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February 19, 2009

357098.SI.BK

Mr. Rob Thomson
Remedial Project Manager
U.S. EPA Region III
1650 Arch Street
Philadelphia, PA 19103

Subject: Response to USEPA Comments on the *Draft Background Study Work Plan* for Naval Weapons Station, Yorktown, Yorktown, VA and Cheatham Annex, Williamsburg, VA

Dear Mr. Thompson,

On behalf of the U.S. Department of the Navy's Naval Facilities Engineering Command (NAVFAC), this letter is in response to your letter dated December 17, 2008 that provided comments regarding the subject document. Your comments are presented in italics, followed by the Navy's response (in blue).

GENERAL COMMENTS:

1. *Section 3.2, Statistical Analysis, of the Work Plan does not provide sufficient information regarding how soil data populations with detections of less than 50 percent were statistically evaluated. It is unclear how uses of surrogate values are representative or justifiable; whether outliers were assessed; and how the distribution assumptions and statistical values for these background data sets are adequately comparable to site data. Accordingly, the following concerns should be addressed:*
 - *The text in Section 3.2 states on page 3-4 that "non-detects will be handled via substitution of a proxy of half the detection limit . . ." EPA guidance (referenced as USEPA 2007 in the Work Plan), pages 28-29 and 89-92, explicitly discourages the use of one-half the detection limit in calculating summary statistics for populations containing non-detects values since more representative and defensible methods currently exist. EPA's Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites (referenced as USEPA 2002b in the Work Plan); ProUCL Version 4.0 Technical Guide; and Data Quality Assessment: Statistical Methods for Practitioners (EPA/240/B-06/003) suggest that other methods may be used to extrapolate surrogate values, or that alternative statistical methods may be used to calculate summary statistics without use of surrogate values. As an example, one method for calculating summary statistics without the use of a surrogate value includes computing an upper percentile value for the distribution of the detections in the background data for comparison with the comparable upper percentile distribution of the site data. A response and/or revision to the Work Plan should be provided which states why use of one-half the detection limit as a surrogate value for calculating summary statistics for the background data set is defensible, and whether alternative data analysis methods were*

evaluated to ensure that the most representative background data sets and best statistical methods for calculating mean values for comparison to site data were used.

- *Additional detail should be provided as to the defensibility of combining soil groups that is based on the lack of variation in analytical results between the soil groups.*
- *Additional detail should be provided on the ANOVA measurements that will be examined. A comparison of groups' means is specified in the text, which is essentially a t-test. ANOVA is commonly used when additional variation measures are desired.*
- *The non-detect surrogate value (one-half the detection limit) is inconsistently referenced as 'sample reporting limit' or 'detection limit' in the text of Section 3.2 and the Quality Assurance Project Plan (QAPP). For clarity, a definition of the term 'detection limit' should be provided in the Work Plan. It is also recommended that the detection limit be referenced as the sample Quantitation limit (QL) to provide consistency with the use of this term in QAPP worksheet #37 and in accordance with EPA National Functional Guidelines terminology, which is considered industry standard.*
- *The text of Section 3.2 does not state whether data sets with a detection percentage less than 50 percent were evaluated for statistical outliers. So that the adequacy and representativeness of the proposed background data sets can be evaluated, this information should be provided.*
- *The text states that data sets with a detect percentage of less than 50 percent were not subject to ANOVA testing, and as stated on page 3-4, distributional assumptions were not tested. Without testing the background data sets for distribution characteristics, it is unclear how it can be demonstrated that the mean and median of the background data populations were sufficiently comparable to the site data. According to pages 4-6, and 5-6 through 5-11 of EPA guidance document, Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites (USEPA 2002b in the Work Plan); Data Quality Assessment: Statistical Methods for Practitioners (EPA/240/B-06/003), and ProUCL Version 4.0 Technical Guide (USEPA 2007 in the Work Plan) page 28, and 89-90; it is recommended that for data sets with less than 50 percent detections but greater than 4 to 5 percent, either non-parametric methods be used to compute the summary statistics, or a probability plot or goodness-of-fit test be performed to verify the distribution. Therefore, for data sets (populations) with fewer than 50 percent, but greater than 4 to 5 percent detections, it appears the ProUCL technical guide does not recommend ignoring distributional assumptions, but rather offers methods for alternative ways to evaluate the population distribution and to calculate summary statistics. Section 3.2 of the Work Plan should be revised to provide further justification for the method used to calculate summary statistics for the data sets with less than 50 percent detections. This justification should demonstrate that the method will provide meaningful comparisons between the background data set and the site data.*
- *Given that the data under examination originates from a variety of time periods and sources, particular attention should be paid to consistency of notation. Specifically, non-detect results must be clearly different from no results or missing data and it should be ensured that quantitation limits (QLs) and method detection limits (MDLs) were equivalent between data sets. If QLs and/or MDLs differed between data sets, the Work Plan should state how this*

was handled in the statistical analyses. The Work Plan should detail a data assessment plan that addresses such issues.

