGEN-HACH (MG/L)	0.2	1.5	9.0		0.15	0.15	2	NA	NA	NA	2.5	5	8	NA	NA	NA	0.28	NA	NA	NA				6	12	11	11
DISSOLVED OXYGEN-METER (MG/L)	1.10	3.11	9.4		3.15	3.15	6.57	3.82	7.01	8.04	3.71	8.45	7.48	3.3	2.14	4.66	1.4	5.50	10.46	3.04				6.34	11.12	11.06	11.06
FERROUS IRON (MG/L)	3.3 >	3.3 >	NA		0	0	0.03	NA	NA	NA	0.02	0.04	0	NA	NA	NA	0.15	NA	NA	NA				0.01	0.01	0.01	0
HYDROXIDE ALKALINITY (MG/L)	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0
NITRATE (MG/L)	0	0	NA		0.05	0.05	0.02	NA	NA	NA	2.43 >	2.43 >	2.43	NA	NA	NA	0.03	NA	NA	NA				1.70	2.43	1.62	1.71
NITRITE (MG/L)	0	0	NA		0	0.005	0	NA	NA	NA	0	0.006	0.001	NA	NA	NA	0.002	NA	NA	NA				0.001	0.001	0.001	0.001
OXIDATION REDUCTION POTENTIAL (M	-141.5	-98	146		2	NA	-3	107.5	93	95	182.9	-5.8	167	-50	-71.0	125.0	-70.3	125.9	210.5	-61				19	132.6	147	NA
PH ()	7.26	6.88	6.73		9.21	NA	7.18	7.24	7.22	6.77	6.57	7.19	7.11	7.02	7.02	7.25	7.16	7.22	7.62	9.44				7.41	7.60	7.55	NA
SPECIFIC CONDUCTIVITY (MS/CM)	0.373	0.215	0.843		0.903	NA	1.884	0.87	0.829	0.488	0.561	1.92	0.782	0.856	2.26	0.577	1.09	0.744	0.314	0.675				0.307	0.434	0.620	NA
SULFATE	28	17	62	60	83	86	810	92	130	51	58	820	61	160	1000	99	270	94	12	120				31	59	49	48
SULFIDE	1 UJ	1 UJ			1 UJ	1 UJ	1 UJ				1 J	1 UJ	2 J				1 UJ							1 UJ	1 UJ	1 UJ	1 UJ
SULFIDE (MG/L)	0.04	0.01	NA		0.01	0	0	NA	NA	NA	0.03	0.03	0.01	NA	NA	NA	0.13	NA	NA	NA				0.01	0	0.02	0.01
TEMPERATURE (C)	16.5	16.05	15.8		15.5	NA	18.9	23.33	21.5	17.1	18.33	19.41	17.37	14.99	17.21	16.16	13.6	27.08	14.7	16.0				19.3	11.74	11.9	NA
TOTAL ORGANIC CARBON	5.1 J	7.3 J	10 J	9.9	7.7 J	6.9 J	7.8 J	8 J	7.4 J	11 J	7 J	7.2 J	8.5 J	7.4 J	8.8 J	11 J	6.6 J	8.7 J	7	7.8 J				7 J	7.5 J	8 J	5 J
TOTAL ORGANIC HALOGENS	0.02 U	0.02 U	0.02 U	0.02 U	0.04	0.02 U	0.02 U	0.02	0.05	0.13	0.06	1.4	0.04	0.02 U	0.02 U	2.3	0.02 U	0.02 U	0.02 U	0.02 U				0.02 U	0.02 U	0.02 U	0.02 U
TOTAL PHOSPHORUS	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U				0.1 U	0.1 U	0.1 U	0.1 U
TOTAL PHOSPHORUS, FILTERED	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U				0.1 U	0.1 U	0.1 U	0.1 U
TURBIDITY (NTU)	3.3	1	2		1	NA	2	0	2	6	1.8	3.8	0	0	0	0	1.5	0	1.4	0				5	4.2	1	NA
WATER LEVEL (FT)	6.51	8.03	37.6		88.0	NA	76.13	78.76	74.7	45.32	49.97	44.15	41.85	64.54	138.07	89.4	46.76	82.58	60.88	223.39				NA	NA	NA	NA

TABLE 2

DESCRIPTIVE STATISTICS SUMMARY FOR DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE
PAGE 1 OF 3

	Downgradient						Upgradient					
Parameter	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection
Volatile Organics (ug/L)												
1,1,1-TRICHLOROETHANE	0/24			0.5	0.25		0/0					
1,1-DICHLOROETHANE	0/24			0.5	0.25		0/0					
1,1-DICHLOROETHENE	0/68			0.5	0.25		0/4			0.5	0.25	
1,2-DICHLOROETHANE	3/24	23 - 29	25.7	0.5	3.43	AC101A99	0/0					
BENZENE	0/24			0.5	0.25		0/0					
CARBON TETRACHLORIDE	3/24	1.2 - 1.6	1.40	0.3 - 0.5	0.34	AC101A99	0/0					
CHLOROETHANE	0/24			0.5	0.25		0/0					
CHLOROFORM	6/24	1.4 - 2.2	1.92	0.3 - 0.5	0.62	AC101A99	0/0					
CIS-1,2-DICHLOROETHENE	15/68	0.7 - 120	32.2	0.5	7.30	AC112A99	0/4			0.5	0.25	
ETHYLBENZENE	0/24			0.5	0.25		0/0					
METHYLENE CHLORIDE	0/24			0.5 - 1	0.42		0/0					
TETRACHLOROETHENE	0/24			0.5	0.25		0/0					
TOLUENE	0/24			0.5	0.25		0/0					
TRANS-1,2-DICHLOROETHENE	4/68	7.2 - 8.8	7.65	0.5	0.69	ABG03C20GW01	0/4			0.5	0.25	
TRICHLOROETHENE	41/68	0.6 - 3700	532	0.5	321	AC201A99	0/4			0.5	0.25	
VINYL CHLORIDE	1/68	8	8.00	0.5	0.36	AC112A99	0/4			0.5	0.25	
XYLENES, TOTAL	0/24			0.5 - 1	0.40		0/0					
Energetics (ug/L)												
1,3,5-TRINITROBENZENE	4/68	6.1 - 6.7	6.38	0.2 - 1.5	0.74	AC203A99	0/4			0.36 - 1.4	0.49	
1,3-DINITROBENZENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
2,4,6-TRINITROTOLUENE	1/68	0.54	0.54	0.2 - 1.5	0.39	ABG03C20GW01	0/4			0.36 - 1.4	0.49	
2,4-DIAMINO-6-NITROTOLUENE	0/33			0.2 - 1.5	0.41		0/0					
2,4-DINITROTOLUENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
2,6-DIAMINO-4-NITROTOLUENE	0/33			0.2 - 1.5	0.40		0/0					
2,6-DINITROTOLUENE	5/68	0.58 - 0.94	0.75	0.2 - 1.5	0.42	09P23A99, ABG03C09P2GW01-A	0/4			0.36 - 1.4	0.49	
2-AMINO-4,6-DINITROTOLUENE	8/68	2.1 - 12	7.05	0.2 - 1.5	1.17	AC201A99, ABG03C20GW01	0/4			0.36 - 1.4	0.49	
2-NITROTOLUENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
3,5-DINITROANILINE	0/33			0.2 - 7.3	0.87		0/0					
3-NITROTOLUENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
4,4'-TN-AZOXY	0/33			0.2 - 1.5	0.40		0/0					
4-AMINO-2,6-DINITROTOLUENE	10/68	0.4 - 19	8.54	0.2 - 1.5	1.59	AC203A99	0/4			0.36 - 1.4	0.49	
4-NITROTOLUENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
HMX	32/68	2.8 - 38	15.9	0.2 - 1.5	7.68	AC123A99	0/4			0.36 - 1.4	0.49	
MNX	5/33	0.32 - 3.1	2.39	0.2 - 1.5	0.71	AC101A99	0/0					
NITROBENZENE	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
NITROCELLULOSE	7/68	850 - 1400	1,150	1000 - 1600	590	AC252A99	0/4			1000	500	
NITROGLYCERIN	0/68			1.9 - 15	3.86		0/4			3.6 - 14	4.89	
PETN	0/68			0.97 - 7.4	1.91		0/4			1.8 - 6.7	2.41	
PICRIC ACID	0/32			1 - 1.2	0.52		0/0					
RDX	34/68	0.7 - 190	71.6	0.2 - 1.5	36.0	ABG03C20GW01	0/4			0.36 - 1.4	0.49	
TETRYL	0/68			0.2 - 1.5	0.39		0/4			0.36 - 1.4	0.49	
TNX	2/33	0.57 - 0.66	0.62	0.2 - 1.5	0.42	AC102A99	0/0					