Please provide a response and/or revise the Work Plan to address these concerns.

Navy Response:

It is important to understand the various contexts of this overall data evaluation. The end goal of this background study is to present a background data set that can be approved as appropriate for comparison to investigative data. That comparison may be in the form of individual site values to background threshold values (which are calculated in this study), or two-sample hypothesis tests which would be handled outside this report as the site data becomes available. These two comparison types are the ones which carry inferential confidence in relation to site versus background comparisons.

EPA comments have stressed the use of approaches presented in various EPA guidance and technical documents that have been referenced in the work plan, in particular USEPA 2007. Concern has been raised that the proposed handling of non-detects may not follow the recommendations in that technical document and instead involve a simple proxy substitution of one-half the detection limit (a traditional method of handling non-detects). Please note that the work plan discusses using such a simple substitution for other summary statistics (other than the background threshold value), to present useful descriptive information for parameters which do not carry inferential connotation. In other words, additional information that might be of interest to a reviewer is included, but the background threshold values are to be calculated using the approaches described in USEPA 2007.

Thus, the approach in the work plan is not in disagreement with EPA's comments nor with USEPA 2007 (on the contrary, it follows them), but the presentation of additional statistics will be included per the work plan to increase the information available to reviewers of the background study.

Another concern of the comments revolves around decisions of whether to merge soil association groups and soil depths (surface versus subsurface). There are a variety of ways to evaluate whether various partitions in the data should be combined or kept separate. These include visual inspection of graphical presentations of the data. This work plan proposed to go beyond visual inspection only with ANOVA, when applicable (greater than 50% detected results as described in the work plan).

The ANOVA approach is described in Section 3.2.1 of the work plan. It is stated that a nonparametric ANOVA (based on ranks) will be used to avert complicated (and often unsuccessful) efforts to transform the data. This is similar to EPA guidance and technical document's recommendations to employ nonparametric two-sample tests (e.g. Wilcoxon Rank Sum test) for site to background comparisons. If appropriate transformations for these comparisons were the preferable way to approach these evaluations, the EPA guidance and technical documents would not propose the use of nonparametric two-sample comparisons.

EPA's comments, however, suggest that the work plan's approach with ANOVA then is in conflict with the EPA guidance on the appropriate approach used for calculating background threshold values (where distributional investigations are applicable and

recommended). Again, in the calculation of background threshold values, our approach did follow the recommendations in EPA guidance and technical documents. These recommendations (concerning calculation of background threshold values), however, do not apply to the ANOVA performed to help determine whether various soil association groups and soil depths should be combined.

Similar to the ANOVA, outlier testing was only performed when 50% detects were available. EPA's comments correctly noted this information was not included in the soil section (Section 3) of the work plan; however, it is the groundwater section (Section 5). The work plan will be revised to include a new Section 3.2 which will contain the language from Section 5.2. The current Section 3.2 will be renumbered to Section 3.3, and its subsections will likewise be renumbered accordingly. A new subsection will be added to the new Section 3.3 and labeled 3.3.2; it will contain the language from Section 5.3.2 that describes the evaluation of outliers. These items will be the only revisions to the work plan related to this comment.

2. *The Work Plan does not provide sufficient information in Section 5.3, Statistical Analysis, with respect to how groundwater constituent data populations with non-detect values will be statistically evaluated. Text in Section 5.3.3., Establishing Statistical Distributions, states "These recent recommendations (USEPA, 2007) also suggest that the distributional assumptions be tested on detected data only. . . All data, both detected and non-detected will be used in the calculation of the summary statistics." Please provide further explanation as to how non-detect values will be handled in the statistical evaluation of groundwater data, and what statistical methods will be used to compute summary statistics for the groundwater background data.*

Navy Response: Please refer back to the response to Comment 1.

3. *The information provided in Section 5.1, Sampling Rationale, regarding the proposed new well locations for collection of additional groundwater background data is insufficient, as follows:*
 - *The text states on page 5-2 that two new background wells are proposed for the Yorktown aquifer and one new well in the Cornwallis Cave aquifer, which according to the text, are depicted in Figures 5-2 (Cornwallis Cave aquifer) and Figure 5-3 (Yorktown aquifer)." However, Figure 5-3 has not been included in the Work Plan, and further, Figure 5-2 is labeled as, and depicts the Yorktown aquifer wells, not the Cornwallis Cave aquifer as the text suggests. Figure 5-3 should be added to the Work Plan and the text should be revised to match the figures.*

Navy Response: The reference to a "Figure 5-3" is a carryover from an earlier working version of the document. A figure was removed from this section and the figures were renumbered as "Figure 5-1" and "Figure 5-2" for the Cornwallis Cave and Yorktown aquifer well locations, respectively; however, the revision was not corrected in the text. The text (Section 5.1, third paragraph, second to last sentence) will be revised as follows (new text is underlined):

"The location of CERCLA sites and the existing and proposed new background monitoring wells are shown on Figures 5-1 (Cornwallis Cave aquifer) and 5-2 (Yorktown aquifer)."

- *The list of existing wells which will be sampled for collection of groundwater background data has not been provided in the text, and well locations depicted on Figure 5-2 are*

referenced as 'E', 'G', 'H', and 'N' wells. It is unclear if these references are the full name of the wells or just abbreviations. For clarity and completeness, please revise the Work Plan to include a listing of all the wells to be sampled.

Navy Response: The references to "E, G, H, etc." are the designations assigned by the USGS for their shallow aquifer system study at Naval Weapons Station Yorktown (Brockman et al, 1997). The Navy agrees that this reference is not clear in the text. The text (Section 5.1, third paragraph) will be revised as follows (new text is underlined):

"To ensure a minimum of ten representative background samples are available for each aquifer, a total of 15 samples will be collected in the Cornwallis Cave aquifer and a total of 13 samples will be collected in the Yorktown-Eastover aquifer. The samples will be collected from the existing background and USGS wells except for three. Two new background wells are proposed for the Yorktown-Eastover aquifer (BGGW09A and BGGW10A), and one new well in the Cornwallis Cave aquifer (BGGW10) to ensure adequate sample size for statistical analyses. Additionally, the new wells will provide groundwater quality data on Croaker Flat, to supplement the existing wells installed on the Lackey Plain. The location of CERCLA sites and the existing and proposed new background monitoring wells are shown on Figures 5-1 (Cornwallis Cave aquifer) and 5-2 (Yorktown-Eastover aquifer). Table 5-1 provides a listing of all wells to be sampled, including aquifer and well designations."

A copy of Table 5-1 is provided as an attachment to this letter.

- *The second bulleted item on page 5-2 states that monitoring wells were selected at varying depths in the Cornwallis Cave and Yorktown aquifers to assess depth variability. However, the depths of the existing and newly proposed well locations have not been provided to support this assertion. Please revise the Work Plan to include monitoring well selection criteria and specific well depth information.*

Navy Response: There is no significant vertical variability in the Cornwallis Cave and Yorktown aquifers at Yorktown; therefore, depth variability is not relevant to this study. Therefore, the wells were selected not based on well depth, but on the previous background investigations that have established that exiting background wells are installed in locations appropriate to characterize background conditions, as stated in Section 5.1, paragraph two. The new well locations were chosen based on spatial extent and that they are located up- or side-gradient of areas potentially impacted by potential CERCLA releases (refer to bullets one and three on page 5-2). The work plan will be revised to remove the second bulleted item on page 5-2. No further revisions to the work plan based on this comment are necessary.

- *The third bullet states that locations for the new wells were chosen up-gradient or side-gradient of areas potentially impacted by CERCLA releases; however, groundwater elevation data and existing/potential CERCLA sites have not been adequately depicted on a figure to justify this assertion. While Figure 2-4, Geohydrologic Section of the Shallow Aquifer System, shows the direction of groundwater flow in the Cornwallis Cave aquifer and Yorktown-Eastover aquifer in the area of the Camp Peary Scarp, neither this figure nor the figures in Section 5 provide a conceptual area-wide depiction of groundwater contours and directional flow near the proposed new wells. It is recommended that a figure be provided in*

Section 5 which more clearly shows groundwater gradient and flow paths and existing/potential CERCLA sites for the entire area surrounding the newly proposed groundwater wells in order to demonstrate that the newly proposed wells are up-gradient or side-gradient of potential source areas. This information is needed to demonstrate that applicability and defensibility of the resulting background groundwater data set.

Navy Response: Figures 5-1 and 5-2 have been revised with call-out boxes that show groundwater contours and groundwater flow around the newly proposed wells and nearby CERCLA sites. The revised figures are included as attachments to this letter.

SPECIFIC COMMENTS:

- 4. Section 2.2.1, WPNSTA Yorktown, Page 2-3:** *This section references two surface water features that are located within the site boundaries but which are not labeled on Figure 2-1, Site Map. These include Pond 10 and Lee Pond. So that a complete understanding of the site hydrologic features can be obtained from the text and figure, it is recommended that these two ponds be labeled on the Site Map.*

Navy Response: Agreed. Figure 2-1 has been revised to included labels for the Pond 10 and Lee Pond surface water features. A copy of the revised figure is included as an attachment to this letter.