TABLE 2

DESCRIPTIVE STATISTICS SUMMARY FOR DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE
PAGE 2 OF 3

	Downgradient						Upgradient					
Parameter	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection
Total Metals (ug/L)												
ANTIMONY	0/68			1.1	0.55		0/4			1.1	0.55	
ARSENIC	14/68	1.1 - 10.3	4.34	1.1	1.33	AB023A99	4/4	1.9 - 2.4	2.20		2.20	ABG03C17GW01
BARIUM	67/68	14.8 - 105	47.2	1.1	46.5	AC02P23A99-AVG	4/4	11 - 13.2	12.2		12.2	AC173A99
BERYLLIUM	0/68			1.1	0.55		0/4			1.1	0.55	
CADMIUM	0/68			1.1	0.55		0/4			1.1	0.55	
CHROMIUM	1/68	82.9	82.9	5.6	3.98	AC112A99	0/4			5.6	2.80	
COBALT	0/68			3.3	1.65		0/4			3.3	1.65	
COPPER	4/68	2.8 - 30.1	13.5	2.2	1.83	AC073A99	0/4			2.2	1.10	
IRON	30/42	107 - 13500	2,603	111	1,875	AB021A99	1/1	1810	1,810		1,810	ABG03C17GW01
LEAD	3/60	2.275 - 8.3	4.56	1.1	0.75	AC073A99	0/3			1.1	0.55	
MANGANESE	33/68	19.1 - 1760	409.1	16.7	203	AB043A99	4/4	114 - 140	125		125	AC173A99
MERCURY	0/68			0.2	0.10		0/4			0.2	0.10	
NICKEL	1/68	137	137	11.1	7.48	AB041A99	0/4			11.1	5.55	
SELENIUM	42/68	1.1 - 8.7	2.29	1.1	1.63	AC112A99	3/4	1.3 - 1.6	1.43	1.1	1.21	AC171A99
SILVER	0/68			3.3	1.65		0/4			3.3	1.65	
THALLIUM	0/68			1.1	0.55		0/4			1.1	0.55	
TIN	0/68			11.1	5.55		0/4			11.1	5.55	
VANADIUM	0/68			2.2	1.10		0/4			2.2	1.10	
ZINC	11/68	13.175 - 99.275	36.5	11.1 - 19.6	10.6	AC02P23A99-AVG	1/4	15	15.0	11.1	7.91	AC172A99
Dissolved Metals (ug/L)												
ANTIMONY	0/67			1.1	0.55		0/4			1.1	0.55	
ARSENIC	11/67	1.2 - 10.9	4.95	1.1	1.27	AB023A99-F	4/4	1.7 - 2.2	2.00		2.00	ABG03C17GW01-F
BARIUM	67/67	11.8 - 107	49.1		49.1	AB043A99-F	4/4	10 - 13.8	11.9		11.9	AC173A99-F
BERYLLIUM	0/67			1.1	0.55		0/4			1.1	0.55	
CADMIUM	1/67	2.6	2.60	1.1	0.58	AC042A99-F	0/4			1.1	0.55	
CALCIUM	66/67	1140 - 237000	89,238	1110	87,914	AC113A99-F	4/4	179000 - 204000	196,250		196,250	AC173A99-F
CHROMIUM	3/67	7.3 - 99	38.0	5.6	4.37	AC112A99-F	0/4			5.6	2.80	
COBALT	0/67			3.3	1.65		0/4			3.3	1.65	
COPPER	4/67	2.6 - 11.2	5.85	2.2	1.38	AC301A99-F	0/4			2.2	1.10	
LEAD	0/67			1.1	0.55		0/4			1.1	0.55	
MAGNESIUM	63/67	2830 - 199000	39,840	1110	37,495	AC041A99-F	4/4	173000 - 205000	193,250		193,250	ABG03C17GW01-F
MANGANESE	27/67	17.8 - 1730	476	16.7	197	AB043A99-F	4/4	105 - 137	121		121	ABG03C17GW01-F
MERCURY	0/67			0.2	0.10		0/4			0.2	0.10	
NICKEL	7/67	11.1 - 33.4	18.0	11.1	6.85	AC113A99-F	1/4	30.7	30.7	11.1	11.8	AC173A99-F
POTASSIUM	55/67	1120 - 165000	6,622	1110	5,536	AC112A99-F	4/4	2720 - 3300	3,095		3,095	AC173A99-F
SELENIUM	41/67	0.875 - 7.2	2.06	1.1	1.48	AC112A99-F	3/4	1.2 - 1.9	1.47	1.1	1.24	AC171A99-F
SILVER	0/67			3.3	1.65		0/4			3.3	1.65	
SODIUM	67/67	4350 - 240000	41,584		41,584	ABG03C03GW01-F	4/4	101000 - 119000	113,500		113,500	C173A99-F, ABG03C17GW01
THALLIUM	0/67			1.1	0.55		0/4			1.1	0.55	
TIN	0/67			11.1	5.55		0/4			11.1	5.55	
VANADIUM	0/67			2.2	1.10		0/4			2.2	1.10	
ZINC	6/67	14 - 233	62.6	11.1	10.7	AC122A99-F	0/4			11.1	5.55	

TABLE 2

DESCRIPTIVE STATISTICS SUMMARY FOR DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE

	Downgradient						Upgradient					
Parameter	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection	Frequency of Detection	Range of Detection	Average of Detections	Range of Non-Detects	Average of All Results	Location of Maximum Detection
Miscellaneous Parameters (mg/L)												
ALKALINITY-FIELD	51/51	75.2 - 408	232		232	AC301A99	3/3	125.6 - 389	289		289	AC171A99
ALKALINITY AS CACO3	17/17	125 - 370	264		264	ABG03C03GW01	1/1	420	420		420	ABG03C17GW01
BICARBONATE ALKALINITY	17/17	125 - 360	258		258	ABG03C25GW01	1/1	420	420		420	ABG03C17GW01
BICARBONATE ALKALINITY-FIE	50/50	74.4 - 408	225		225	AC301A99	3/3	125.6 - 389	289		289	AC171A99
CARBON DIOXIDE-FIELD	27/28	33.55 - 2000	91.6	0	91.6	AC112A99	0/0					
CARBONATE ALKALINITY	1/17	100	100	2	6.82	ABG03C03GW01	0/1			2	1.00	
CARBONATE ALKALINITY-FIEL	0/50			0			0/3					
CHLORIDE	56/59	1 - 75	12.5	5	12.0	AC02P23A99-AVG	2/3	3 - 4	3.50	5	3.17	AC171A99
CYANIDE	1/68	0.00375	0.00375	0.005 - 0.01	0.00439	AC033A99-AVG	0/4			0.005 - 0.01	0.0044	
DISSOLVED OXYGEN-HACH-FI	25/28	0 - 9	1.27	0	1.27	AC02P23A99-AVG	0/0					AC171A99
DISSOLVED OXYGEN-METER-F	68/68	0.29 - 28.39	5.48		5.48	AC262A99, AB041A99	4/4	1.26 - 2.24	1.91		1.91	AC172A99
FERROUS IRON-FIELD	25/27	0 - 3.3	0.42	0	0.42	AB041A99	0/0					AC171A99
HYDROXIDE ALKALINITY-FIELD	0/50			0			0/3			0	0.00	
NITRATE-FIELD	21/27	0 - 2.43	0.29	0	0.29	AC103A99	0/0					AC172A99
NITRATE, AS NITROGEN	8/17	0.8 - 4.7	2.33	0.2	1.15	ABG03C09P2GW01-AVG	0/1			0.2	0.10	
NITRITE-FIELD	17/27	0.001 - 0.012	0.00099	0	0.00099	AC112A99	0/0					AC172A99
NITRITE, AS NITROGEN	0/7			0.1	0.05		0/0					
SULFATE	68/68	8 - 980	179		179	AC112A99	4/4	830 - 1300	1,058		1,058	AC172A99
SULFIDE	2/24	1 - 2	1.50	1	0.58	AC123A99	0/0					
SULFIDE-FIELD	19/27	0.005 - 0.47	0.0266	0	0.0266	AC111A99-AVG	0/0					AC172A99
TOTAL ORGANIC CARBON	48/68	0.75 - 11	4.18	1	3.10	AC203A99, AC09P23A99	3/4	1.2 - 8.8	3.80	1	2.98	AC173A99
TOTAL ORGANIC HALOGENS	30/68	0.02 - 3	0.46	0.02	0.21	AC201A99	0/4			0.02	0.010	
TOTAL PHOSPHORUS	0/54			0.1	0.05		0/4			0.1	0.050	
TOTAL PHOSPHORUS AS P	12/81	0.01 - 0.0425	0.02	0.01 - 0.1	0.04	ABG03C09P2GW01-AVG	0/4			0.01 - 0.1	0.028	

Bold indicates downgradient results found to be statistically higher than

TABLE 3

NON-PARAMETRIC ANOVA (MANN-WHITNEY U TEST) RESULTS FOR COMPARISON OF DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE
PAGE 1 OF 4

VOLATILE ORGANICS

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
CIS-1,2-DICHLOROETHENE	2512	116	106	0.7375067	0.4608197	1.0390402	0.2987939	68	4	36.94	29.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
TRANS-1,2-DICHLOROETHENE	2490	138	128	0.196668	0.844088	0.495428	0.620301	68	4	36.62	34.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
TRICHLOROETHENE	2564	64	54	2.015852	0.043824	2.10153	0.035602	68	4	37.71	16.00	Yes

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
VINYL CHLORIDE	2484	144	134	0.049167	0.960786	0.242536	0.808367	68	4	36.53	36.00	No

ENERGETICS

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
1,3,5-TRINITROBENZENE	2449	179	103	-0.8112574	0.4172239	-0.8117862	0.4169204	68	4	36.01	44.75	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
2,4,6-TRINITROTOLUENE	2439	189	93	-1.057093	0.2904771	-1.0577991	0.290155	68	4	35.87	47.25	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
2,6-DINITROTOLUENE	2449.5	178.5	104	-0.7989656	0.4243163	-0.799583	0.4239584	68	4	36.02	44.63	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
2-AMINO-4,6-DINITROTOLUENE	2458	170	112	-0.5900054	0.5551912	-0.5902807	0.5550066	68	4	36.15	42.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
4-AMINO-2,6-DINITROTOLUENE	2461	167	115	-0.5162547	0.6056801	-0.5164665	0.6055322	68	4	36.19	41.75	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
HMX	2526	102	92	1.0816766	0.2794044	1.081955	0.2792807	68	4	37.15	25.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
NITROCELLULOSE	2520	108	98	0.9341752	0.3502206	1.2050724	0.2281843	68	4	37.06	27.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sun DOWN	Rank Sun UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
RDX	2531.5	96.5	86.5	1.2168862	0.2236565	1.2173657	0.2234741	68	4	37.23	24.13	No

TABLE 3

NON-PARAMETRIC ANOVA (MANN-WHITNEY U TEST) RESULTS FOR COMPARISON OF DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE
PAGE 2 OF 4

TOTAL METALS

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
ARSENIC	2379	249	33	-2.53211	0.011343	-3.3303	0.000869	68	4	34.99	62.25	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
BARIUM	2614	14	4	3.24503	0.001176	3.245134	0.001175	68	4	38.44	3.50	Yes
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
CHROMIUM	2484	144	134	0.049167	0.960786	0.242536	0.808367	68	4	36.53	36.00	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
COPPER	2490	138	128	0.196668	0.844088	0.495403	0.620319	68	4	36.62	34.50	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
IRON	911	35						42	1	21.69	35.00	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
LEAD	1924.5	91.5	85.5	0.145237	0.884525	0.393562	0.693907	60	3	32.08	30.50	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
MANGANESE	2386	242	40	-2.36002	0.01828	-2.50843	0.012132	68	4	35.09	60.50	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
NICKEL	2484	144	134	0.049167	0.960786	0.242536	0.808367	68	4	36.53	36.00	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
SELENIUM	2494.5	133.5	124	0.307294	0.758621	0.315958	0.752037	68	4	36.68	33.38	No
Mann-Whitney U Test (wrs.sta) By variable GRADIENT Group 1: 100-DOWN Group 2: 101-UP												
ZINC	2475	153	129	-0.172085	0.863372	-0.256585	0.797501	68	4	36.40	38.25	No

TABLE 3

NON-PARAMETRIC ANOVA (MANN-WHITNEY U TEST) RESULTS FOR COMPARISON OF DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE

DISSOLVED METALS

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
ARSENIC, FILTERED	2310	246	32	-2.54365	0.010975	-3.56401	0.000366	67	4	34.48	61.50	No
BARIUM, FILTERED	2542	14	4	3.241905	0.001189	3.241987	0.001188	67	4	37.94	3.50	Yes
CADMIUM, FILTERED	2414	142	132	0.049875	0.960222	0.244339	0.80697	67	4	36.03	35.50	No
CALCIUM, FILTERED	2290	266	12	-3.0424	0.002349	-3.04317	0.002343	67	4	34.18	66.50	No
CHROMIUM, FILTERED	2418	138	128	0.149626	0.88106	0.429267	0.667732	67	4	36.09	34.50	No
COPPER, FILTERED	2420	136	126	0.199502	0.841871	0.499236	0.617616	67	4	36.12	34.00	No
MAGNESIUM, FILTERED	2282.5	273.5	4.5	-3.22944	0.001242	-3.22976	0.00124	67	4	34.07	68.38	No
MANGANESE, FILTERED	2314	242	36	-2.4439	0.014535	-2.69676	0.007005	67	4	34.54	60.50	No
NICKEL, FILTERED	2390	166	112	-0.54863	0.583263	-0.999314	0.31765	67	4	35.67	41.50	No
POTASSIUM, FILTERED	2332.5	223.5	54.5	-1.98255	0.047426	-1.98742	0.046884	67	4	34.81	55.88	No
SELENIUM, FILTERED	2413.5	142.5	133	0.037407	0.970161	0.038503	0.969287	67	4	36.02	35.63	No
SODIUM, FILTERED	2299	257	21	-2.81796	0.004836	-2.81806	0.004834	67	4	34.31	64.25	No
ZINC, FILTERED	2424	132	122	0.299253	0.764749	0.620337	0.53504	67	4	36.18	33.00	No

TABLE 3

NON-PARAMETRIC ANOVA (MANN-WHITNEY U TEST) RESULTS FOR COMPARISON OF DOWNGRADIENT AND UPGRADIENT WELLS
MONITORING EVENTS NO. 1 THROUGH 4
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER, CRANE
PAGE 4 OF 4