- 5. Section 2.2.2, CAX, Page 2-3:** *Two man-made ponds, referred to in the text as Youth Pond and Catfish Pond have not been depicted on Figure 2-1, Site Map. Although it is understood that these ponds are one to two acres in size, it is recommended that these ponds be depicted on the Site map so that a complete understanding of the site hydrologic features can be obtained.*

Navy Response: Agreed. Figure 2-1 has been revised to included labels for the Youth Pond and Rodgers Pond surface water features. In addition, the upstream pond (upstream of Youth Pond) has been noted and a reference to it added to the text, as shown below. (Note: The reference to “Catfish Pond” was in error. There is no Catfish Pond at CAX; it is instead known as Rodgers Pond.)

The text (Section 2.2.2, second to last sentence), has been revised as follows (new text is underlined):

“Three small man-made ponds (Youth Pond [2 acres], Rodgers Pond [1 acre], and Upstream Pond [upstream of Youth Pond and < 1 acre in size]) are also present at the facility.”

A copy of the revised figure 2-1 is included as an attachment to this letter.

- 6. Section 3.1, Summary of Existing Soil Data, Page 3-1:** *The text states that because subsurface soils were collected at varying depths at WPNSTA Yorktown and the CAX background subsurface sample collection depths ranged from 6 to 24 inches below ground surface (bgs), only the two subsurface samples collected at 1-3 feet bgs at WPNSTA were retained for inclusion in the combined background data set. While the rationale for only including WPNSTA background subsurface data collected from the 1 to 3 feet bgs interval in the combined background subsurface data set is appropriate, it is unclear whether the data excluded from the combined data set will be retained for further evaluation of site investigation subsurface soil samples collected at depths below 3 feet bgs. Additionally, Section 3.1 states samples collected along the former*

railroad tracks were excluded from the combined data set since they are considered overly biased. This too appears to be justifiable and appropriate, however it has not been stated whether site contamination exists or is thought to exist at other on-site locations near railroad tracks such that use of this background data would be deemed necessary. Please revise the Work Plan to address these concerns.

Navy Response: Regarding the existing subsurface soil sample data that are below three feet bgs, there is not enough data to allow statistical comparison. Subsurface soil samples below three feet generally are not collected. However, the data will be maintained in the Yorktown/CAX database if future site investigations evaluate soils below the three-foot depth and a non-statistical comparison of the site data could be made if the soil is from the same soil type. This sentence will be added to Section 3.1, paragraph two, (following the sentence that begins "Because subsurface soils were collected at varying depths . . ."):

"There is not enough data below the three-foot depth to allow for statistical comparison, and subsurface soil samples below three feet generally are not collected. However, the data will be maintained in the Yorktown/CAX database if future site investigations evaluate soils below the three-foot depth and a non-statistical comparison of the site data could be made if the soil is from the same soil type."

Regarding the samples collected along the former railroad tracks that were excluded from the combined data set, use of this background data will not be necessary, as the group of compounds that would be detected (e.g., PAHs, creosote, etc.) would not be part of this report. Should site conditions indicate contamination may/does exist near railroad tracks and is related to the former railroad tracks, the evaluation will end there as railroad activities are not considered a CERCLA release. The following text will be added to work plan (Section 3.1, first paragraph, last sentence):

"No further use of the railroad sample data set will be deemed necessary as any site contamination near and related to railroad tracks will not be evaluated because no CERCLA release has occurred."

7. **Section 3.2.1:** *The factors used to determine how soil associations will be grouped are not clearly defined in the draft Work Plan. Please define these factors in the revised Work Plan.*

Navy Response: The first paragraph (last sentence) of Section 3.2.1 states that analysis of variance (ANOVA) and box and whisker plots were used to establish whether significant differences exist among soil associations and soil depths and thus, would determine how soil groups and depths would be combined. The third and fourth paragraphs of Section 3.2.1 give a detailed explanation of how ANOVA was applied. The fifth through seventh paragraphs provide the details for how box and whisker plots were evaluated. In addition, the reader is referred to Appendix C, which contains figures with the visual comparison of the soil associations and tables with summary statistics. Therefore, the Navy does not understand what further explanation is needed to explain the factors used to determine how the soil associations would be grouped. Please clarify.