MISCELLANEOUS PARAMETERS

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
ALKALINITY	1376	109	50	-1.00071	0.316973	-1.00077	0.316946	51	3	26.98	36.33	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
ALKALINITY AS CACO3	153	18						17	1	9.00	18.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
BICARBONATE ALKALINITY	153	18						17	1	9.00	18.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
CARBONATE ALKALINITY - FIEL	1323	108	48	-1.03923	0.298705	-1.03929	0.298676	50	3	26.46	36.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
CARBONATE ALKALINITY	162	9						17	1	9.53	9.00	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
CHLORIDE	1891.5	61.5	55.5	1.082549	0.279017	1.087103	0.276999	59	3	32.06	20.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
CYANIDE	2482.5	145.5	136	0.012292	0.990193	0.016352	0.986954	68	4	36.51	36.38	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
DISSOLVED OXYGEN - METER	2555	73	63	1.7946	0.072727	1.794629	0.072722	68	4	37.57	18.25	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
NITRATE, AS NITROGEN	165.5	5.5						17	1	9.74	5.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
SULFATE	2348.5	279.5	2.5	-3.2819	0.001032	-3.28288	0.001029	68	4	34.54	69.88	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
TOTAL ORGANIC CARBON	2491	137	127	0.221252	0.824898	0.224191	0.82261	68	4	36.63	34.25	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjusted	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
TOTAL ORGANIC HALOGENS	2542	86	76	1.475013	0.140219	1.648367	0.099287	68	4	37.38	21.50	No

Mann-Whitney U Test (wrs.sta)
By variable GRADIENT
Group 1: 100-DOWN Group 2: 101-UP

	Rank Sum DOWN	Rank Sum UP	U	Z	p-level	Z adjustec	p-level	Valid N DOWN	Valid N UP	Average Downgradien Rank	Average Upgradien Rank	Downgradien Statistically Higher than Upgradient?
TOTAL PHOSPHORUS AS P	1593	118	108	0	1			54	4	29.50	29.50	No

Downgradient concentration is deemed statistically higher than upgradient concentration when Zadjusted > +1.96

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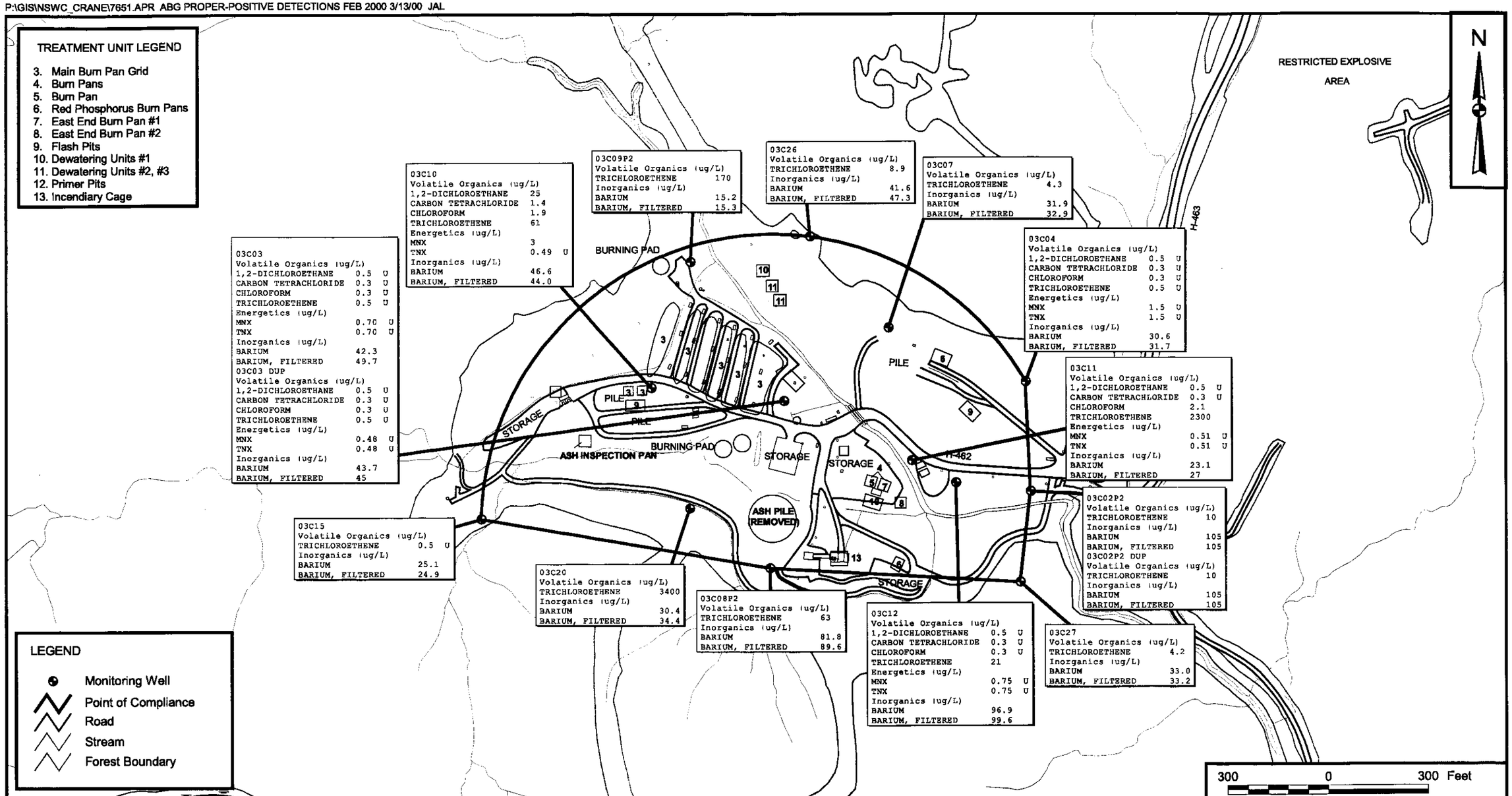

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY J. LAMEY DATE 2/29/00
CHECKED BY DATE
COST/SCHEDULE-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

AMMUNITION BURNING GROUND PROPER
MONITORING EVENT #4
DOWNGRADIENT CHEMICAL CONCENTRATIONS
STATISTICALLY DISSIMILAR FROM DOWNGRADIENT
NSWC CRANE, INDIANA

CONTRACT NUMBER N7840
OWNER NUMBER —
APPROVED BY — DATE —
APPROVED BY — DATE —
DRAWING NO. FIGURE 1
REV 0

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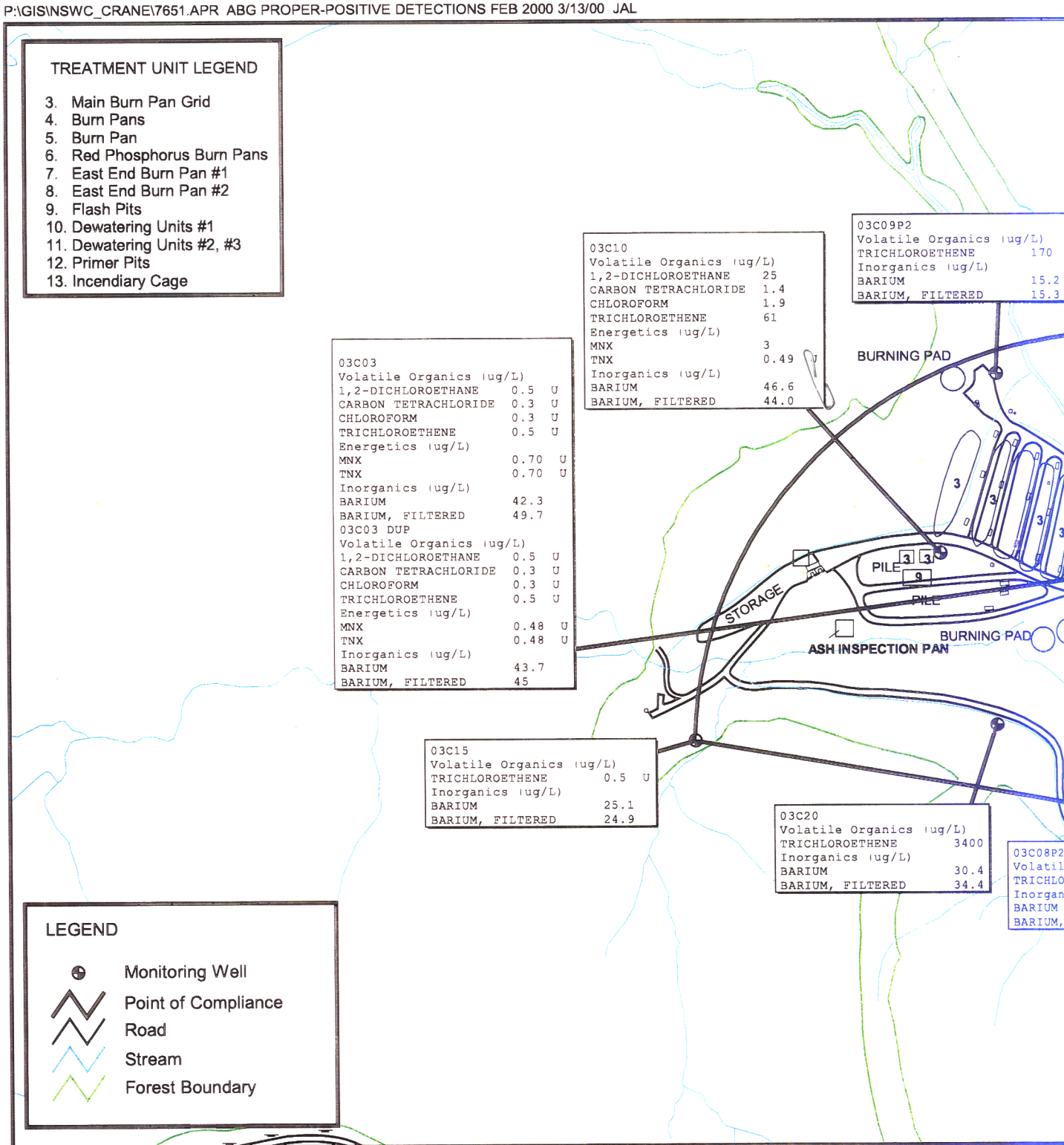
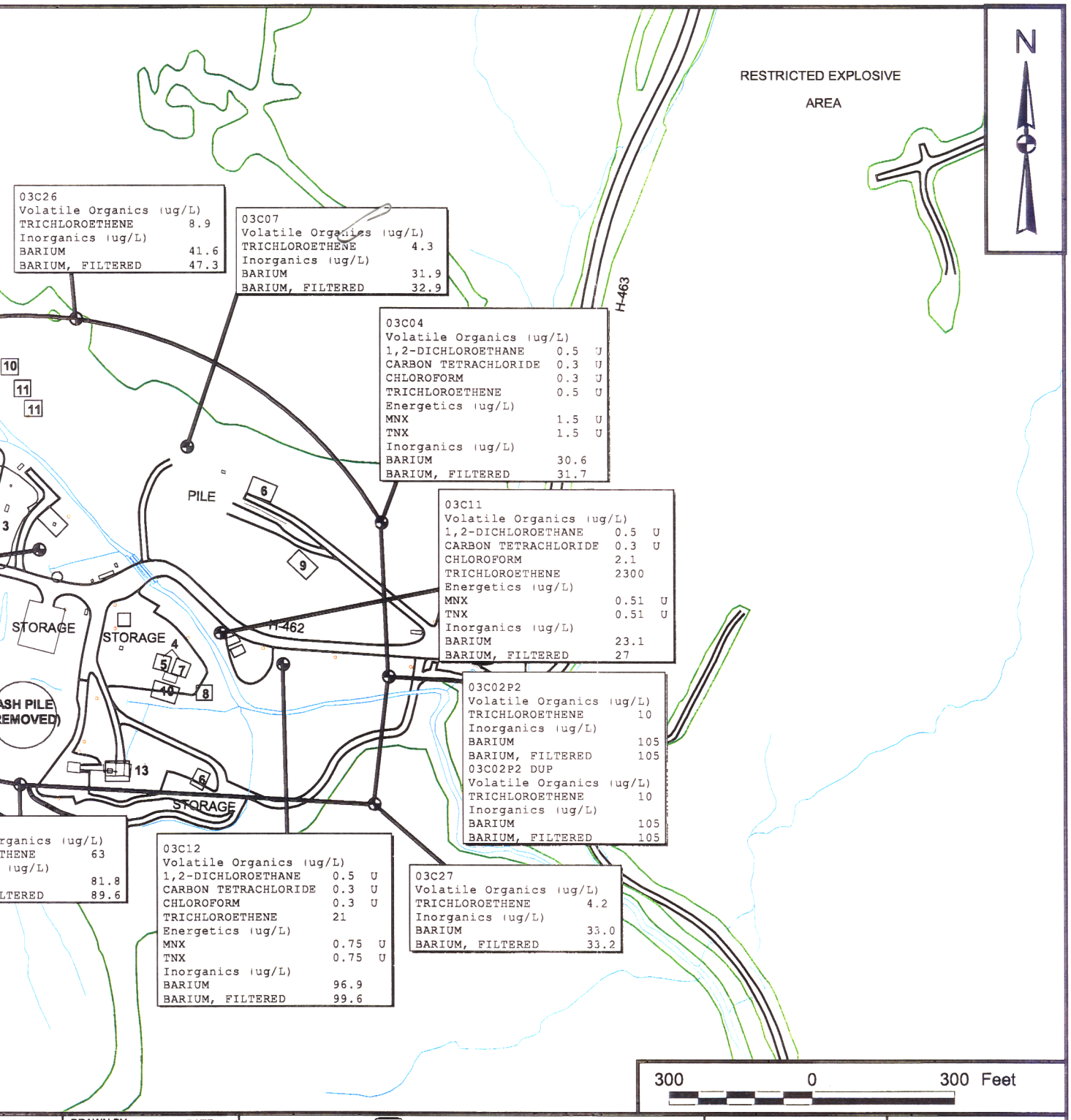


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES



DRAWN BY J. LAMEY	DATE 2/29/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N7640 / OWNER NUMBER —
CHECKED BY —	DATE —	AMMUNITION BURNING GROUND PROPER MONITORING EVENT #4 DOWNGRADIENT CHEMICAL CONCENTRATIONS STATISTICALLY DISSIMILAR FROM DOWNGRADIENT NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 / REV 0

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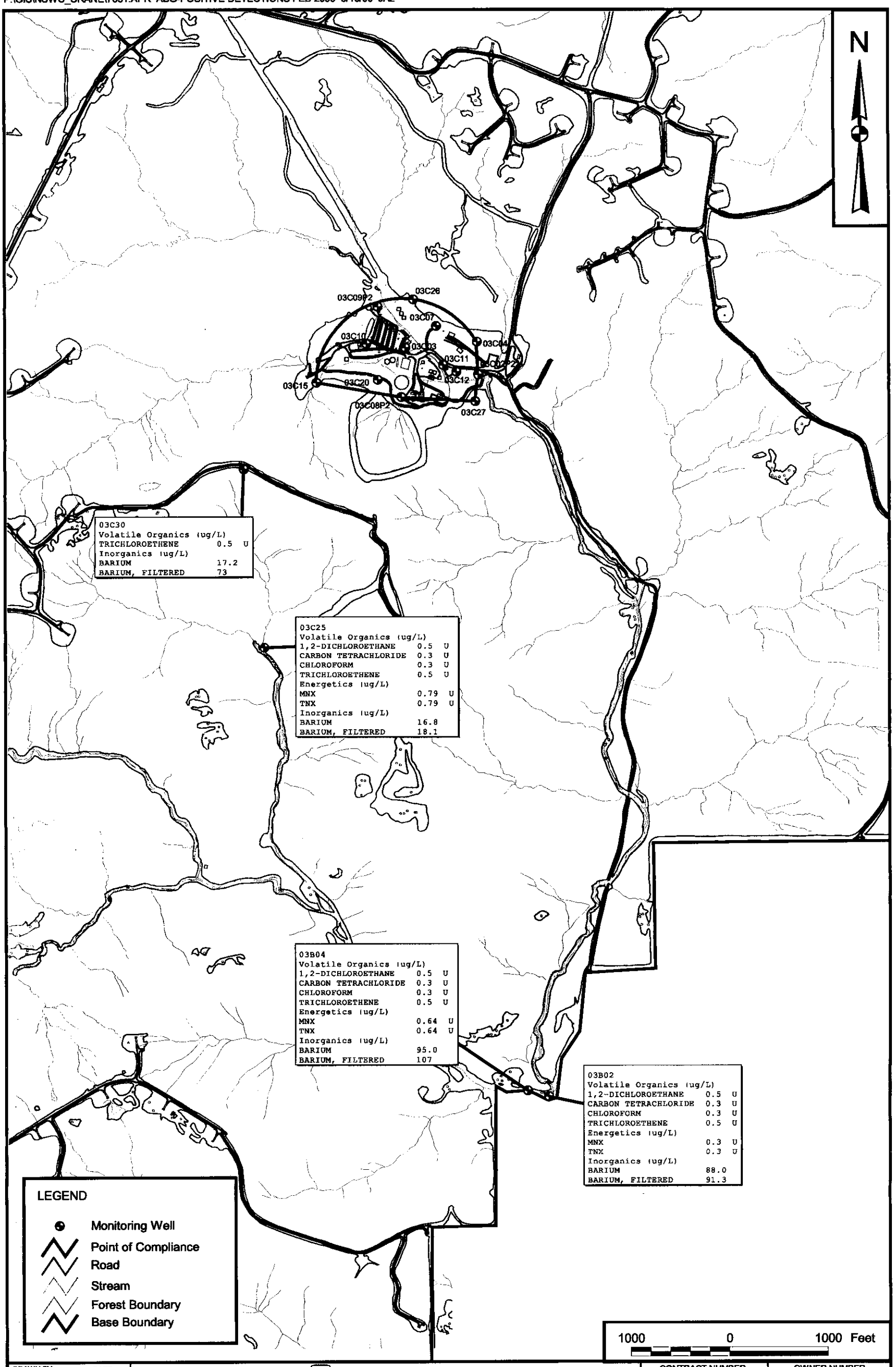