8. **Section 5.1, Sampling Rationale, Page 5-2:** *The second paragraph states "To ensure a minimum of ten representative background samples are available for each aquifer, 15 samples will be*

collected in the Cornwallis Cave aquifer and 13 samples collected in the Yorktown aquifer." The Work Plan has not provided the basis for stating a minimum of 10 representative samples are required. If 10 samples are needed to meet the requirements of a statistical evaluation, the Work Plan should include this information. Please revise the Work Plan to include an explanation for requiring the collection of a minimum of 10 background samples.

Navy Response: USEPA 2007 recommends a sample size of at least 8-10 samples for calculation of background threshold values. This suggestion will be included in the report.

9. *Section 5.3.1, Aquifer-Specific Data Sets, Page 5-3: The text states "[F]or constituents with a detect percentage of less than 50 percent, professional judgment will be used to decide how their aquifer assignment (pooled or separate) will be assigned." In accordance with EPA' ProUCL Technical Guide, it is unclear why statistics will not be used to evaluate data sets with a detect percentage of less than 50 percent but greater than 4 to 5 percent. Additionally, it is unclear why the statistical protocols presented in Section 3 of the Work Plan for soil data sets with less than a 50 percent detection frequency are not planned for groundwater data sets such that background data for all matrices are evaluated in a consistent and defensible manner. Please revise the Work Plan to address these concerns.*

Navy Response: The approaches for soil and groundwater matrices are consistent, aside from the different physical features involved (soil associations and depths as opposed to groundwater aquifer assignments). As discussed in the response to Comment 1, the pursuit of ANOVA to compare data from different partitions is additional evaluation beyond mere visual inspection of the data. The distributional approaches provided in ProUCL for calculations of UTLs, UCLs of the mean, etc. do not apply to nonparametric ANOVA, just as they do not apply to nonparametric two-sample hypothesis testing (e.g. the nonparametric Wilcoxon Rank Sum test).

10. *Section 5.3.2, Evaluation of Outliers, Page 5-3 and 5-4: This section states that a mathematical outlier test will be applied to the data and further states that "Most such tests, including Dixon's, assume that the remaining concentrations represent a normal distribution (after the potential outlier is excluded). This assumption is often not true in application, based on the Shapiro-Wilk test using a significance level of 0.05. An effort will be made to transform the data (USEPA, 2000) to obtain an improved adherence to normality." According to EPA's ProUCL Technical Guide, Section 4.2.4.1 on page 91, use of transformations is discouraged. Further, Section 4.2.4.1 of the ProUCL Technical Guide cautions that statistics and results obtained from transformed data should be back-transformed to the original scale before using the results for comparison with site data. In accordance with EPA guidance, please revise the Work Plan to provide additional discussion of why transforming the data is deemed the best method to evaluate the data, and to document the requirement to back-transform the data before comparing the results to site data sets. This is particularly important to track if each outlier could be transformed using a different method.*

Navy Response: Back-transformation is not required for the outlier evaluation. We are not calculating a statistic in transformed values that will need to be compared to untransformed values; there is a simple decision of whether the elevated value appears inconsistent with the other values.

The use of transformations in outlier evaluation is mentioned in USEPA 2006 (an updated version of the USEPA 2000 which also mentioned it). Transformations for outlier evaluation deal with the tendency of data in a skewed tail to appear more unlike the other data if that skewed data is evaluated using an assumption of normality (which is a symmetric distribution such that skewed data will tend to appear unlike the rest of the distribution if one is anticipating symmetry on both sides of the mean). Symmetric background data might be expected by some, for instance, with a pristine background data set. With the Yorktown background with its potential anthropogenic sources, however, we do not typically expect a symmetrical background distribution.

11. *Appendix A Quality Assurance Project Plan, QAPP Worksheet #37, Page 121: The Usability Assessment states that the evaluative procedures are used to assess overall measurement error associated with the project, but does not indicate what the completeness criteria is in terms of the total number of acceptable data required for statistical evaluation. Please revise the Work Plan QAPP Worksheet #37, Usability Assessment to provide the data completeness objective. This objective should ensure that sufficient data will be available to complete the statistical analyses for the background groundwater evaluation as stated in Section 5.3 of the Work Plan.*

Navy Response: This bullet will be added to QAPP Worksheet #37:

- A minimum of 8-10 samples should be obtained to calculate a defensible background value threshold values (BTVs) (USEPA, 2007).

12. *Appendix B, Figure Background Sample Locations York River Drainage Basin: The figure entitled "Background Sample Locations York River Drainage Basin" includes a legend that indicates proposed background surface water/sediment/biota and surface soil sample locations have been selected in addition to the proposed background monitoring well locations. However, the Work Plan and Background Study QAPP only address collection of additional groundwater samples for the background study. Please revise the figure label to provide the date and/or name of the Work Plan associated with the sample locations identified on the map in order to clearly indicate that is map does not correspond to proposed sampled locations in the October 2008 Work Plan. Additionally, the depiction of groundwater wells on the map is blurry and unusable as presented. The map should be revised so that the features and well names on the map are legible.*

Navy Response: Appendix B contains the "Previous Background Investigation Sampling Location Figures," as stated in the Table of Contents. There should have been a flysheet at the beginning of the Appendix that stated its contents as well, but it was mistakenly omitted. A flysheet with the appendix title will be added.