DRAWN BY J. LAMEY	DATE 2/29/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N7640 / OWNER NUMBER —
CHECKED BY —	DATE —	AMMUNITION BURNING GROUND MONITORING EVENT #4 DOWNGRADIENT CHEMICAL CONCENTRATIONS STATISTICALLY DISSIMILAR FROM UPGRADIENT NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2 / REV 0

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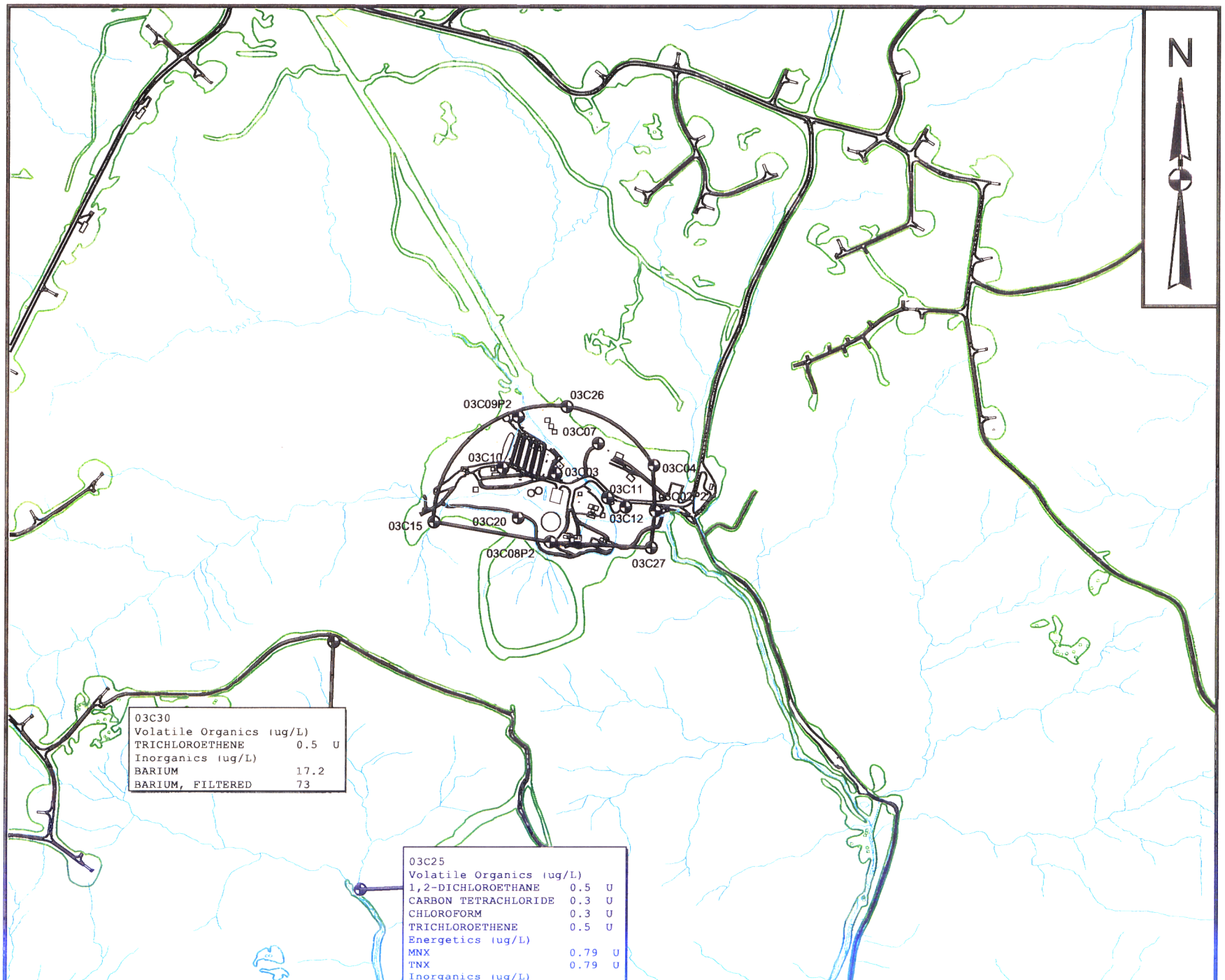