The figure "Background Sample Locations York River Drainage Basin is a historic figure from the previous Yorktown Background Study (Baker, 2005). We will attempt to locate a copy of the original native file to make the suggested revisions to the legend, and print a more legible copy.

Sincerely,

CH2M HILL



Marlene Ivester
Project Manager

cc: Mr. Thomas Kowalski/NAVFAC MIDLANT
Mr. Christopher Murray/NAVFAC MIDLANT
Ms. Susanne Haug/USEPA
Mr. Wade Smith/VDEQ
Mr. William Friedmann/CH2M HILL
Ms. Rebekah Klyukin/CH2M HILL
Ms. Stephanie Sawyer/CH2M HILL

References cited in responses:

Baker Engineering (Baker). 1995. *Final Summary of Background Constituent Concentrations and Characterization of Biotic Community from the York River Drainage Basin, Naval Weapons Station Yorktown, Yorktown Virginia*. July.

Brockman et al. 1997. *Geohydrology of the Shallow Aquifer System, Naval Weapons Station Yorktown, Yorktown, Virginia*. U.S. Geological Survey Water-Resources Investigations Report 97-4188.

U.S. Environmental Protection Agency (USEPA). 2007. *ProUCL Version 4.0 Technical Guide*. Office of Research and Development, EPA/600/R-07/041. April

USEPA. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*. Office of Environmental Information, Washington, D.C.