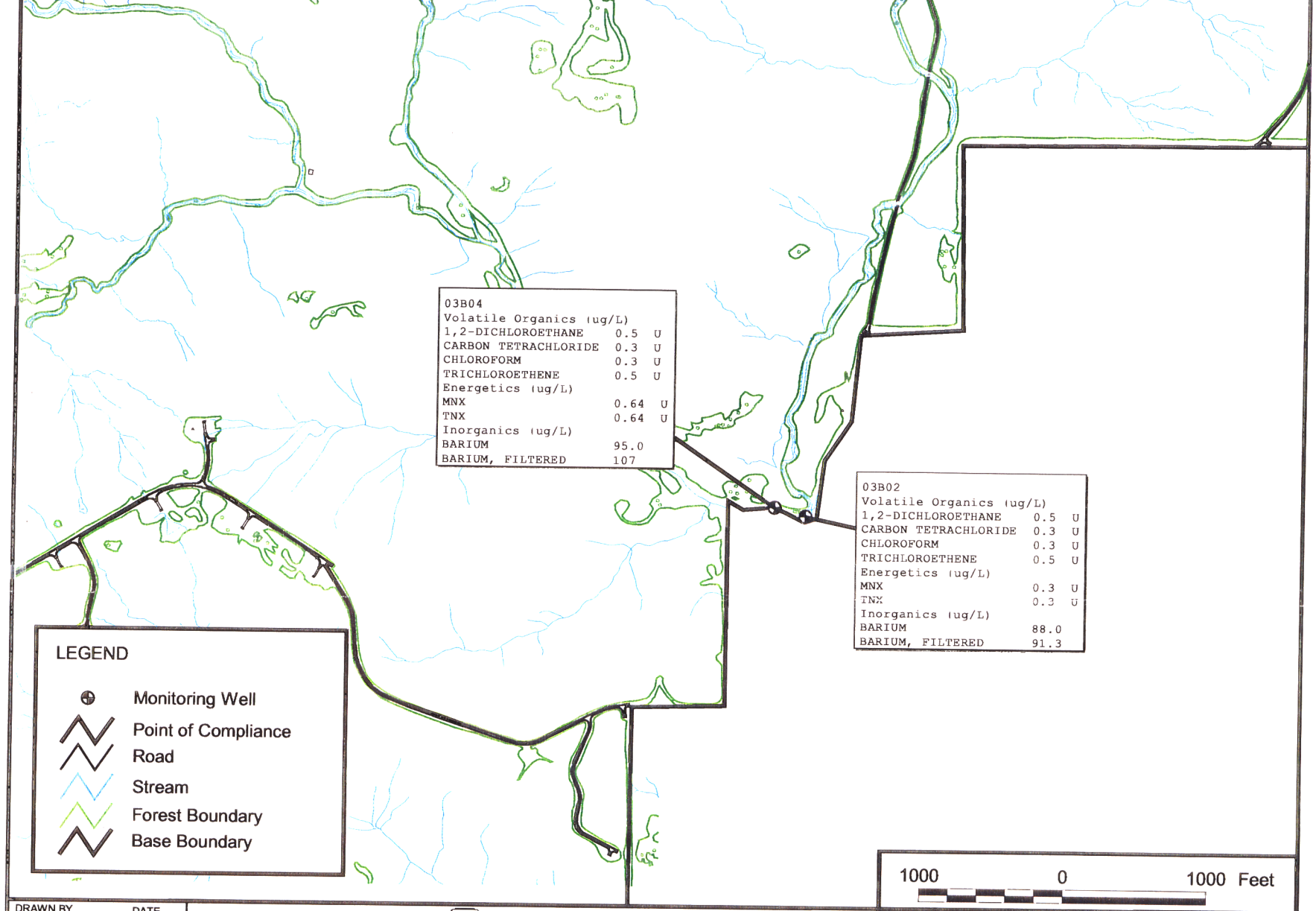

DRAWN BY J. LAMEY	DATE 2/29/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N7640 / OWNER NUMBER —
CHECKED BY —	DATE —	AMMUNITION BURNING GROUND MONITORING EVENT #4 DOWNGRADIENT CHEMICAL CONCENTRATIONS STATISTICALLY DISSIMILAR FROM UPGRADIENT NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2 / REV 0

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC CRANE	JOB NUMBER 7651-038
SUBJECT SAMPLE CALCULATIONS OF STATISTICAL ANALYSIS (ABG)	
BASED ON SELENIUM @ ABG M.E. #1 - #4	DRAWING NUMBER
BY BEL / CHECKED BY MEP	APPROVED BY / DATE 02/03/00

1. WILCOXON RANK-SUM TEST (MANN-WHITNEY U TEST)

COMBINE BOTH UPGRADIENT & DOWNGRADIENT DATA. ORDER THE COMBINED DATA SET FROM SMALLEST TO LARGEST INCLUDING 1/2 DL FOR ND VALUES. SELENIUM CONCENTRATIONS AT ABG UPGRADIENT AND DOWNGRADIENT WELLS FOR MONITORING EVENTS #1 THROUGH #4 IN µG/L.

	GRADIENT	LOCATION	ROUND	SAMPLE	RESULT	VALUE	RANK
1	DOWN	03B02	1		1.1U	0.55	14
2	DOWN	03B02	2		1.1U	0.55	14
3	DOWN	03B02	3		1.1U	0.55	14
4	DOWN	03B02	4		1.1U	0.55	14
5	DOWN	03B04	1		1.1U	0.55	14
6	DOWN	03B04	2		1.1U	0.55	14
7	DOWN	03B04	3		1.1U	0.55	14
8	DOWN	03B04	4		1.1U	0.55	14
9	DOWN	03C02P2	2		1.1U	0.55	14
10	DOWN	03C02P2	3		1.1U	0.55	14
11	DOWN	03C03	1		1.1U	0.55	14
12	DOWN	03C03	2		1.1U	0.55	14
13	DOWN	03C03	3		1.1U	0.55	14
14	DOWN	03C03	4		1.1U	0.55	14
15	DOWN	03C08P2	3		1.1U	0.55	14
16	DOWN	03C12	1		1.1U	0.55	14
17	DOWN	03C25	1		1.1U	0.55	14
18	DOWN	03C25	2		1.1U	0.55	14
19	DOWN	03C25	3		1.1U	0.55	14
20	DOWN	03C25	4		1.1U	0.55	14
21	DOWN	03C26	1		1.1U	0.55	14
22	DOWN	03C27	1		1.1U	0.55	14
23	DOWN	03C27	4		1.1U	0.55	14
24	DOWN	03C30	1		1.1U	0.55	14
25	DOWN	03C30	2		1.1U	0.55	14
26	DOWN	03C30	4		1.1U	0.55	14

Encl (2)

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSLOC GRADE	JOB NUMBER 7651-038
SUBJECT SAMPLE CALCULATIONS OF STATISTICAL ANALYSIS (ABG)	
BASED ON SELENIUM @ ABG M.E. #1 - #4	DRAWING NUMBER
BY BEL / CHECKED BY MEP	APPROVED BY / DATE 02/03/00

	GRADIENT	LOCATION	ROUND	SAMPLE	RESULT	VALUE	RANK
27	UP	03C17	1		1.1U	0.55	14
28	DOWN	03C15	1		1.1		28
29	DOWN	03C12	2		1.2		30.5
30	DOWN	03C12	4		1.2		30.5
31	DOWN	03C20	1		1.2		30.5
32	DOWN	03C27	3		1.2		30.5
33	DOWN	03C08P2	1		1.3		36
34	DOWN	03C09P2	1		1.3		36
35	DOWN	03C20	2		1.3		36
36	DOWN	03C20	4		1.3		36
37	DOWN	03C26	2		1.3		36
38	DOWN	03C26	4		1.3		36
39	UP	03C17	4		1.3		36
40	DOWN	03C27	2		1.35		40
41	UP	03C17	3		1.4		41
42	DOWN	03C20	3		1.6		42.5
43	UP	03C17	2		1.6		42.5
44	DOWN	03C26	3		1.7		44
45	DOWN	03C07	4		1.8		45.5
46	DOWN	03C09P2	3		1.8		45.5
47	DOWN	03C07	2		1.9		48
48	DOWN	03C10	1		1.9		48
49	DOWN	03C15	2		1.9		48
50	DOWN	03C15	3		1.95		50
51	DOWN	03C07	1		2.0		52
52	DOWN	03C09P2	4		2.0		52
53	DOWN	03C15	4		2.0		52
54	DOWN	03C04	2		2.1		55
55	DOWN	03C07	3		2.1		55
56	DOWN	03C09P2	2		2.1		55
57	DOWN	03C11	1		2.2		57
58	DOWN	03C02P2	1		2.3		59
59	DOWN	03C04	4		2.3		59

CLIENT NYSEG CFANE	JOB NUMBER 7651-038
SUBJECT SAMPLE CALCULATIONS OF STATISTICAL	
BASED ON	DRAWING NUMBER
BY	CHECKED BY MCF APPROVED BY DATE

	GRADIENT	LOCATION	ROUND	SAMPLE	RESULT	VALUE	RANK
60	DOWN	03C30	3		2.3	2.3	59
61	DOWN	03C02P2	4		2.55	2.55	61
62	DOWN	03C08P2	2		2.6	2.6	63
63	DOWN	03C08P2	4		2.6	2.6	63
64	DOWN	03C12	3		2.6	2.6	63
65	DOWN	03C10	4		3.0	3.0	65
66	DOWN	03C10	2		3.2	3.2	66
67	DOWN	03C04	1		3.6	3.6	67
68	DOWN	03C04	3		3.8	3.8	68
69	DOWN	03C11	2		3.85	3.85	69
70	DOWN	03C10	3		4.3	4.3	70
71	DOWN	03C11	4		4.4	4.4	71
72	DOWN	03C11	3		8.7	8.7	72

- ASSIGN A RANK TO EACH RESULT FROM SMALLEST TO LARGEST
- IN THE CASE OF TIES, ASSIGN THE MIDDLE RANK, I.E. THE AVG. RANK OF TIED RESULTS.

RANK SUM UPGRADIENT = 14 + 36 + 41 + 42.5 = 133.5

RANK SUM DOWNGRADIENT = $W_{RS} = \sum_{i=1}^{72} i - 133.5 = \frac{(72)(73)}{2} - 133.5$

$W_{RS} = 2628 - 133.5 = 2494.5$

$$Z_{ADJUSTED} = \frac{W_{RS} - \frac{n_1(m+1)}{2}}{\sqrt{\frac{n_1 n_2}{12}\left(m+1 - \frac{\sum_{j=1}^{g} t_j(t_j^2-1)}{m(m-1)}\right)}}$$

WHERE n_1 = # OF DOWNGRADIENT RESULTS = 68
n_2 = # OF UPGRADIENT RESULTS = 4
m = # OF TOTAL RESULTS = 72

g = # of tied groups = 10
t_j = # of measurements in the jth tied group

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: USWC CRANE	JOB NUMBER: 76SL.038
SUBJECT: SAMPLE CALCULATION OF STATISTICAL ANALYSIS (ABG)	
BASED ON: SELENIUM @ ABG M.E. #1 - #4	DRAWING NUMBER:
BY: BEL / CHECKED BY: MGP	APPROVED BY: / DATE: 02/03/00

$$Z_{ADJUSTED} = \frac{2494.5 - \frac{(68)(73)}{2}}{\sqrt{\frac{(68)(4)}{12}\left[73 - \frac{\left(27(728)+4(15)+7(48)+2(3)+2(3)+3(8)+3(8)+3(8)+3(8)\right)}{(72)(71)}\right]}}$$

$$Z_{ADJUSTED} = \frac{2494.5 - 2482}{\sqrt{22.667\left[73 - \frac{(1956+60+336+6+6+24+24+24+24+24)}{5112}\right]}}$$

$$Z_{ADJUSTED} = \frac{12.5}{\sqrt{22.667\left[73 - \frac{20184}{5112}\right]}} = \frac{12.5}{\sqrt{22.667\left[73 - 3.949\right]}}$$

$$Z_{ADJUSTED} = \frac{12.5}{\sqrt{22.667(69.052)}} = \frac{12.5}{\sqrt{1565.17}} = \frac{12.5}{39.562}$$

$$Z_{ADJUSTED} = +0.31596$$

SINCE $Z_{ADJUSTED} = +0.31596 < Z_{CRITICAL} = +1.96$ WE CONCLUDE THAT THE DOWNGRADIENT SELENIUM CONCENTRATIONS ARE NOT HIGHER THAN UPGRADIENT CONCENTRATIONS TO A 95% LEVEL OF CONFIDENCE (5% SIGNIFICANCE LEVEL)

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NSWC CRANE	JOB NUMBER: 7657-038
SUBJECT: SAMPLE CALCULATIONS OF STATISTICAL ANALYSIS (ABG)	
BASED ON: SELENIUM @ ABG M.E # 1-#4	DRAWING NUMBER:
BY: BEL / CHECKED BY: MEF	APPROVED BY: / DATE: 02/03/00

2. 95% UPPER CONFIDENCE LIMIT (NORMAL)

$$UCL_{0.95} = \bar{X} + t_{0.95,n-1} \frac{S_x}{\sqrt{n}}$$

WHERE $\bar{X}$ = AVERAGE CONCENTRATION
$t_{0.95,n-1}$ = t score for 95% CONFIDENCE AND n-1 DEGREES OF FREEDOM
S_x = STANDARD DEVIATION OF CONCENTRATIONS
n = # OF RESULTS

FOR UPGRADIENT SELENIUM CONCENTRATIONS:

$$\bar{X} = \frac{0.55 + 1.3 + 1.4 + 1.6}{4} = \frac{4.85}{4} = 1.2125 \text{ ug/L}$$

$$S_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{(0.55-1.2125)^2 + (1.3-1.2125)^2 + (1.4-1.2125)^2 + (1.6-1.2125)^2}{3}}$$

$$S_x = \sqrt{\frac{(-0.6625)^2 + (0.0875)^2 + (0.1875)^2 + (0.3875)^2}{3}}$$

$$S_x = \sqrt{\frac{0.4389 + 0.0077 + 0.0352 + 0.1502}{3}} = \sqrt{\frac{0.6320}{3}}$$

$$S_x = \sqrt{0.21067} = 0.4589 \text{ ug/L}$$

$t_{0.95,3} = 2.353$

$$UCL_{0.95} = 1.2125 + (2.353)\left(\frac{0.4589}{2}\right) = 1.2125 + 0.5399 = 1.7524$$

$UCL_{0.95} = 1.7524$ ug/L

CLIENT NSWC CRANE		JOB NUMBER 7651-038	
SUBJECT SAMPLE CALCULATIONS of STATISTICAL ANALYSIS (ABC)			
BASED ON SELENIUM @ ABC M.G. #1 - #4		DRAWING NUMBER	
BY BEL	CHECKED BY MBF	APPROVED BY	DATE 02/03/00

3. 95% UPPER CONFIDENCE LIMIT (LOGNORMAL)

$$UCL_{0.95} = e^{\left(\bar{y} + 0.5S^2 + \frac{S H_{0.95}}{\sqrt{n-1}}\right)}$$

WHERE: e = euler's constant

S = Standard deviation of log transformed data $= \sqrt{\frac{\sum_{i=1}^{n} (y_i - \bar{y})^2}{n-1}}$

y_i = natural log of x_i

$\bar{y}$ = mean of the log transformed data

$H_{0.95}$ = H STATISTIC FOR ONE-SIDED CONFIDENCE LIMIT WITH 95% CONFIDENCE

	x_i	y_i
1	0.55	-0.5978
2	1.3	0.2624
3	1.4	0.3365
4	1.6	0.4700

$\bar{x} = 1.2125$ $\bar{y} = 0.1178$

$$S = \sqrt{\frac{(-0.5978 - 0.1178)^2 + (0.2624 - 0.1178)^2 + (0.3365 - 0.1178)^2 + (0.4700 - 0.1178)^2}{3}}$$

$$S = \sqrt{\frac{(-0.7156)^2 + (0.1446)^2 + (0.2187)^2 + (0.3522)^2}{3}}$$

$$S = \sqrt{\frac{(0.5121) + (0.02091) + (0.0478) + (0.1240)}{3}} = \sqrt{\frac{0.7048}{3}}$$

$$S = \sqrt{0.2349} = 0.4847$$

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC CARDE	JOB NUMBER 7651-033
SUBJECT SAMPLE CALCULATIONS OF STATISTICAL ANALYSIS (ABG)	
BASED ON SELENIUM @ ABG M.G. #1-#4	DRAWING NUMBER
BY BEL / CHECKED BY MBF	APPROVED BY / DATE 02/03/00

$H_{0.95} = 4.6011$

$$UCL_{0.95} = e^{\left[(0.1178 + (0.484))^{0.5}{}^2 + \frac{(0.4847)(4.6011)}{\sqrt{3}}\right]}$$

$$UCL_{0.95} = e^{[0.1178 + 0.1175 + 1.2876]} = e^{1.5229} = 4.5855 \text{ UG/L}$$

QUALITY ASSURANCE PROJECT PLAN
FOR
RCRA GROUND WATER MONITORING
AT THE
AMMUNITION BURNING GROUNDS,
OLD RIFLE RANGE, AND DEMOLITION RANGE

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 2
FEBRUARY 1999

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0038

Date 10/27/99
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Date 4-12-00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Date 5/20/99
CAROL WITT-SMITH
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

Date 03-29-00
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Date 4/10/00
ALLAN SPRAYBERRY
AIR LABORATORY DIRECTOR
MICROSEEPS, INC.

Date 4/12/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Date 4-14-99
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

Date 4/13/00
~~PAUL FREED~~ Thomas J. Brent
FACILITY PERMIT MANAGER
NSWC CRANE
Ground Water Program

Date 04/04/00
BELEN RUEDA
LABORATORY MANAGER
TRIANGLE LABORATORIES, INC.
Frank Stevens
Co Director Analytical Services

Encl (3)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Env. Protection Department Mgr.
TITLE

4/17/00
DATE

Enclosure (4)