**Table 5-1
Summary of Background Study
Wells to be Sampled**

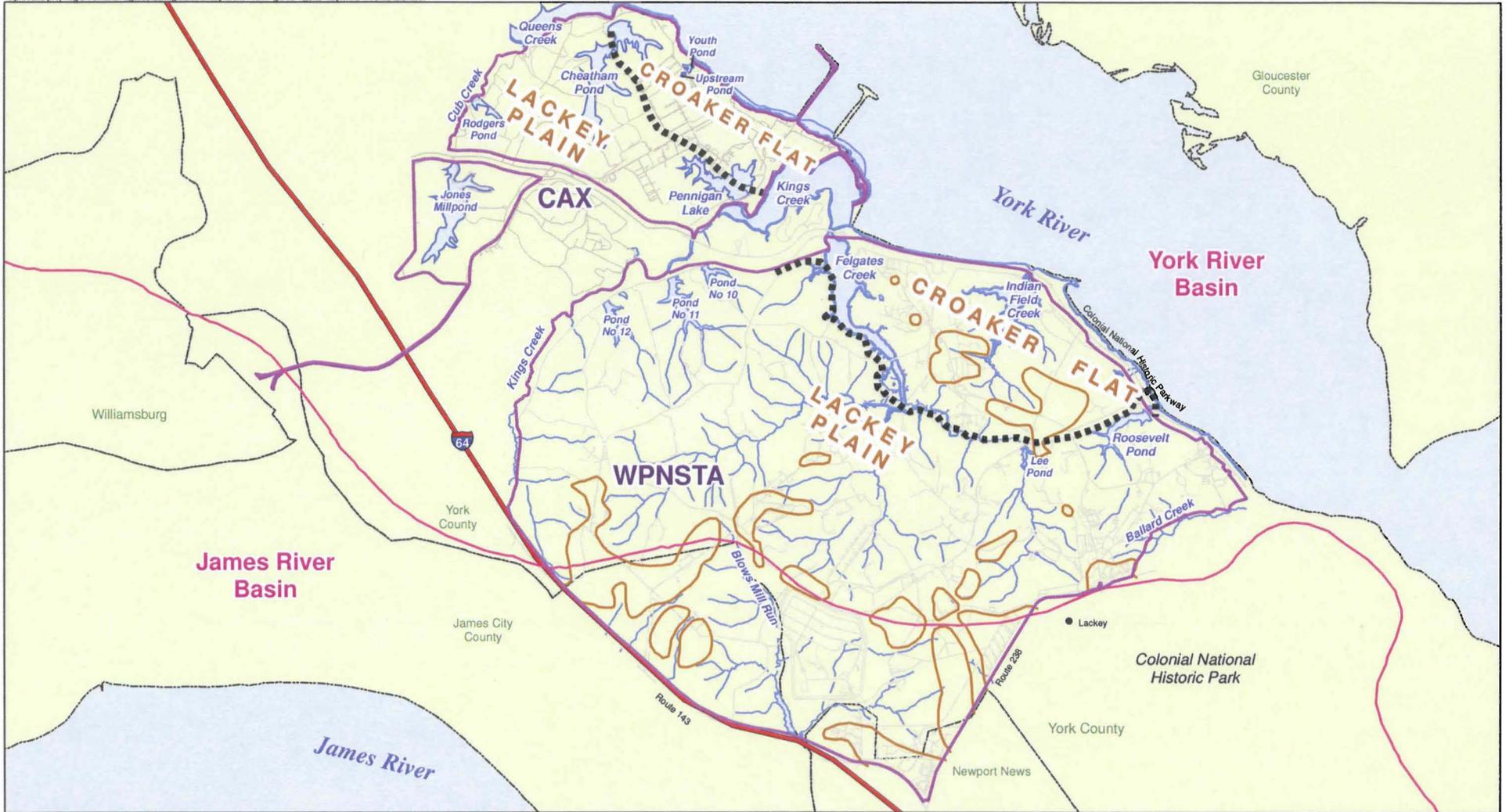
Aquifer	Well ID (listed basically left to right as they appear on Figures 5-1 or 5-2)	Existing Well?	
		Yes	No
Cornwallis Cave (Figure 5-1)	CXBG3-MW01 ⁽¹⁾	X	
	CXBG1-MW01 ⁽¹⁾	X	
	58G57 (N3) ⁽²⁾	X	
	58G58 (N4) ⁽²⁾	X	
	58F120 (I3) ⁽²⁾	X	
	BGGW07A ⁽³⁾	X	
	BGGW07 ⁽³⁾	X	
	BGGW01 ⁽³⁾	X	
	BGGW06A ⁽³⁾	X	
	58F110 (G3) ⁽²⁾	X	
	58F115 (H3) ⁽²⁾	X	
	BGGW03A ⁽³⁾	X	
	BGGW05A ⁽³⁾	X	
	58F105 (E3) ⁽²⁾	X	
	BGGW10 ⁽⁴⁾		X
Yorktown-Eastover (Figure 5-2)	58G55 (N1) ⁽²⁾	X	
	58G56 (N2) ⁽²⁾	X	
	58F118 (I1) ⁽²⁾	X	
	58F119 (I2) ⁽²⁾	X	
	BGGW01A ⁽³⁾	X	
	58F108 (G1) ⁽²⁾	X	
	58F109 (G2) ⁽²⁾	X	
	58F113 (H1) ⁽²⁾	X	
	58F114 (H2) ⁽²⁾	X	
	58F103 (E1) ⁽²⁾	X	
	58F104 (E2) ⁽²⁾	X	
	BGGW09A ⁽⁴⁾		X
	BGGW10A ⁽⁴⁾		X

⁽¹⁾Installed as part of the CAX Background Study (Baker, 2003). This is the well identification assigned by Baker for the study.

⁽²⁾Installed as part of the USGS Shallow Aquifer Study of Naval Weapons Station Yorktown (Brockman et. al, 1997). The USGS installed seven four-well clusters (labeled B, E, F, G, H, I, and N) and gave each well within the cluster its own unique identifier (e.g., 58F105), along with a cluster designation (e.g., E3). The cluster designation has been used on Figures 5-1 and 5-2 for brevity and less "clutter."

⁽³⁾Installed as part of the Yorktown Background Study (Baker, 1995). This is the well identification assigned by Baker for the study.

⁽⁴⁾New well to be installed as part of 2009 Background Study. The well identification number follows Baker's nomenclature for the Yorktown Background Study and starts sequentially where that study ended (i.e., Baker's study ended at BGGW08A).



Legend

- Activity Boundaries
- Camp Peary Scarp
- Watershed Boundaries
- Interstate 64
- Approximate Boundary of Columbia Aquifer, February 3, 1997
- Roads
- Shoreline and Water Bodies
- City / County Boundaries

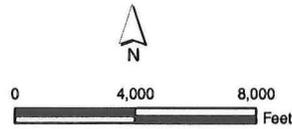
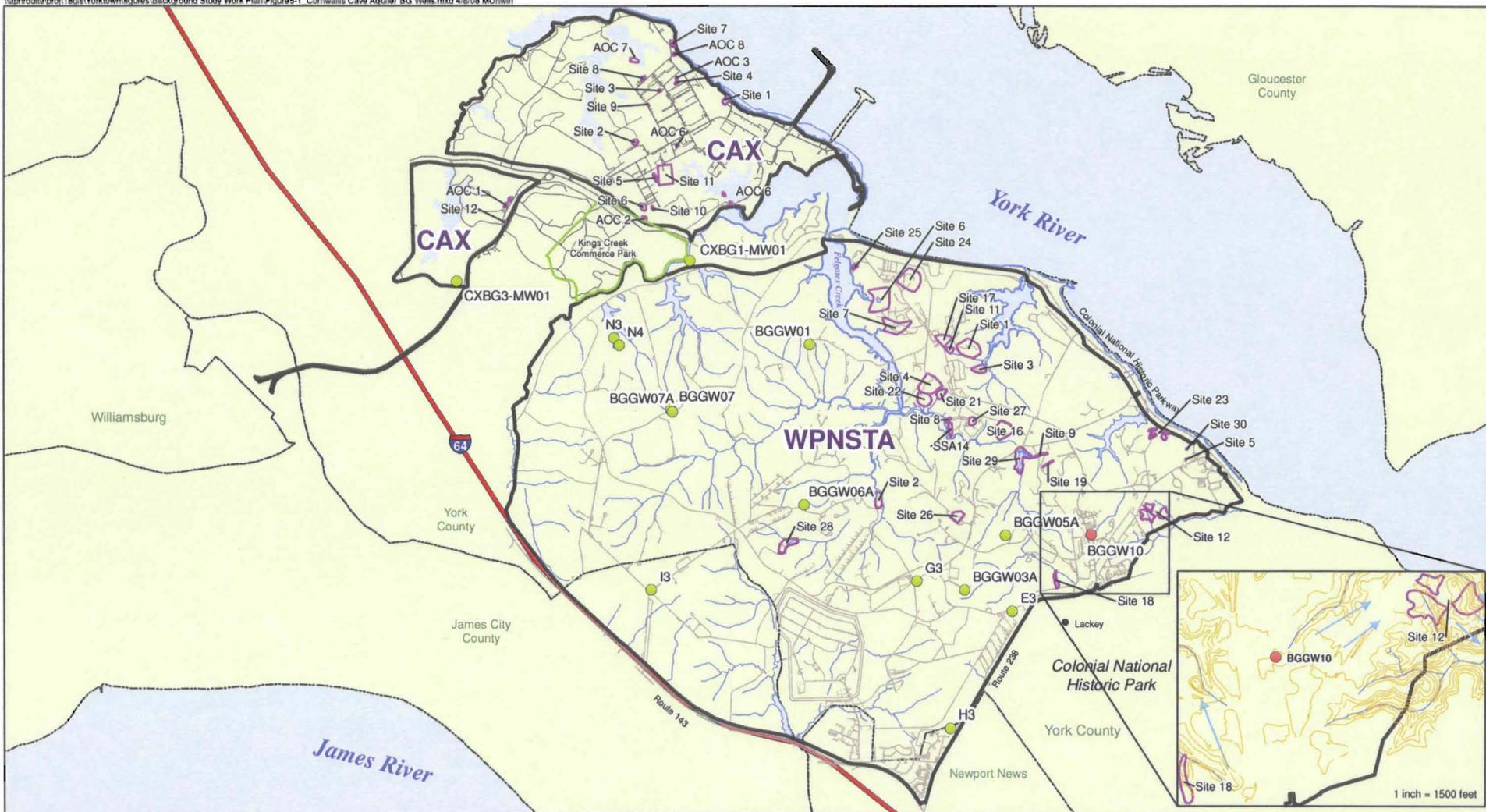


Figure 2-1
Site Map
 Background Study Work Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia



- Legend**
- Proposed New Well for Background
 - Proposed Existing Well for Background
 - Roads
 - Shoreline and Water Bodies
 - Contours
 - Interstate 64
 - City / County Boundaries
 - ← Groundwater Flow Arrow (the surface water body to which flow was going)
 - Site Boundaries
 - Activity Boundaries
 - Kings Creek Commerce Park

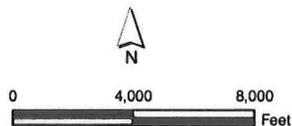


Figure 5-1
 Cornwallis Cave Aquifer Background Wells
 Background Study Work Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia



- Legend**
- Proposed New Well for Background
 - Proposed Existing Well for Background
 - Roads
 - Shoreline and Water Bodies
 - Interstate 64
 - Contours
 - City / County Boundaries
 - ← Groundwater Flow Arrow (the surface water body to which flow was going)
 - Site Boundaries
 - Activity Boundaries
 - Kings Creek Commerce Park

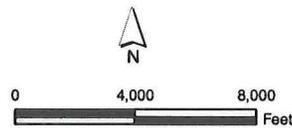


Figure 5-2
 Yorktown Aquifer Background Wells
 Background Study Work Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia