DEPARTMENT OF THE NAVY
NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA 47522-5000

N00164.AR.000040
NSWC CRANE
5090.3a

5090/H11.9
0924

4 JUN 1990

RCRA Activities
U.S. EPA, Region V
Post Office Box A-3587
Chicago, Illinois 60690-3587

Gentlemen:

Submitted for review is the RFI Phase II Ground Water Release Assessment Work Plan for the Demolition Area (Site 06) and the RFI Phase III Ground Water Release Assessment Work Plan for the Old Rifle Range (Site 07). Requirements for submittal of these reports were set forth in the Corrective Actions portion of the Hazardous Waste Part B Permit issued to Naval Weapons Support Center Crane (NWSCC) in January 1990.

NWSCC point of contact is Mr. Jim Hunsicker, Code 0924, telephone 812-854-3233.

Sincerely,

J. P. [illegible]
Public Works Officer
By direction of the
Commanding Officer

Encl:
(1) RFI Phase II Ground Water Release Assessment Work Plan for the Demolition Area (Site 06).
(2) RFI Phase III Ground Water Release Assessment Work Plan for the Old Rifle Range (Site 07).
(3) Certification Statement

Copy to:
NORTHNAVFACENGCOM, Philadelphia (Code 14)
COMNAVSEASYSCOM (SEA-6541)
WES

Corrective Action Work Plan
RCRA Facility Investigation Phase II
Release Assessment, Ground Water
Demolition Area (Site 06), Crane NWSC

1. **Task A: RFI Phase II Work Plan.**

a. RFI Phase II Project Management Plan.

The Waterways Experiment Station (USAEWES) will perform a RCRA Facility Investigation (RFI) Phase II, Release Assessment (ground water) for the Crane Naval Weapons Support Center (NWSC), Crane, Indiana at the Demolition Area Solid Waste Management Unit (SWMU), also known as Corrective Action Plan (CAP) Site number 06 (Figs 1 and 2). This document outlines the objectives of the RFI, discusses the technical approach, quality assurance/quality control measures, and personnel to be used in the RFI, and provides a schedule of work to be performed.

Technical Approach. The purpose of the Phase II work is to determine the presence or absence of a contaminant release to ground water from operations at the Demolition Area. Phase II work will also evaluate ground water flow patterns, identify aquifers at the site, and define the hydrogeology of the site. Sufficient ground water monitoring wells will be installed, exploratory borings emplaced, and other subsurface investigation conducted to assess ground water flow characteristics and presence of contamination, if any. Phase II work will establish only general ground-water flow patterns and general site geology, stratigraphy, and aquifer and aquiclude extent because of the limited number of wells installed for a Phase II study.

Quantitative chemical analysis of monitoring wells will be performed for specified compounds. Geologic and ground-water profiles will be prepared from monitoring well and other data showing geometry of piezometric surfaces and geologic units and vertical distribution of contamination, if any. Ground-water level contour maps will be prepared showing direction and gradient of flow and lateral extent of contamination, if any. Details of drilling and sampling activities to be conducted in the Phase II work are presented below.

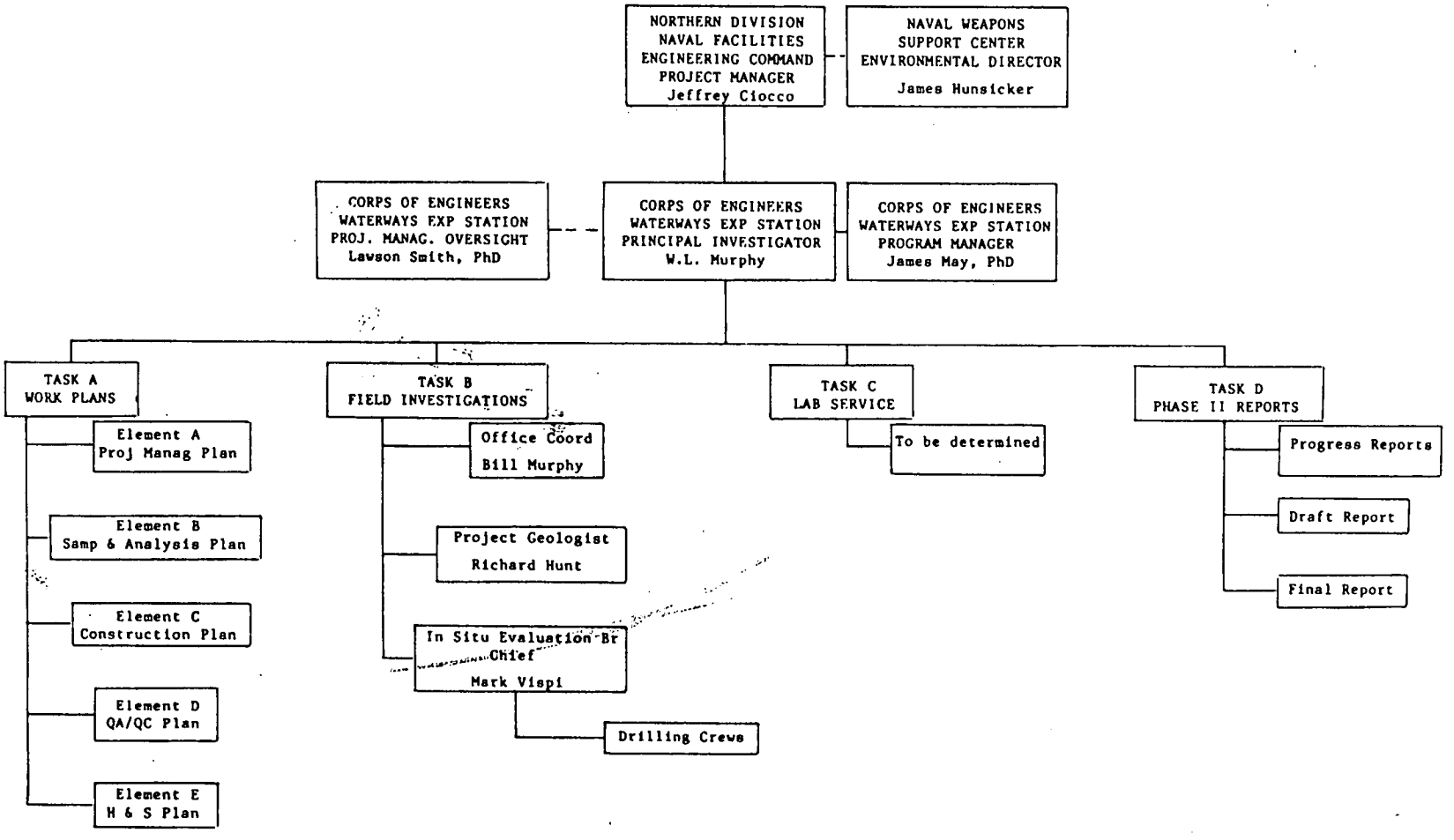
Personnel. Phase II ground-water work will be conducted by WES personnel, other CE personnel, or contractors approved by Crane working under WES supervision. All personnel doing on-site work will be schooled in personal protection and safety and will have had a comprehensive physical examination within the 12 months preceding their involvement in the field work (see Health and Safety Plan, Part f., below. An organization chart of key personnel and tasks is presented in Table 1.

Schedule. Phase II ground-water work has already begun at the Demolition Area with the drilling, coring and geologic logging (interpretation) of exploration bore holes and monitoring wells. The Phase II ground water work plan will be submitted by May 22, 1990. Within 30 days of receipt of EPA Region V comments on the work plan a modified work plan will be sumitted for EPA approval. Within 30 days of EPA approval the Phase II work will be implemented to accommodate Region V recommendations.

b. RFI Phase II Sampling and Analysis Plan.

(1) Sampling objectives. Sampling of the water in monitoring wells will be designed to determine the presence or absence of specified compounds in the ground water of aquifers underlying and adjacent to the Demolition Area. Monitoring wells will be placed and screened to sample water in unique ground

TABLE 1. RCRA FACILITY INVESTIGATION, PHASE II GROUND WATER
DEMOLITION AREA
PROJECT ORGANIZATION CHART



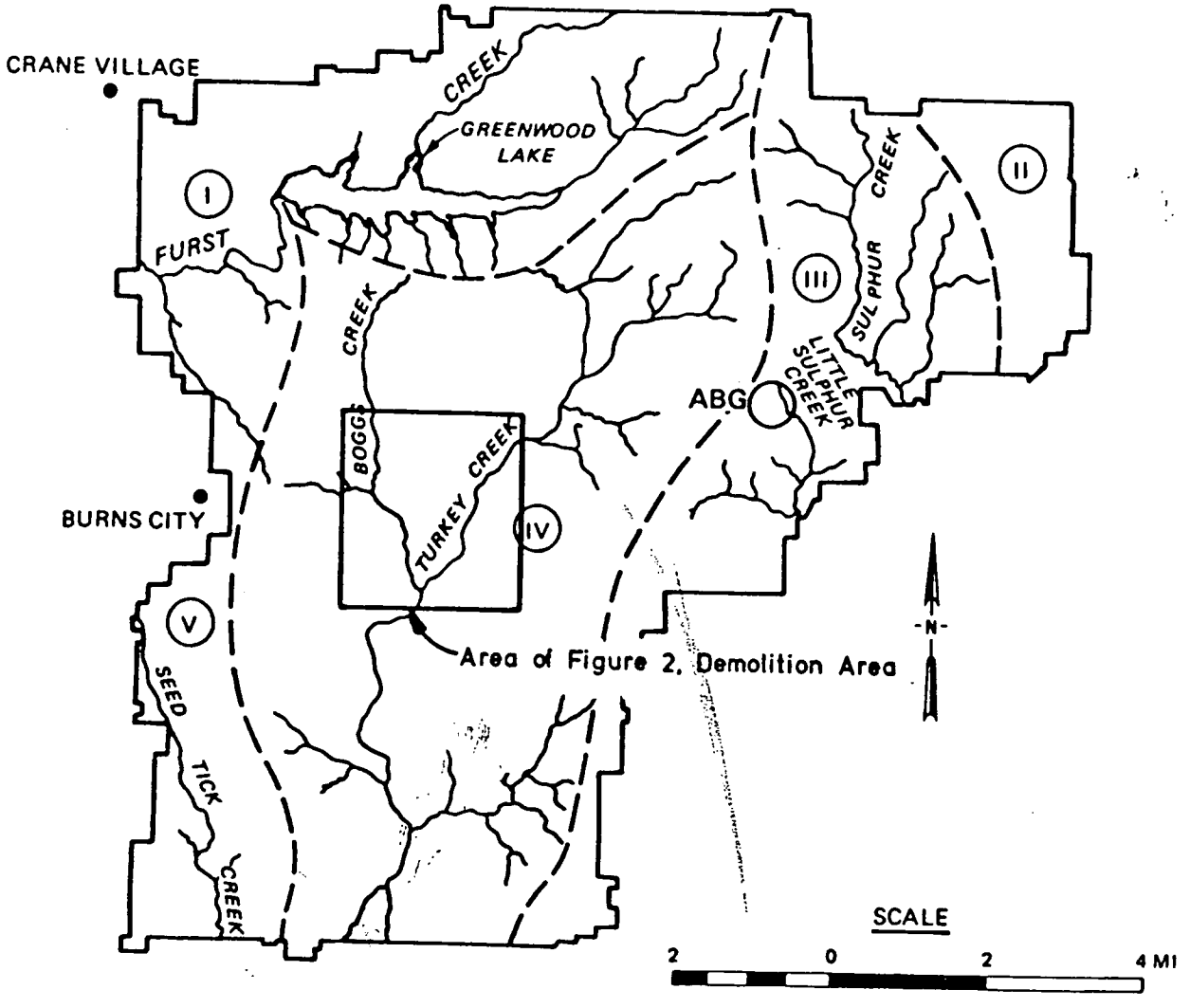
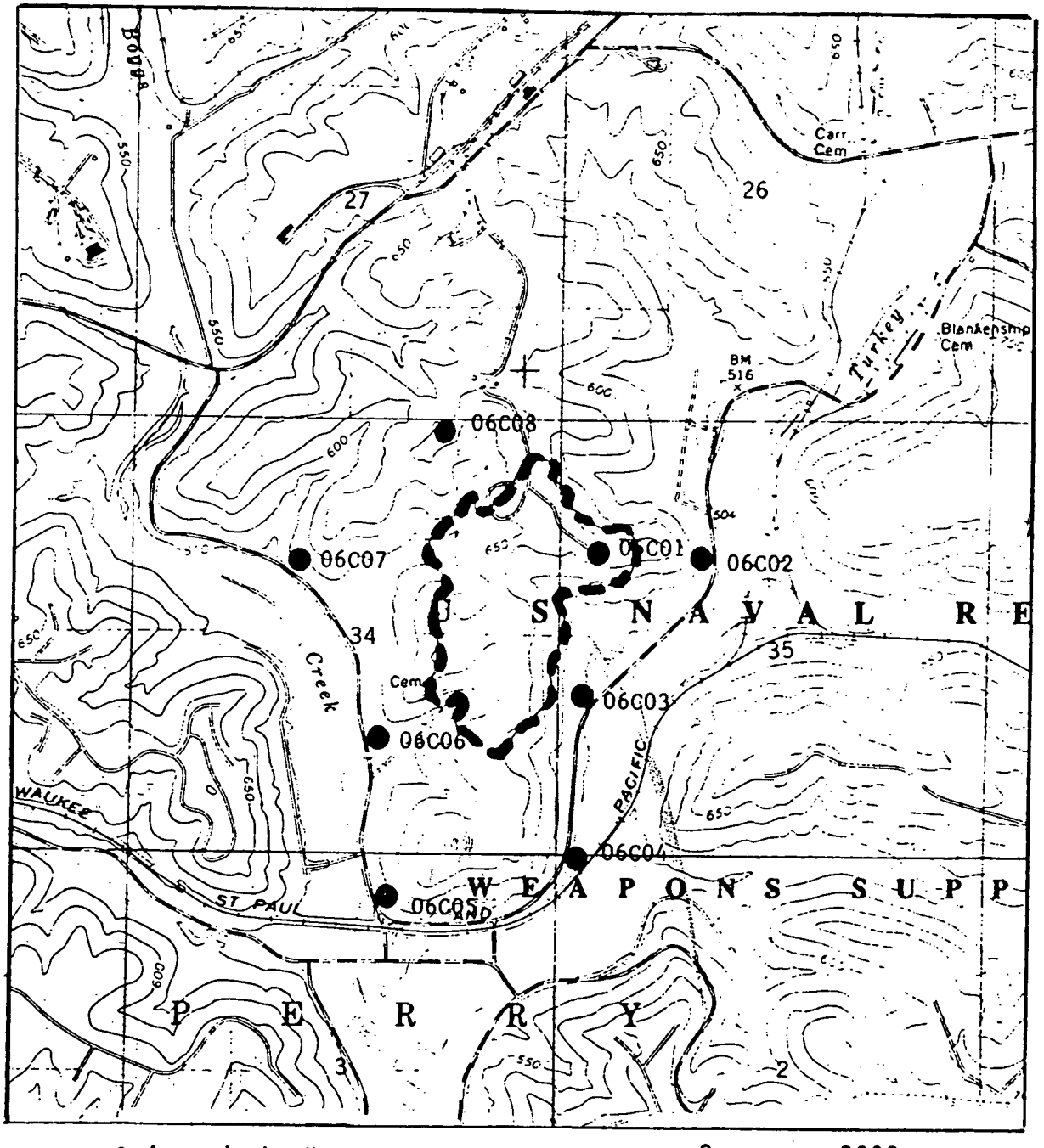

CRANE VILLAGE
CREEK
GREENWOOD LAKE
I
FURST
CREEK
II
CREEK
SUL PHUR
III
LITTLE SULPHUR CREEK
ABG
BOGG
TURKEY CREEK
IV
BURNS CITY
V
SEED
TICK
CREEK
Area of Figure 2, Demolition Area
-N-
SCALE
2
0
2
4 MI

Figure 1




Approximate limits of Demolition Area

0 2000
Scale, FT

Phase II monitoring wells for Demolition Area

Figure 2.

water zones, i.e. zones hydraulically isolated from other ground water zones. Screens will be placed in the uppermost zone encountered and in subsequent zones (using cluster wells) down to the lowermost aquifer determined to be accessible to water migrating downward from the surface. Data from preliminary borings and well emplacements indicate that the lowermost aquifer of concern at the Demolition Area is the contiguous Big Clifty sandstone-Beech Creek limestone and that the aquifer is underlain by a considerable thickness (>10 ft) of Elwren shale, which has been identified as an aquiclude (confining stratum) at other Crane sites. Water flow within and through the Big Clifty/Beech Creek aquifer appears to be primarily in joints and bedding planes. Because it is not known which joints and bedding planes contribute to the water flow, screens of 20 ft length will commonly be installed in the Big Clifty-Beech Creek aquifer at the Demolition Area for the Phase II study. The 20 ft screens will insure that a sufficiently thick water-producing section of the aquifer is sampled during monitoring to determine the chemical quality of the water in the aquifer.

(2). Sampling equipment and containers. Sampling equipment and containers are discussed in Part I of the accompanying document in "QA/QC Document for Sampling and Analysis of Ground Water at Crane NWSC, Crane, IN."

(3). Analytical parameters and test methods. Analytical methods in general are described in Part II of the accompanying QA/QC document (in preparation). Data validation and reporting will conform to Naval Energy and Environmental Support Activity (NEESA) standards (reference NEESA 20.2-047B), Level C.

Thirteen monitoring wells were installed at the Demolition Area in 1981 for initial site assessment. The wells have been sampled and the water tested approximately yearly to the present for metals of Group I, compounds of groups II and III, and explosives. No explosives compounds have been detected. Metals (Group I) have been detected in small quantities in some of the wells in the previous sampling events.

Five successive quarters of samples will be taken from the Demolition Area ground-water monitoring wells and analyzed for Appendix IX parameters, Group III ground water contamination parameters, and explosive compounds by HPLC. Appendix I describes the HPLC method for Explosives and lists applicable compounds. Table 2 summarizes the sampling requirements for Phase II work.

(4) Sample types. Well placement and water sampling at the Demolition area can be classified as random. The Phase II investigation must be performed before biased sampling in selected aquifers at selected depths and at selected map locations can be conducted. The deep boring of all cluster wells will be continuously cored to obtain samples necessary to interpret the subsurface geology (stratigraphy, hydrology, structure and lithology).

(5) Sample locations, depths and frequency. Eight additional well clusters (see Figure 2) have been installed for the Phase II investigation for a total of 17 new wells (1989-90). Thirteen wells were installed previously (1981). The total number of wells to be sampled is 30. The Demolition Area is atop a ridge that drops 180 to 200 ft on three sides to two stream valleys that converge at the south end, or nose, of the ridge. Well clusters will be emplaced atop the ridge near the edge of the demolition zone but sufficiently distant to be protected from the effects of demolition activities. The remaining clusters will be emplaced at or near the toe of the ridge slope on

Table 2. Ground-Water Sampling Summary, Demolition Area Phase II

| PARAMETER | SAMPLES (30 wells) | FIELD DUPS (10% of Samples) | QC BLANKS Trip Blnks 1/day | QC BLANKS Field Blnks 1/day | EQUIP. RINSATE 1/day |
|---|---|---|---|---|---|
| Appendix IX | 30 | 3 | 3 (volatiles) | 1 | 3 |
| Explosives by HPLC | 30 | | | | |
| Group III | | | | | |
| pH (quad) | 120 | | | | |
| Conductivity (quad) | 120 | | | | |

all three sides of the ridge. The deepest well boring will be approximately 250 ft. Shallow well clusters will generally be 40 to 60 ft in depth. Initial boring data indicate that clusters of two wells each will be required, one in the uppermost aquifer and one in the deep aquifer at the base of the ridge. Wells emplaced along the base periphery of the site will need to be only about 80 ft in maximum depth.

A preliminary background well location has been established in the ridge top northeast of the demolition zone. The suitability of the location will have to be assessed after analysis of cluster well water samples.

Water quality samples will be collected in five consecutive rounds on a quarterly frequency as required by the CAP.

(6) Sampling schedule. The ground-water sampling schedule is presented in Figure 3, a time-line for Demolition Area Phase II ground Water Assessment.

(7) Sampling procedures. Monitor well sampling procedures are described in detail in Section B.1.d of this document. Soil and rock sampling wil be conducted from a truck-mounted rotary drilling rig. Rock cores will be collected continuously using a diamond-bitted HQ wire-line core barrel (HQ wireline retrieves a 2-1/2-in diameter core from a 3-3/4-in diameter borehole). The wireline coring technique has been shown to be effective in obtaining high-quality core in the Crane geological environment by previous drilling/sampling work.

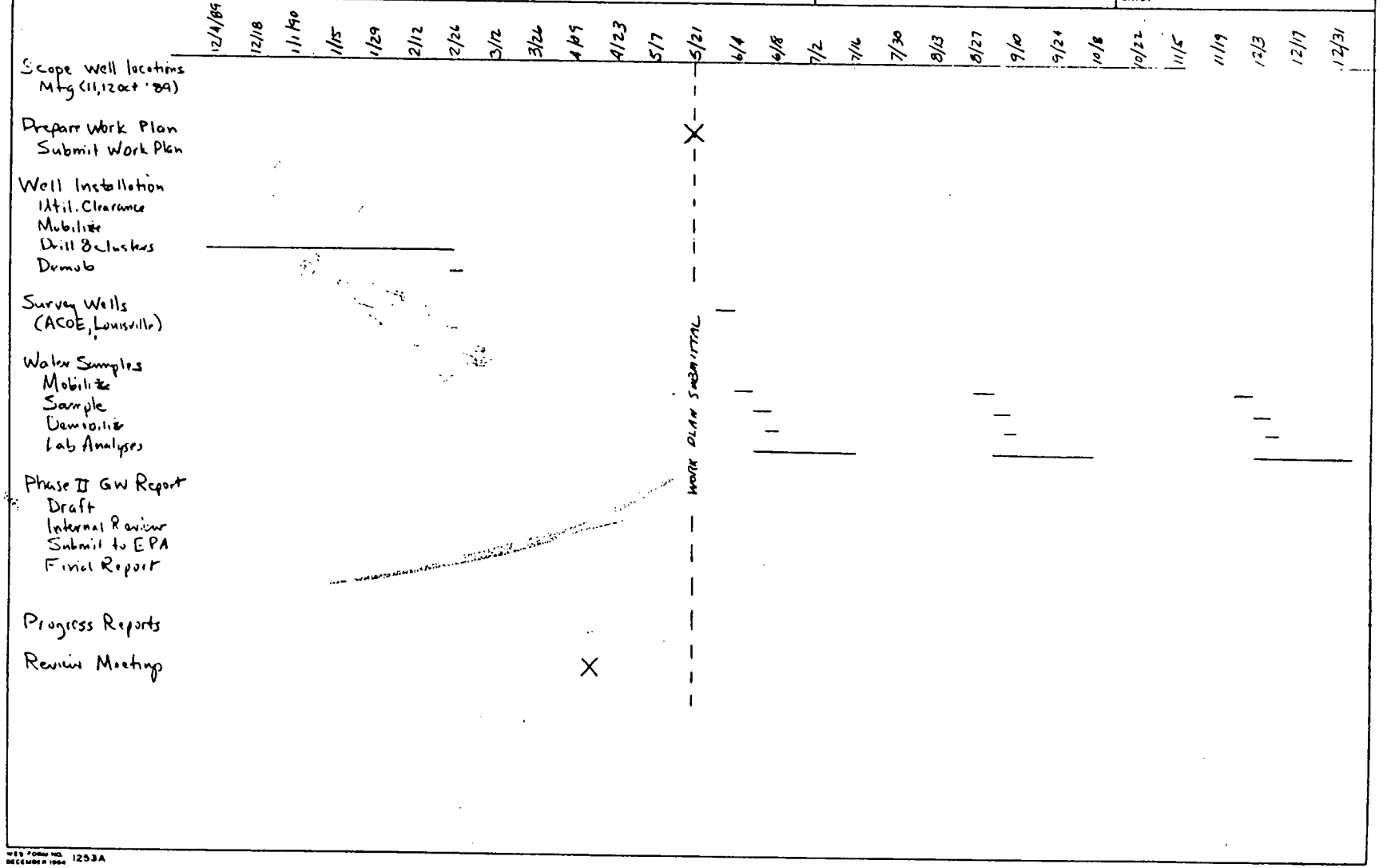
Drilling water is currently drawn from the water treatment plant for the NWSC, which derives its potable water supply from Lake Greenwood within the NWSC boundaries. Prior to the start of drilling a boring, the drill rig and appurtenances will be steam-cleaned. Drill cuttings will be removed from the boring by circulating clean water from a steel mud pan sealed around the boring top to prevent contamination of the subsurface from surface runoff. The mud pan will be cleaned and refilled periodically as conditions warrant. In borings penetrating more than one aquifer, upper zones will be sealed before the boring is advanced. PVC casing will be grouted 3 to 5 ft into the confining stratum at the base of the aquifer and allowed to set overnight before advancing the boring. The boring will then be advanced through the upper casing and grout and smaller casing will be set for the next aquifer.

(8) Rationale for sampling location and choice of analytes. All operable wells installed for the Demolition Area will be sampled in Phase II work. The analytes identified in section b.(3), above, were selected from past sampling experience dating back to 1983. Rationale for earlier sampling was based on findings of the Initial Assessment Study of NWSC by NEESA, May 1983. High-explosive waste munitions have been disposed of by detonation at the Demolition Area since the 1940s. As much as 10 tons per day were destroyed at the site from 1956 to 1960. Approximately 20 shots per day are presently allowed and the limit per shot is 500 lbs. Unexploded ordnance (UXO) has been found within the range limits. The Demolition Area is atop a ridge with surface runoff potential to Boggs Creek and Turkey Creek and potential infiltration to the water table. Four sedimentation ponds have been constructed downslope to intercept runoff. Potential contaminants from demolition activities, identified in the initial assessment, included TNT, RDX, HMX and ammonium picrate. Annual testing of monitoring well water from 1982 through 1989 has indicated small quantities of certain metals. No explosives have been detected in Demolition Area wells but RDX and TNT were detected in wells at the adjacent Old Rifle Range SWMU.

(9) Environmental conditions at time of sampling. Environmental

SUBJECT: NWSC Crane Demolition Area (Site 06)
RFI Phase II Ground Water Release Assessment

COMPUTED BY:
CHECKED BY:
DATE:
DATE:




WES FORM NO. 1253A
DECEMBER 1984

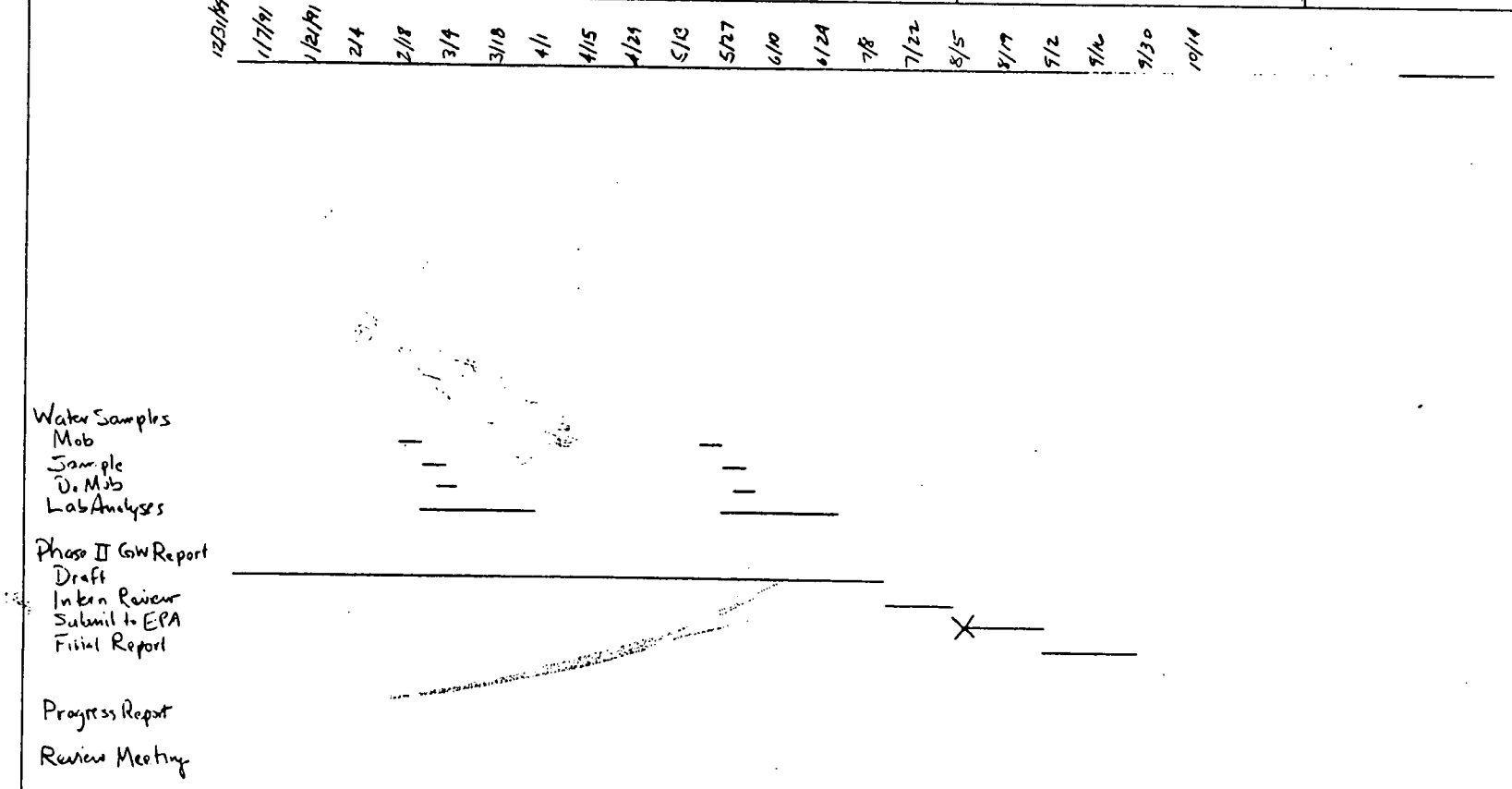


FIGURE 3

SUBJECT: Demolition Area
RFI Phase II Ground Water Release Assessment (CON'D)

COMPUTED BY:
CHECKED BY:

DATE:
DATE:




WES FORM NO. 1253A
DECEMBER 1984

conditions at the Demolition Area are affected by demolition activities at the site and by potential release to the air of contaminants released by boring operations. Demolition activities are monitored by Crane personnel who require field crews to evacuate the area in times of hazardous operations. The presence of volatile organic compounds in the air at the drill location will be continuously monitored using a photoionization organic vapor detector and a combustible gas detector (see Section f., Health and Safety Plan). Dust released by drilling operations will be minimal because drilling is done with water.

(10) Chain-of-custody forms and procedures. Chain-of-custody is described in the accompanying QA/QC document , Part I.

(11) Decontamination procedures. Decon procedures for ground-water sampling are described in detail in Part I of the accompanying QA/QC document. Decontamination of the drilling and coring equipment will consist of steam cleaning the drilling rig and appurtenances before start of a new boring. In addition, the down-hole equipment (drill rods, rock bits and core barrels) will be steam-cleaned after sealing of a ground-water zone and before advancing through the aquiclude to the next aquifer.

(12) Documentation. Ground-water sampling logs will be kept as described in QA/QC (section d.). Soil and rock sampling logs will be kept for each borehole and well as the borehole is advanced. Figures 4, 5, and 6 are examples of soil sampling, rock sampling, and well installation logs typically prepared during field operations. All sampling activities, methods, and analytical results will be presented in written reports at the end of the RFI for the Demolition area.

(13) Calibration of field devices. Calibration of the air-monitoring devices is described in the Health and Safety Plan (part f. of this document). Calibration of field water quality analysis devices such as pH meters is discussed in Section d. (QA/QC).

(14) Sample preservation. Ground-water sample preservation methods are described in Section d. (QA/QC). Soil and rock core samples collected for geologic analysis are stored in lidded jars and wooden core boxes, respectively.

c. RFI Phase II Construction Plan.

(1). Objective of construction of monitoring/sampling wells. Monitoring wells will be installed in and around the Demolition Area to provide monitoring of ground-water levels and piezometric surfaces and sampling for chemical analysis. Wells also provide access to aquifers for determination of aquifer parameters. Wells will be positioned to define and intercept contaminant transport paths and to describe and monitor flow away from the Demolition Area (in Phase II resolution). Wells will be constructed with materials and methods designed to prevent addition of contaminants to the well environment and cross-contamination of vertically separated aquifers.

(2) List of equipment. Drilling of all well borings will be with a truck-mounted Failing 1500 hydraulic drill rig or equivalent. Flight augers or hollow stem augers will advance the hole through soil overburden until rock is encountered. Diamond-impregnated HQ-sized wireline core bit and barrel will drill and retrieve the core samples. Standard rotary rock bits will be used to advance the boring in a non-sampled borehole (only the first and deepest well boring of a cluster of wells is cored and logged). A stainless steel bailer will be used to develop the well after the screen and casing are

Hole No. WES-3-VF2-87

| DRILLING LOG | DIVISION US Navy | INSTALLATION NWSC | SHEET 1 OF 1 SHEETS |
|---|---|---|---|
| 1. PROJECT Hydrogeologic Studies, ABG | | 10. SIZE AND TYPE OF BIT 3" Splitspoon + Auger | |
| 2. LOCATION (Coordinates or Station) ABG Valley Fill | | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) | |
| 3. DRILLING AGENCY WES | | 12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500 | |
| 4. HOLE NO. (As shown on drawing title and file number) 3-VF2 | | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED / UNDISTURBED |
| 5. NAME OF DRILLER Dan Taylor | | 14. TOTAL NUMBER CORE BOXES | |
| 6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT. | | 15. ELEVATION GROUND WATER | |
| | | 16. DATE HOLE | STARTED 6/23/87 / COMPLETED 6/23/87 |
| | | 17. ELEVATION TOP OF HOLE 581.5 | |
| 7. THICKNESS OF OVERBURDEN 7.5 | | 18. TOTAL CORE RECOVERY FOR BORING % | |
| 8. DEPTH DRILLED INTO ROCK | | 19. SIGNATURE OF INSPECTOR Geologist R.W. Hunt | |
| 9. TOTAL DEPTH OF HOLE 7.5 | | | |

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | 0 | | Clayey silt, w/ss pebbles + frags, m-d Br, firm, sl moist dry | | 1 | Samples were put in qt Jars |
| | 1 | | | | 1.5 | |
| | 2 | | | | 2 | |
| | 3 | | | | 3.0 | |
| | | | Increase in ss frags below 3.0', + moist | | 3 | |
| | 4 | | Blk coal? flakes between 4.0 + 4.5 | | 4.5 | |
| | 5 | | weathered Big Clifty ss w/ silty clay + clayey silt in eroded open jts, moist | | 4 | |
| | 6 | | | | 6.0 | |
| | 7 | | | | 5 | |
| | | | | | 7.5 | |
| | 8 | | Bot. Depth 7.5' (Refusal on Top of Big Clifty ss) | | | |

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Figure 4.

Hole No. WES-3-C1-86

| DRILLING LOG | DIVISION US Navy | INSTALLATION Crane In | SHEET 1 OF 20 SHEETS |
|---|---|---|---|

1. PROJECT: NWSC Groundwater Study
2. LOCATION (Coordinates or Station): ABG Geologic Studies
3. DRILLING AGENCY: WES
4. HOLE NO. (As shown on drawing title and file number): WES-3-C1-86
5. NAME OF DRILLER: Dan Taylor
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 4.2'
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 197.2
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: UNDISTURBED:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED Aug 2, 1986 COMPLETED Sept 29 1986
17. ELEVATION TOP OF HOLE: ~~[illegible]~~ 624.8'
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF ~~[illegible]~~ Geologist: Richard W. Hunt

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | 0 | | Ls rk surface (work area) | | | Started Sampling w/an 8" dia Failing Auger |
| | 1 | | clayey Silt, (ml-cl) yBr - rBr, w/rk frags, firm - v firm, | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | Set 6" dia casing to 4.3' (steel) |
| | 5 | | Sandstone, yBr + lGr, fine grained, cross bedded, wea + oxidized, occ soft clay lens, numerous random fractures that are tight to partially open and coated w/ limonite, few frac have a clay filling. Frac are rough + irregular. (Fractures are shown in legend) w/ amount of dip | Run 1 | | Started coring w/ 4 x 5½" dia. Core bbl at 4.2' SS is either Hardinburg or (Penn) |
| | 6 | | | 4.6/5.0 | | Core Recovery — Run length |
| | 7 | | sdy clay, gnGr | 0.4 | | core loss (or 30:) |
| | | | clay, gnGr, carbonized veins | | | |
| | 8 | | clay lens | | | |
| | | | | | | Contact - 8.7' Golconda Fm |
| | 9 | | Shale, olive Gr + yBr, thi bd, flaky, wea (mostly ground away) | 9.2 | | |
| | | | | Run 2 0.4/1.2 | | |
| | 10 | | Limestone brGr, v hard crystalline, fossils | 0.8 | | Core bbl shaked ground away core |

PROJECT: HOLE NO.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

Figure 5.

**DRILLING LOG** | DIVISION | INSTALLATION | SHEET OF SHEETS

1. PROJECT: WELL INSTALLATION
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): WES 03-C 1-86
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | | | Well No: WES-3-C1-E6 (Beaver Bend Ls) | | | Date well screen was set: 12/12/86 |
| 627.5 | | | +2.7 | | | |
| 624.8 | | | 0.0' Ground surface | | | |
| | | | Grout mixture | | | Water level just Prior to setting Screen – 109.2' Note: small amount of water was leaking around casing tho' it did over seal in the Elwren Shale at the time of drilling the well. Higher than normal water level was due to this leakage from the Beach Creek Ls. |
| | | | 160.0' | | | |
| | | | Bentonite Pellets | | | |
| | | | 162.0 | | | |
| | | | Filter Pack | | | |
| 450.8 | | | 174.0' | | | |
| | | | Well Screen | | | |
| 440.8 | | | 184.0 | | | |
| | | | Trap | | | |
| | | | 185.0' | | | |
| | | | 197.2' Boring Depth | | | |

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Figure 6.

emplaced and grouted.

(3) Construction materials. The well riser pipe will consist of standard 2-in I.D. Schedule 40 PVC flush-fit threaded casing. Well screen will consist of 5- or 10-ft lengths of 2-in, 0.020-in slotted PVC. If groundwater sample analysis shows potential for problems with the use of PVC at the Demolition area, other material, such as Teflon or stainless steel, will be used to construct subsequent wells. Aquifer zones will be sealed off and casing emplaced using Portland cement with a bentonite seal. Siliceous coarse sand, certified clean and shipped to the site in sealed bags, will be used to fill the annulus around the screen in the aquifer zones and serve as a filter pack for the well.

(4) Construction locations. Locations and depths of wells were presented in section b.(5) of this document.

(5) Construction schedule. Well construction has already begun at the Demolition area for Phase II work.

(6) Construction procedures. Wells will be bored and emplaced in the following manner. Prior to the start of drilling and between setups at each of the boring sites the drill rig and drilling tools will be steam-cleaned. After setup the soil zone in each of the core borings will be sampled with a folding auger or hollow-stem auger down to refusal (top of rock). If the depth to refusal is less than approximately 11 ft (the depth needed to start coring with the HQ wire line core barrel), a 2-ft-long NX core barrel will be used to sample the rock to 11 ft. Remaining cores will be obtained with the wireline rig. A surface casing will be installed from approximately 6 inches above the ground surface to just below top of rock to prevent caving of the soil portion of the boring and to serve as surface protection. The surface casing will consist of 8- or 10-inch casing as needed and will extend well below the freeze depth.

Drill cuttings will be removed by circulating clean water in a steel mud pan sealed around the surface casing. Cuttings will be distributeed about the borehole on the ground unless sampling or other monitoring indicates the presence of elevated contaminant levels in the soil or rock. Contaminated cuttings will be placed in drums and treated as hazardous waste.The mud pan will be cleaned and refilled from the water truck when necessary. In borings penetrating more than one aquifer, the upper aquifer will be sealed off before advancing the boring. PVC casing will be grouted a few feet into the aquiclude stratum (usually shale) underlying the upper zone and allowed to set overnight. Downhole drilling equipment will be steam-cleaned before advancing into the next aquifer zone. In well borings penetrating three aquifer zones, typically an 8-inch surface casing will be followed by 6-inch casing in the next deeper zone and finally an open hole in the lower zone in which the 2-inch casing and screen are set.

Well screens will be set at the base of the well in lengths dependent on aquifer thickness. PVC riser pipe attached to the well screen will extend through the protective casing to approximately 2.5 ft above ground surface. The annulus of the screened section of the well and the entire thickness of the aquifer zone (the formation producing water) will be backfilled with siliceous sand. The sand willI be poured in slowly from the top of the well and checked for depth periodically with a tape measure. The filter sand will be brought up to the next higher aquiclude (shale stratum) and capped with a 3- to 5-ft thickness of bentonite pellets as a sealer. This method of well packing assures that no grout will be introduced out into the aquifer and thus

prevents potential clogging of the aquifer. The bentonite will be allowed to set 1/2 to 1 hour for swelling time, and the well will then be grouted to the surface above the bentonite. The grout will be piped into the well from the bottom up through a 3/4-in diameter pipe. A PVC vented cap will be placed atop the 2-inch riser. A steel cylindrical well cap with locking lid will be placed over the PVC riser and cemented into the surface casing to protect the well casing.

(7) Rationale for construction location. See section b.(8) above.

(8) Environmental conditions. See section b.(9) above.

(9) Decontamination procedures. See section b.(11) above.

(10) Documentation. See section b.(12) above.

(11) Well development procedures. The wells will be developed by alternating a surging and bailing technique. Surging will be done with a stainless steel rod with rubber washers attached at each end. The surging tool will be lowered into the well on 1/8-inch steel cable and pulled up and down to create a surging action in the well. The well will be bailed alternately with a 1-1/8-inch diameter, 5-ft long stainless steel bailer lowered by a stainless steel cable. The bailer will be operated by a portable wire-line winch straddling the well. The well will be bailed until the water from the well becomes relatively clear. Bailed water will be poured onto the ground away from the well casing unless sampling or other monitoring indicates the presence of elevated levels of contaminants in the water. Contaminated water will be placed in drums and treated as a hazardous waste.

(12) Soil classifications and description of cores. Soils encountered during drilling will be examined by a certified professional geologist at the site and classified under the Unified Soil Classification System (USCS). Any other characteristics of the soil, such as color, odor, or inclusions will also be noted and logged. Cores will be examined and classified by the geologist and their descriptions logged in a permanent field log (see Figure 4). The geologist will describe the lithology of the sample, grain size, color, texture, odor (if any) and will evaluate its in situ condition. He (or she) will note the presence of joints and other discontinuities, taking care to describe and measure open discontinuities capable of transmitting ground water. He will also note other descriptive features of the core that enable him to interpret the stratigraphy of the geologic units encountered at the Demolition area for correlation from well to well. The geologist will also note the presence of hydrologic indicators such as loss or gain of water during drilling, zones of oxidation in the core, and the presence and condition of potential confining strata such as shales or clays.

(13) Survey data. All well sites will be surveyed by certified professional surveyors. The top of casing of every well will be surveyed to determine its elevation (NGVD) and east-west coordinates using the Indiana State Plane Coordinate System. The surveyors will supply WES with all field survey data and a table of well elevations and locations.

d. RFI Phase II Quality Assurance/Quality Control (QA/QC) Plans.

The QA/QC documentation is in preparation.

e. RFI Phase II Data Management Plan.

(1). RFI Phase II Data Record. Records of data collected in the field and in the laboratory will be maintained indefinitely for the Demolition Area RFI in a dedicated file at WES. Some duplicate records will be maintained at

the NWSC. Field data records will include logs of all borings and the core or other samples extracted from them, well installation logs, results of any aquifer tests performed, memoranda for record of field visits, raw and corrected positioning survey data, and monitoring well sampling activities.

Each sample taken during the investigation will be assigned a unique number corresponding to the well or boring from which it was obtained. Well numbers will identify the SWMU (Demolition Area, Site 06) and the particular well in a cluster. An example of a well number would be 06C01P2, which identifies well P2 of cluster C01 of site 06. Water samples will be identified by well number, depth and date sampled. Each water sample will be assigned a laboratory analysis ID number by the contract laboratory.

(2). RFI Phase II Tabular Displays. Tables of data will be prepared for well information and water sampling and analysis events. Well information tables will list well numbers, dates installed, type of boring, total depth, elevation of well casing and ground, depth to screen and screen length, and identification of aquifer. Water level measurements for dates measured for each well will be tabulated. Tabulated water sampling data will include site, well number, date and depth sampled and laboratory analysis results for each parameter tested.

(3). RFI Phase II Graphical Displays. Graphical displays will include site maps showing well locations, topographic maps of the site, water table or piezometric surface contour maps of the aquifers encountered, contour maps of pertinent geologic structure, maps of ground-water contamination distribution in sampled aquifers, and other maps as needed. Line or bar graphs will be constructed to show variations in water or piezometric levels for different aquifers, for different wells, and for different dates. Graphs will also be constructed showing distribution in contaminant concentrations for different aquifers, wells and dates. Other graphs will be constructed as necessary.

f. RFI Phase II Health and Safety Plan.

**Background.** An initial assessment study of the NWSC conducted in 1981 to identify potential contamination sources determined that past activities at the NWSC have resulted in possible contamination of soil and ground water by potentially hazardous chemicals in several areas of the facility. The chemicals, by their presence in the soil and ground water, present a potential hazard to personnel conducting RFIs. RFI activities will require drilling of subsurface borings, installation of wells, and sampling of soils, rock and ground and surface waters. The health and safety plan is intended to (a) describe field activities to identify potential hazards associated with each activity, (b) insure safety consciousness by each individual involved with the field activities, (c) control exposure to potentially hazardous chemical compounds by specifying protective gear and monitoring procedures commensurate with the anticipated risk, and (d) provide emergency procedures in the event of unanticipated high contaminant concentrations, incident response, control and disposal of generated waste materials.

**Drilling and Well Installations.** Drilling and well installation operations will require a combination of up to four steps:

Step 1. Step 1 drilling will consist of dry auger boring using an Iwan or flight type auger. The drilling operation will extend to rock, to the water table, to unstable soil or to some other change of condition that requires a different drilling technique. Step 1 operations should produce no

appreciable dust and no liquid splash hazard. The operators will contact the drilled soil with their hands in removing the soil from the auger. The operators will be near the freshly cut and disturbed soils and thus could be subjected to the release of residual chemical vapors.

Step 2. Step 2 drilling will be by the air rotary method by which the material drilled is cut by the rotation of a cutter or bit while compressed air is pumped down through the drill pipe to cool the bit and remove the cuttings. The air escapes through the annulus of the drilled hole and carries the cuttings to the surface. Since rotary drilling requires fluid circulation, compressed air will be used instead of a liquid in Step 2 to reduce the risk of injecting contamination into the soils if site conditions require. Step 2 drilling will produce significant dust, but the dust ingestion and inhalation problem will be mitigated by an air jet eductor at the top of the boring which will draw much of the dust away from the drill operators. The air jet eductor will be positioned so as to blow the dust downwind from the operators. Step 2 drilling can submit the operators to chemical vapors released from the disturbed soils. However, the hazard is mitigated by dilution in the injected air and the effect of the air jet eductor.

Step 3. Step 3 drilling will be by the wet (water) rotary method, which is similar to Step 2 drilling except that the fluid is liquid and the working conditions are somewhat different. Dust problems are eliminated and some vapors are absorbed in the fluid. There is, however, a liquid splash and spill hazard. Chemical compounds in the fluid are somewhat diluted but can contact operators' skin.

Step 4. Step 4 operations will not involve drilling or other disturbing of the in situ materials. Step 4 will consist of the installation of monitoring wells and will entail setting well casing, placing filter materials, bentonite seals, and grouting of previously drilled borings. None of the potential hazards associated with Steps 1, 2, and 3 are anticipated. However, it is possible that vapor released from the subsurface soils will be present at the top of the boring and operators could contact and/or inhale the vapors.

**Other activities.** Other field activities that could expose personnel to contaminants include well sampling, well testing, and surface water sampling and flow measurement. Well sampling requires removal of several bore quantities of water from the well, the retention of a sample of the ground water entering the well, and preparation of the sample for shipment to the laboratory for analysis.

Well testing requires measuring the rate of flow of water being withdrawn from or injected into the aquifer through the well, for example by pumping tests or by slug tests, for the purpose of determining aquifer flow parameters. Well testing may also require measurement of water levels in monitoring wells near the pumping well. Because personnel may contact withdrawn ground water and be exposed to vapors emanating from the wells, potential splash and vapor ingestion hazards exist similar to those of Step 3 drilling operations.

Additional flow measurement may be required whereby surface waters in streams and water issuing from springs are sampled and the rate of flow determined. Concentrations of contaminants in surface waters will be decreased by dilution. Some dilution and aeration will also occur in spring

fed waters. Field personnel should nonetheless be alert for any signs of contamination such as discoloring of the water or the presence of odors or vapors.

A particular hazard to personnel exists at the Demolition Area as a result of demolition activities there. Explosive destruction of ordnance at the Demolition area produces blast waves and flying debris. All personnel are required to leave the vicinity of the Demolition area during demolition activities. Control of personnel evacuation is the responsibility of the range safety officer at the Demolition area.

Previous laboratory analysis of monitoring wells at the Demolition area has indicated the presence of only minor amounts of some heavy metals in the ground water. Unexpected releases to the air near the boreholes will be monitored by air monitoring devices as described below. Drilling will not be done in areas with potential buried unexploded ordnance or other hazardous materials.

**General Personnel Safety.** The monitoring and precautionary measures specified in the following paragraphs are considered reasonable and prudent for general field investigations planned for the RFI. Each employee will have a comprehensive physical examination within the 12 months preceding his/her field involvement to provide background information. Upon completion of the project, or annually, whichever occurs first, each employee will have a routine physical examination. Physical examinations will consist of the following:

a. Comprehensive Physical Examination. Basic health history, basic physical examination, routine EKG, chest X-ray, pulmonary function, audio testing, eye evaluation, hemoccult, Chem-screen 26, CBC w/differential, acetylcholinesterase activity, heavy metals in blood to include lead, cadmium, mercury, arsenic, chromium, and strontium; urinalysis.

b. Routine Physical Examination. Basic physical examination, resting EKG, chest X-ray, pulmonary function, SMA-26, urinalysis, audiometric.

**Air Monitoring.** The most common halogenated organic compounds in industrial use and OSHA allowable inhalation limits are listed in Table 3 (OSHA Safety and Health Standards 29CFR 1910).

Table 3. Limits of Exposure and Detection for Common Organic Solvents.

| Solvent | Maximum Allowable* Exposure, 8 hrs. | Sensitivity** Photoionization | Detection*** Limit |
|---|---|---|---|
| Benzene | 10 ppm | High | 5 ppm |
| 1,1 Dichloroethane | 100 ppm | High | - |
| 1,2 Dichloroethane | 200 ppm | High | - |
| Methylene Chloride | 500 ppm | High | 100 ppm |
| Trichloroethylene | 100 ppm | High | 2 ppm |

* OSHA Safety and Health Standards (29 CFR 1910) OSHA 2206

** HNu Model PI-101 with 11.7 ev lamp, HNu Systems, Newton, Mass.

*** Draeger Detector Tubes, National Draeger Inc., Pittsburg, PA

Air monitoring efforts will concentrate on monitoring for organic solvents and combustible gas. The presence of dust will be determined visually.

The presence of volatile organic compounds in the air at the drill location will be continuously monitored using a photoionization organic vapor detector (HNu Systems Model 101, Hazardous Waste Detector) and a combustible gas detector (Neotronics Meter, EXOTOX Model 40-OFH).

The photoionization unit is a non-specific detector that can semiquantitatively determine the concentration of a broad range of potentially hazardous organic compounds in the air. The unit will be calibrated relative to benzene concentration or to standards traceable to benzene. The unit will be set to provide an audible alarm at 75 percent of the threshold limit value (TLV) for benzene. The photoionization unit will be calibrated in accordance with manufacturer's recommendation and checked periodically for proper operation.

The combustible gas/respirable air unit is a catalytic and thermal conductivity unit that measures the concentration of flammable gas, hydrogen sulfide and oxygen levels in the air. The combustible gas sensor is calibrated on methane and will provide an alarm at 25 percent of the lower explosive limit (LEL) of methane in air. The combustible gas/respirable air unit will be calibrated before field work is started and semiannually throughout the period of use as recommended by the manufacturer.

a. Specific monitoring. The concentration of three common solvents (benzene, methylene chloride, and trichloroethylene) in the air will be determined at the drilling location at the beginning of the morning and afternoon work periods using colorimetric monitoring devices (detector tubes). The limits of detection of the colorimetric tubes are at or below 50 percent of the TLV in all cases. Records of readings will be maintained and correlated with readings from continuous monitoring devices.

b. Control of particulates. Dust generated from off-site locations could move over the drilling locations and other field activity areas intermittently. Dust will be generated by Step 2 drilling operations also on an intermittent basis. Monitoring for intermittently occurring particulates is of limited value. The effects of Step 2 drilling-generated dust will be mitigated by the use of an air jet eductor. Efforts to avoid ingestion of significant amounts of dust will include:

a. Physically avoiding the main stream concentration of dust.
b. Wetting down the work area as feasible.
c. Injecting water into drilling air stream if necessary.
d. Discontinuing work when dust cannot be adequately controlled.
e. Respirators with organic vapor cartridges and dust filters will be accessible at the drill location for each worker.

c. Action levels. In the event air monitoring indicates levels of combustible gas or organic vapors that exceed the action levels (Table 4), work will be suspended and the work site evacuated. A Crane NWSC industrial hygiene specialist will be brought onsite to define the specific hazard and specify necessary protective measures which will be implemented before work is resumed.

Table 4. Action Levels for Air Monitoring Instruments.

| Instrument | Level | Rationale |
|---|---|---|
| Photoionization | 40 ppm Benzene equivalent | 80 percent of OSHA threshold level for benzene, 8-hr exposure |
| Combustible gas | 1.25 percent methane, equiv. methane | 25 percent LEL* |

* Lower Explosive Limit

To permit a safe and orderly shutdown of operations and evacuation of the crew from the site, respirators with particulate filters and organic vapor cartridges will be issued and fitted by NWSC to each worker. Each respirator will be individually fitted to the crew member to whom it is issued. Respirators will be checked for serviceability, readiness and accessibility. Respirators will be kept in sealed plastic (Ziplock) bags.

**Limiting skin contact.** All persons involved in handling soil samples or equipment contaminated with soil from the work site will wear rubber gloves, safety-toe rubber boots, disposable coveralls, hard hats and safety glasses or face shields. Higher levels of protective clothing, such as Levels A, B, or C, will be issued and worn if or when working conditions require them. Protective equipment will be inspected daily. Worn or damaged equipment will be cleaned and discarded or disposed of as contaminated waste.

**Decontamination.** All tools and equipment contaminated by material from drill locations will be cleaned with high-pressure hot water or steam and/or commercial washing compounds and water when removed from that location. The intention is to limit the spread of contamination and prevent cross-contamination from one site to another. Wash water and waste from contaminated sites will be retained for disposal. Wash water and wastes will be tested for contaminants and disposed of in compliance with local requirements.

Well casings and screens and sampling and pumping apparatus will be thoroughly cleaned using high pressure hot water or steam before they are installed or placed in a boring. Filter material used will be clean natural gravel and/or sand that has been tested or certified to assure that no contaminants are introduced into the borings.

# APPENDIX

High Performance Liquid Chromatography (HPLC) Method for Determining Concentrations of Explosives in Water (Source: Jenkins, T.F., Miyares, P.H., and Walsh, M. E., 1988, "An improved RP-HPLC method for determining nitroaromatics and nitramines in water," Cold Regions Research and Engineering Laboratory, Special Report 88-23, September.

# Reversed-Phase HPLC Method for the Determination of Nitroaromatics and Nitramines in Water

## I. Summary

A. Analytes: The following analytes can be determined using this analytical method: HMX, RDX, 135TNB, 13DNB, 246TNT, 24DNT, 26DNT, NB, 2NT, 3NT, 4NT and TETRYL.

B. Matrix: This method is suitable for the determination of nitroaromatics and nitramines in a water matrix.

C. General Method: This method involves diluting the water sample 1:1 with methanol, mixing thoroughly, filtering and determining by reversed-phase HPLC on an LC-18 column, using an eluent of 1:1 (V/V) water-methanol, and UV detection at 254 nm.

## II. Application

A. Tested Concentration Range: This method was found to be linear over the following concentration ranges: HMX (10-203 μg/L) RDX (10-201 μg/L), 135TNB (2-40 μg/L), 13DNB (2-40 μg/L), 246TNT (2-36 μg/L), 24DNT (2-40 μg/L), 26DNT (2-40.1 μg/L), NB (3-64 μg/L), 2NT (11-214 μg/L), 3NT (11-221 μg/L), 4NT (13-256 μg/L), and TETRYL (9-184 μg/L).

B. Sensitivity: The response of the UV detector at 254 nm for the various analytes is presented below.

| Analyte | Sensitivity* |
|---|---|
| HMX | $9.5 \times 10^{-5}$ |
| RDX | $8.0 \times 10^{-5}$ |
| 135TNB | $7.2 \times 10^{-5}$ |
| 13DNB | $4.8 \times 110^{-5}$ |
| NB | $4.4 \times 10^{-5}$ |
| 246TNT | $4.3 \times 10^{-5}$ |
| 26DNT | $3.4 \times 10^{5}$ |
| 24DNT | $3.9 \times 10^{-5}$ |
| 2NT | $3.5 \times 10^{-5}$ |
| 3NT | $2.1 \times 10^{-5}$ |
| 4NT | $2.0 \times 10^{-5}$ |
| TETRYL | $2.6 \times 10^{-4}$ |

* Absorbance units at the Certified Reporting Limit.

C. Reporting Limits: Certified Reporting Limits (CRL) for the following analytes were determined over a 4-day period using the method of Hubaux and Vos as described in the USATHAMA Installation Restoration Program Quality Assurance Program (1987). CRL values for the various analytes are given below.

| Analyte | Certified Reporting Limit (μg/L) |
|---|---|
| HMX | 13 |
| RDX | 14 |
| 135TNB | 7.3 |
| 13DNB | 4.0 |
| NB | 6.4 |
| 246TNT | 6.9 |
| 26DNT | 9.4 |
| 24DNT | 5.7 |
| 2NT | 12 |
| 3NT | 7.9 |
| 4NT | 8.5 |
| TETRYL | 44 |

D. Interferences: Either 24DNT or 26DNT can be determined using this protocol, however, their retention times differ by only 0.2 min. Thus a large amount of either would preclude the low level determination of the other. The method was also qualitatively tested for a number of potential interferences. Retention times for certified analytes and potential interferences on LC-18 and LC-CN are presented in Table 1. Use of LC-CN for second column confirmation has proven satisfactory.

Table 1. Retention times and capacity factors for primary analytes and potential interferences on LC-18 and LC-CN columns eluted with 1:1 V\V water-methanol at 1.5 mL/min.

| | Retention Time (min) | | Capacity Factor (k)* | |
|---|---|---|---|---|
| Substance | LC-18 | LC-CN | LC-18 | LC-CN |
| HMX | 2.44 | 8.35 | 0.49 | 2.52 |
| RDX | 3.73 | 6.15 | 1.27 | 1.59 |
| 135TNB | 5.11 | 4.05 | 2.12 | 0.71 |
| 13DNB | 6.16 | 4.18 | 2.76 | 0.76 |
| 246TNT | 8.42 | 5.00 | 4.13 | 1.11 |
| 24DNT | 10.05 | 4.87 | 5.13 | 1.05 |
| TETRYL | 6.93 | 7.36 | 3.23 | 2.11 |
| NG | 7.74 | 6.00 | 3.72 | 1.53 |
| NB | 7.23 | 3.81 | 3.41 | 0.61 |
| 3NT | 14.23 | 4.45 | 7.68 | 0.88 |
| 4NT | 13.26 | 4.41 | 7.09 | 0.86 |
| 2NT | 12.26 | 4.37 | 6.48 | 0.84 |
| 2ADNT | 9.12 | 5.65 | 4.56 | 1.38 |
| 4ADNT | 8.88 | 5.10 | 4.41 | 1.15 |
| SEX | 2.40 | 5.07 | 0.46 | 1.14 |
| TAX | 2.78 | 3.70 | 0.70 | 0.56 |
| 245TNT | 8.44 | 5.89 | 4.15 | 1.49 |
| 24DANT | 3.16 | 4.20 | 0.93 | 0.77 |
| 26DANT | 2.39 | 3.70 | 0.46 | 0.56 |
| 26DNT | 9.82 | 4.61 | 4.99 | 0.95 |
| Benzene | 11.22 | 3.48 | 5.84 | 0.47 |
| Toluene | 23.0 | 3.93 | 13.02 | 0.66 |

* Capacity factors are based on an unretained peak for nitrate at 1.71 min on LC-18 and 2.00 min on LC-CN.

E. Analysis Rate: Approximately 25 samples and working standards can be prepared and analyzed in an 8-hour day provided that stock solutions are already prepared and that the instrumentation is equipped with an auto sampler.

F. Safety Information: The normal safety precautions appropriate to use of flammable organic solvents should be employed.

## III. Apparatus and Chemicals

A. Glassware/hardware:

1) Filters: 0.5-μm Millex-SR, disposable (1/sample).

2) Pippettes: 50 mL (1), 10 mL (2), 5 mL (20), 4 mL (1), 2 mL (2), 1 mL (8) volumetric, glass.

3) Volumetric flask: 100 mL (14), 250 mL (6), 200 mL (6), 50 mL (2).

4) Scintillation vials: 20 mL, glass (2/sample).

5) Auto sampler vials: glass (Septa Teflon faced) (1/sample).

6) Disposable springs: Plastipak, 10 mL (1/sample).

B. Instrumentation:

1) HPLC Perkin Elmer Series 3 or Spectra-Physics SP8810 pump (or equivalent), an injector equipped with a 100-μL injection loop and a Spectra-Physics SP8490 UV detector set at $\lambda$ = 254 nm (or equivalent fixed UV-254 or variable set at 254 nm). Both RP-HPLC columns are eluted at 1.5 mL/min with a 1:1 V/V methanol-water eluent.

2) Strip chart recorder (Linear 500 or equivalent).

3) Digital Integrator (HP3393A or equivalent).

4) Autosampler (optional) (Dynatech Model LC-241 or equivalent).

5) LC-18 (Supelco) RP-HPLC column 25-cm x 4.6-mm (5 μm).

6) LC-CN (Supelco) RP-HPLC column 25-cm x 4.6-mm (5 μm).

C. Analytes:

1) HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
BP: decomposes
MP: 282°C
Solubility in water at 22.5°C: 5.0 μg/L
Octanol/water partition coefficient: 1.3
CAS #2691-41-0.

2) RDX (hexahydro-1,3,5-trinitro, 1,3,5-tetrazine)
BP: decomposes
MP: 203.5°C
Solubility in water at 25°C: 60 μg/L
Octanol/water partition coefficient: 7.5
CAS #121-82-4.

3) 135TNB (1,3,5-trinitrobenzene)
BP: decomposes
MP: 122°C
Octanol/water partition coefficient: 15
CAS #25377-32-6.

4) 13DNB (1,3-dinitrobenzene)
BP: 302°C
MP: 90°C
Octanol/water partition coefficient: 31
CAS #99-63-01.

5) TETRYL (methyl 2,4,6-trinitrophenylnitramine)
BP: 187°C
MP: 131°C
Octanol/water partition coefficient: 43
CAS #479-45-8.

6) 246TNT (2,4,6-trinitrotoluene)
BP: 280°C (explodes)
MP: 80.1°C
Solubility in water: 130 mg/L
Octanol/water partition coefficient: 68
CAS #118-96-7.

7) 24DNT (2,4-dinitrotoluene)
BP: 300°C (decompose)
MP: 70°C
Solubility in water: 300 mg/L
Octanol/water partition coefficient: 95
CAS #121-14-2.

8) 26DNT (2,6-dinitrotoluene)
MP: 66°C
Octanol/water partition coefficient: 97
CAS # 606-20-2.

9) NB (nitrobenzene)
BP: 211°C (Flashpoint 88°C)
MP: 5.7°C
Solubility in water: 2 g/L
Octanol/water partition coefficient: 71
CAS #98-95-3.

10) 2NT (ortho-nitrotoluene)
BP: 225°
MP: -4 to -3°C
Octanol/water partition coefficient: 171
CAS #88-72-2.

11) 4NT (para-nitrotoluene)
BP: 238°
MP: 54°C
Octonal/water partition coefficient: 202
CAS #99-99-0.

12) 3NT (meta-nitrotoluene)
BP: 231°
MP: 15°C
Octonal/water partition coefficient: 263
CAS #99-08-1.

D. Reagents and SARMS:

1) HMX-SARM quality
2) RDX-SARM quality
3) TNB-SARM quality
4) DNB-SARM quality
5) TETRYL-SARM quality
6) TNT-SARM quality
7) 24DNT-SARM quality
8) 26DNT-SARM quality
9) NB-SARM quality
10) 2NT-Reagent grade
11) 3NT-Reagent grade
12) 4NT-Reagent grade
13) Methanol-HPLC grade
14) Water-regents grade

## IV. Calibration

A. Preparation of Standards: Standards for each analyte were dried to constant weight in a vacuum desicator in the dark. About 0.1 gm (100 mg) of each dried SARM was weighed out to the nearest 0.1 mg and transferred to individual 100-mL volumetric flasks and diluted to volume with HPLC grade

acetonitrile. Stock standards are stored in a refrigerator at 4°C in the dark. Stock standards are usable for periods up to a year after the date of preparation.

If both 24DNT and 26DNT are to be determined, two separate combined analyte stock standards must be prepared. For stock standard #1, 10.0 mL of the HMX and RDX stock standards and 5.0 mL of the 135TNB, 13DNB, NB, 246TNT and 24DNT stock standards are combined in a 500-mL volumetric flask and diluted to volume with methanol. This solution contains 20,000 μg/L of HMX and RDX and 10,000 μg/L of 135TNB, 13DNB, NB, 246TNT and 24DNT. Stock solution #2 is prepared by combining 10.0 mL of the TETRYL and 5.0 mL of the 26DNT, 2NT, 3NT and 4NT stock solutions in a 500-mL volumetric flask and diluting to volume with methanol. This solution contains 20,000 μg/L of TETRYL and 10,000 μg/L of 26DNT, 2NT, 3NT and 4NT.

A 10.0-mL aliquot of combined stock standard #1 is pipetted into a 100-mL volumetric flask and diluted to volume with methanol, giving a concentration of approximately 2000 μg/L HMX and RDX, and approximately 1000 μg/L of the remaining analytes. This solution will be referred to as Solution A. In a similar fashion, a 10.0-mL aliquot of combined stock standard #2 is diluted to 100 mL with methanol giving a concentration of 2000 μg/L of TETRYL and 1000 μg/L of 26DNT, 2NT, 3NT and 4NT. This solution will be referred to as solution AA.

From Solution A and AA, two identical series of working standard are prepared as described below.

Calibration Standards

| STD | Aliquot of Solu. A (mL) | Size of Vol. Flask (mL) | Solution Conc. (µg/L) HMX, RDX | Solution Conc. (µg/L) 135TNB, 13DNB, NB 246TNT, and 24DNT |
|---|---|---|---|---|
| B | 25.0 | 50 | 1000 | 500 |
| C | 25.0 | 100 | 500 | 250 |
| D | 10.0 | 100 | 200 | 100 |
| E | 5.0 | 100 | 100 | 50 |
| F | 5.0 | 200 | 50 | 25 |
| G | 1.0 | 100 | 20 | 10 |
| H | 10.0 of E | 100 | 10 | 5 |
| I | 5.00 of E | 100 | 5 | 2.5 |

Calibration Standards

| STD | Aliquot of Solu. AA (mL) | Size of Vol. Flask (mL) | Solution Conc. (µg/L) TETRYL | Solution Conc. (µg/L) 26DNT, 2NT, 3NT and 4NT |
|---|---|---|---|---|
| BB | 25.0 | 50 | 1000 | 500 |
| CC | 25.0 | 100 | 500 | 250 |
| DD | 10.0 | 100 | 200 | 100 |
| EE | 5.0 | 100 | 100 | 50 |
| FF | 5.0 | 200 | 50 | 25 |
| GG | 1.0 | 100 | 20 | 10 |
| HH | 10.0 of EE | 100 | 10 | 5 |
| II | 5.00 of EE | 100 | 5 | 2.5 |

B. Initial Calibration: All of the standards are diluted 5/5 (V/V) with water in scintillation vials and well shaken (by hand) before analyzing. Duplicate injections of each standard over the concentration range of interest are made in a random order. Peak areas or peak heights are obtained for each analyte. Retention times for the analytes under these conditions are presented in Table 1.

C. Analysis of Calibration Data: The acceptability of a linear model with zero intercept is assessed using the protocol specified in the USATHAMA QA Program (2nd Edition, March 1987). Experience indicates that a linear model with a zero intercept is appropriate. Thus the slope of the best fit

regression line is equivalent to a response factor that can be compared with values obtained from replicate analyses of a single standard each day.

D. Daily Calibration: Standards B and BB, described above, are used for daily calibrations after each are diluted 5/5 (V/V) with water. Standards B and BB can be used for a period of 28 days after preparation. Standards are analyzed in triplicate at the beginning of each day, singly after the last sample of the day, and singly at the midway point of the analysis of each day. Response factors for each analyte are obtained over the course of the day and compared with the response factors obtained for the initial calibration.

The mean response factors for daily calibration must agree within ± 25% of the response factors obtained for the initial calibration for the first seven calibrations. Subsequently, response factors must agree within two standard deviations of the initial calibration. If these criteria are not met, a new initial calibration must be obtained.

## V. Certification Testing

Individual analyte certification stock solutions are prepared in an identical manner to that described for the calibration stock standards. As with calibration standards, two sets of certification solutions are required if 26DNT and 24DNT or NB and TETRYL are to be included. Combined analyte stock certification standard solutions are also prepared in the manner described for the combined calibration stock standards.

From the combined certification stock solutions, 25.0-mL aliquots are pipetted into individual 500-mL volumetric flasks and diluted to volume with reagent grade water, giving solutions with concentrations of approximately

1000 μg/L of HMX, RDX and TETRYL and approximately 500 μg/L of the remaining analytes.

A series of diluted certification solutions are prepared from these solutions by diluting with water as follows:

Certification Solutions

| Level | Aliquot of Solu. A (mL) | Size of Vol. Flask (mL) | Certification Solution 1 (μg/L) HMX, RDX | Certification Solution 1 (μg/L) 135TNB, 13DNB, NB 246TNT, 24DNT | Certification Solution 2 (μg/L) TETRYL | Certification Solution 2 (μg/L) 26DNT, 2NT, 4NT, 3NT |
|---|---|---|---|---|---|---|
| 50X | - | - | 1000 | 500 | 1000 | 500 |
| 70X | 100.0 | 250 | 400 | 200 | 400 | 200 |
| 10X | 50.0 | 250 | 200 | 100 | 200 | 100 |
| 5X | 25.0 | 250 | 100 | 50 | 100 | 50 |
| 2X | 10.0 | 200 | 40 | 20 | 40 | 20 |
| 1X | 5.0 | 200 | 20 | 10 | 20 | 10 |
| 0.5X | 10.0 mL or 5X | 100 | 10 | 5 | 10 | 5 |

Certification test samples are processed as described below.

VI. Sample/Solution Storage

Combined stock standards should be refrigerated at 4°C, stored in the dark and be used within 30 days of preparation. Certification solutions and samples should be prepared the day of the analysis.

VII. Procedure:

A. Sample Preparation: Samples and certification solutions are prepared for analysis by combining a 5.00-mL aliquot with an equal volume of methanol in scintillation vials, shaking thoroughly and filtering through 0.5-μm Millex-SR filters. The first 3 mL of solution is discarded, and the remainder is collected in a clean scintillation vial. These filtered solutions will be referred to as sample solutions.

B. Determination: Determination of analyte concentration in the sample solutions is obtained by RP-HPLC-UV at 254 nm. A 100-$\mu$L injection loop is flushed with 500 $\mu$L of sample solution and injected onto an LC-18 column eluted with 1.5 mL/min of 1:1 V/V methanol-water. Retention times and capacity factors for the analytes of interest and a number of potential interferences are given in Table 1 for both LC-18, the primary column, and LC-CN, the confirmation column. Chromatograms obtained for the primary analytes are shown in Figure 1.*

## VIII. Calculation

A. Response factors: Since a linear calibration curve with zero intercept is to be expected, calculations of results on a daily basis are obtained using response factors calculated for each analyte. The mean response ($\bar{R}$) for each analyte from repeated determinations of Standards B and BB is obtained in either peak area or peak height units. The response factor (RF) for each analyte is obtained by dividing the mean response by the known concentration (C) in units of $\mu$g/L

$$RF = \frac{\bar{R}}{C} \quad . \qquad (1)$$

B. Analytical Concentration: The concentrations ($\mu$g/L) of each analyte ($C_a$) are obtained by dividing the response for each analyte ($R_a$) by the appropriate response factor ($RF_a$)

$$C_a = \frac{R_a}{RF_a} \quad . \qquad (2)$$

* Editor's note: included here as the bottom portion of Figure 2.

## IX. Daily Quality Control

A. Control spikes: Spiked water samples are prepared as described for Class 1 method in the USATHAMA QA Program (2nd Edition, March 1987). This requires the use of a method blank, a single spike at two times the certified reporting limit and duplicate spikes at ten times the certified reporting limit for each analytical lot. Control spikes are prepared using the appropriate spiking solution in an identical manner as described in Section V.

B. Control Charts: The control charts required are described for Class 1 methods in USATHAMA QA Program (2nd Edition, March 1987). This will require use of standard Shewhart $\overline{X}$ and R charts for the duplicate high spike and moving average $\overline{X}$ and R charts for the single low spike. Details on the charting procedures required are specified in USATHAMA QA Program (2nd Edition, March 1987).

☆ U. S. GOVERNMENT PRINTING OFFICE: 1988--600-057--82059

Corrective Action Work Plan
RCRA Facility Investigation Phase III
Release Assessment, Ground Water
Old Rifle Range (Site 07), Crane NWSC

1. Task A: RFI Phase III Work Plan.

a. RFI Phase III Project Management Plan.

The U.S. Army Engineer Waterways Experiment Station (WES) will perform a RCRA Facility Investigation (RFI) Phase III Release Assessment (ground water) for the Crane Naval Weapons Support Center (NWSC), Crane, Indiana, at the Old Rifle Range (ORR) Solid Waste Management Unit (SWMU). This site was previously designated as Corrective Action Plan (CAP) Site Number 07 (Figs 1 and 2). This document outlines the objectives of the RFI, discusses the technical approach, quality assurance/quality control measures, and personnel to be used in the RFI, and provides a schedule of work to be performed.

Objective. The objective of the Phase III work is to determine the rate and extent of migration of hazardous waste or hazardous constituents in the ground water. Phase III work will also further define ground-water flow patterns, identify aquifers at the site, and delineate the hydrogeology at the site.

Technical Approach. Groundwater monitoring wells will be installed, exploratory borings emplaced, and other subsurface investigations conducted to assess ground-water flow characteristics and the extent of contamination. Techniques to measure rate of contaminant migration will be determined from site specific conditions. If a pumping test is needed, a pumping well and observation wells will be installed. Other possibilities include falling head tests or dye tracer tests. The dye tracer test would be feasible only if large fractures or solution cavities are encountered during the coring operations.

Quantitative chemical analysis of existing and proposed monitoring wells and surface waters will be conducted for specific compounds. Geologic and ground-water profiles will be prepared from monitoring well and other data showing the orientation of the subsurface geologic units. Ground-water level contour maps will be prepared showing direction of flow and lateral extent of contamination. The details of drilling and sampling activities to be conducted during the Phase III work are presented below.

Personnel. Phase III ground-water work will be conducted by WES personnel, other CE personnel, or contractors approved by Crane working under WES supervision. All personnel working at the site will be trained in personal protection and safety and will have had a comprehensive physical examination within the 12 months preceding their involvement in the field work (see Health and Safety Plan, Part f). An organization chart of key personnel is presented in Table 1.

Schedule. The Phase III ground-water plan will be submitted by 22 May 1990. The Regional Administrator will approve, modify and approve, or disapprove and provide comments to the Permittee as to the corrections or modifications needed for the RFI Phase III Work Plan. Within 30 days after receiving comments from the Regional Office, the Permittee must modify or submit a new plan for approval. The

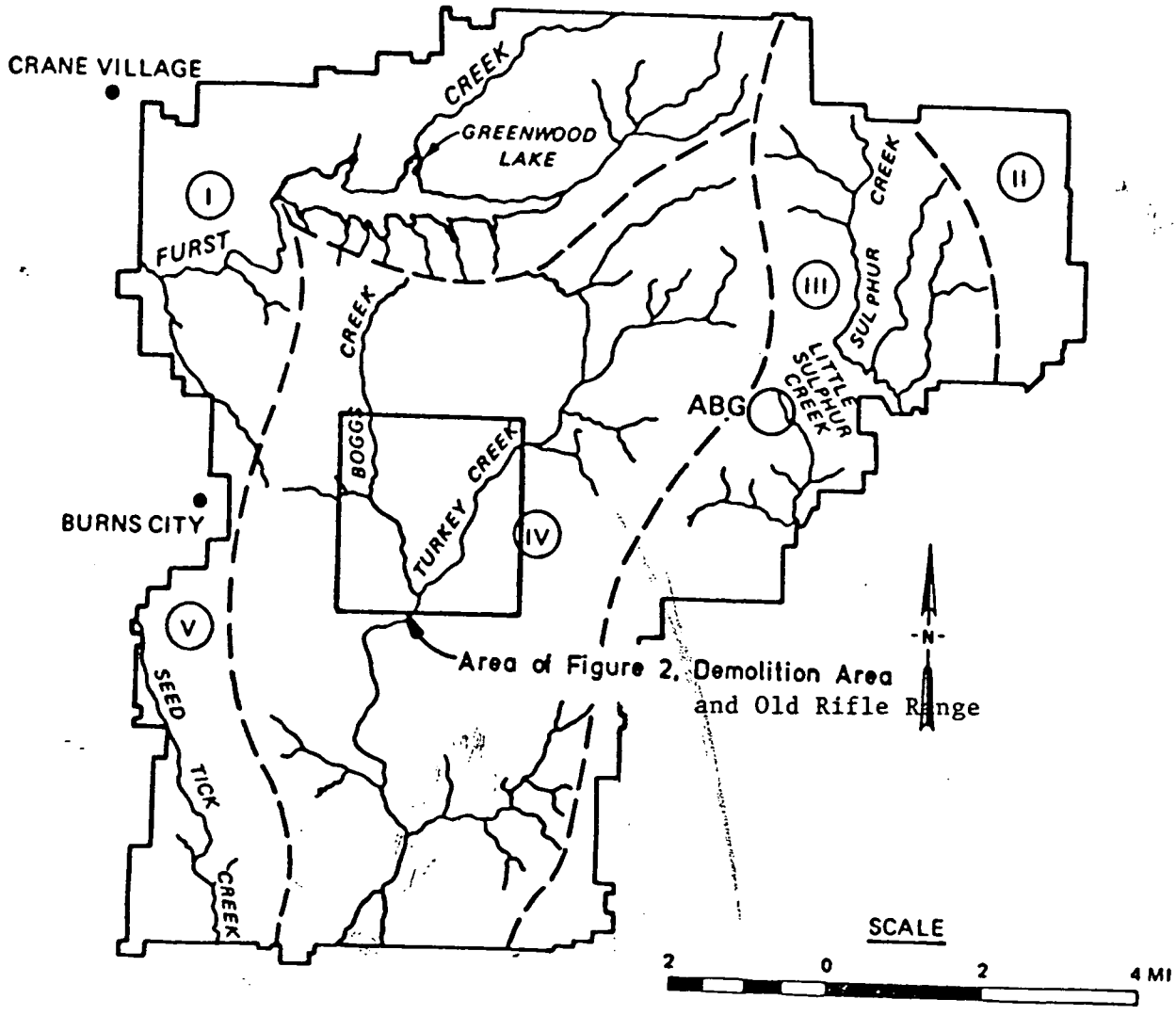
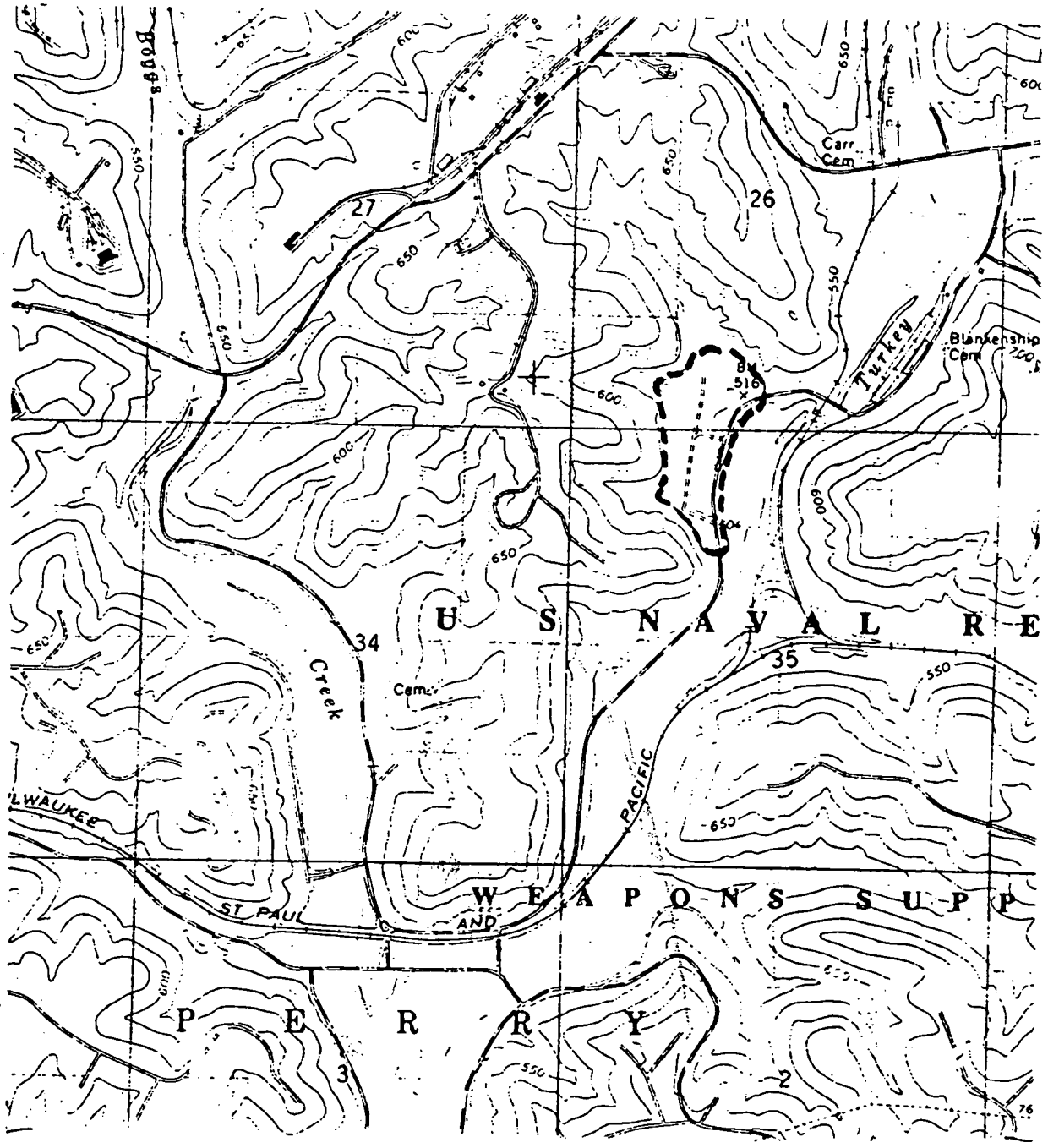

CRANE VILLAGE
CREEK
GREENWOOD LAKE
I
FURST
CREEK
II
CREEK
III
SULPHUR
LITTLE SULPHUR CREEK
ABG
BOGGS
TURKEY CREEK
IV
BURNS CITY
V
SEED
TICK
CREEK
Area of Figure 2, Demolition Area and Old Rifle Range
N
SCALE
2
0
2
4 MI

Figure 1

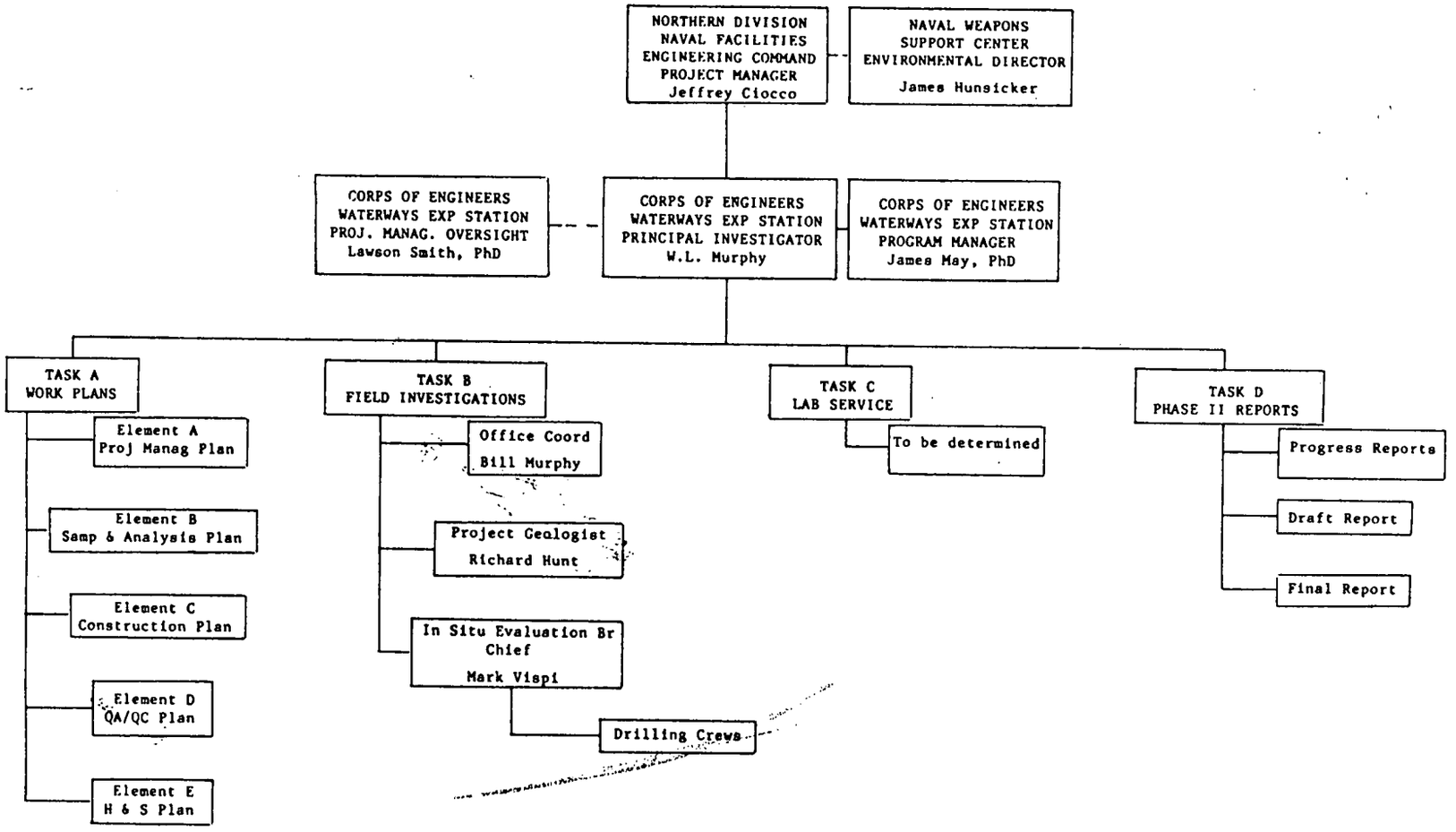



Approximate limits of Old Rifle Range

0 2000
Scale, FT

Figure 2

TABLE 1. RCRA FACIL[illegible]TIGATION, PHASE II GROUND WATER
[illegible]ION AREA
PROJECT O[illegible]IZATION CHART




particular cluster site if additional water-producing zones are encountered. The

Table 2. Ground-Water Sampling Summary, Old Rifle Range Phase III

| PARAMETER | SAMPLES (27 wells) | FIELD DUPS (10% of samples) | QC BLANKS Trip Blks 1/day | QC BLANKS Field Blnks 1/day | EQUIP. RINSATE 1/day |
|---|---|---|---|---|---|
| Appendix IX | 27 | 3 | 3 volatiles | 1 | 3 |
| Explosives by HPLC | 27 | | | | |
| Group III | | | | | |
| pH (quad) | 108 | | | | |
| conductivity (quad) | 108 | | | | |

wells that will extend to the Elwren shale will be up to 60 ft deep. Wells screened in the water table could be as shallow as 10 ft. Water table contour maps by Dunbar 1984, indicate local ground-water flow is to the east toward Turkey Creek. However, recently aquired data from the nearby Demolition Area indicate the regional flow from the ORR could be toward the west. The influence of a suspected buried channel or thick soil sequence on the rate and extent of contaminant movement at the ORR will be addressed.

A preliminary background well location will be established as soon as feasible. The suitability of one of the existing wells for the background well will be assessed.

Water quality samples will be collected in five consecutive rounds on a quarterly frequency as required by the CAP.

(6). Sampling Schedule. The ground-water sampling schedule will depend on the date of implementation of the Phase III work plan. The time-line for Old Rifle Range Phase III ground water assessment is presented in Figure 3.

(7). Sampling Procedures. Monitoring well sampling procedures are described in detail in section B.1.d of this document (QA/QC, in preparation). Soil and rock sampling will be conducted from a truck-mounted rotary drilling rig. Rock cores will be collected continuously using a diamond-bitted HQ wire-line core barrel (HQ wireline retrieves a 2-1/2-in. diameter core from a 3-3/4-in. diameter borehole). The wireline coring technique has been shown during previous drilling/sampling work at Crane to be effective in obtaining high quality core .

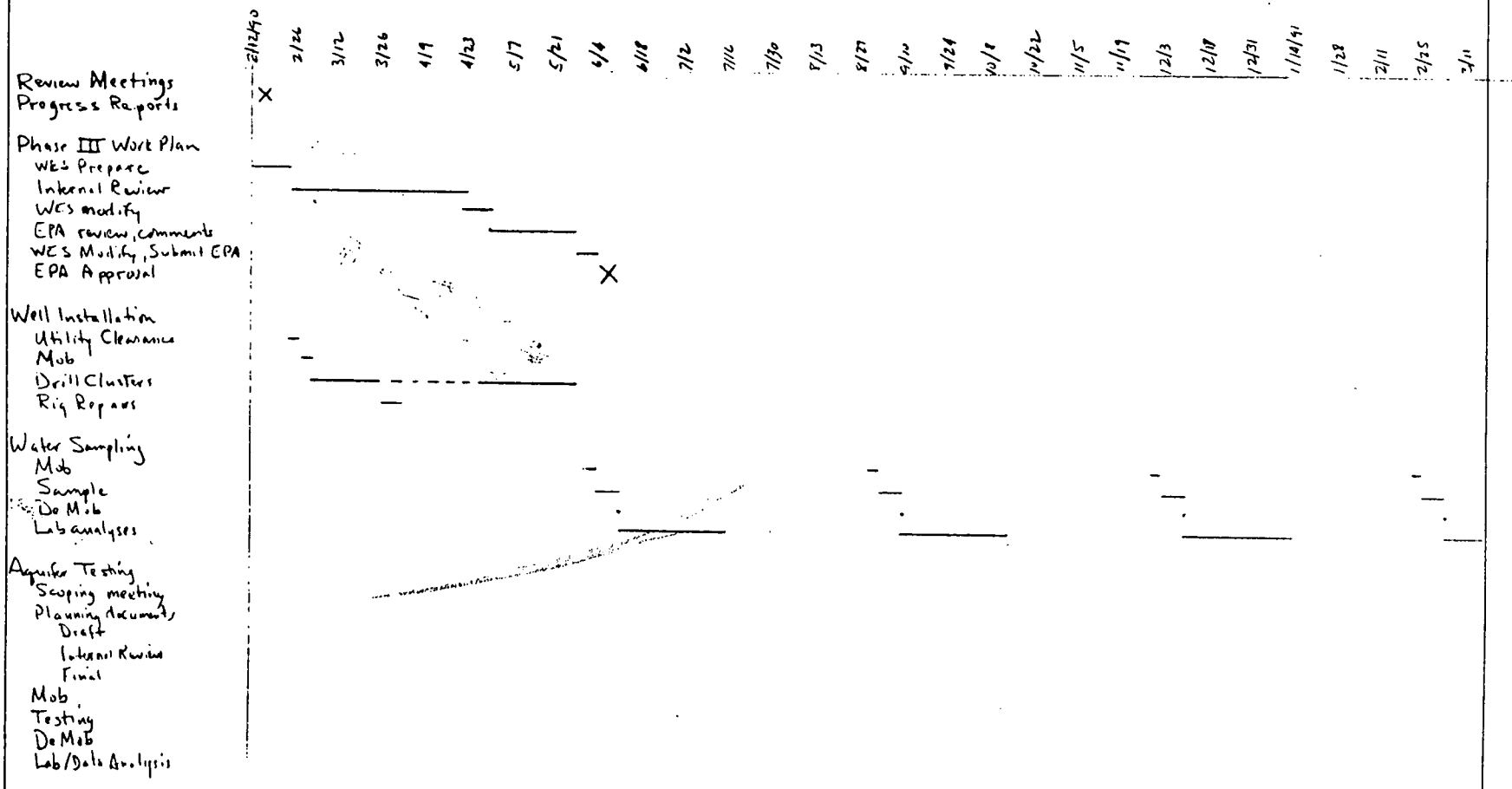
Drilling water is currently drawn from the water treatment plant at the Crane installation which draws its potable water from Lake Greenwood located within the NWSC boundaries. Prior to the start of drilling, the drill rig and appurtenances will be steam-cleaned. Drill cuttings will be removed from the boring by circulating clean water from a steel mud pan sealed around the boring top to prevent contamination of the subsurface from surface runoff. The mud pan will be cleaned and refilled periodically as conditions warrant. In borings penetrating more than one aquifer, the upper zones will be sealed before the boring is advanced. PVC casing will be grouted 3 to 5 ft into the confining stratum at the base of the aquifer and allowed to set overnight before advancing the boring. The boring will then be advanced through the upper casing and grout and smaller casing will be set for drilling the next aquifer.

(8). Rationale for Sampling Location and Choice of Analytes. The locations of the well clusters are based on the previous work at the ORR and the recent work at the Demolition Area. The analytes to be sampled include the explosives TNT, RDX, and HMX and the metals arsenic, chromium, and barium. The ORR was used for bomb cook-off testing and open burning. The high explosive bulk and loaded projectiles were burned in clay lined steel pans. Black powder and red and white phosphorous reportedly had been destroyed in the area. Contamination in the area would be from explosive residues and their by-products. Ten wells were drilled in the Old Rifle Range in 1983. Sampling and analysis of ground water from those wells yielded occasional detection of RDX and TNT in two of the wells.

(9). Environmental Conditions at the Time of Sampling. Environmental conditions at the ORR are affected by activities at the nearby Demolition Area, open burning of munitions at the ORR, and by potential release to the air of contaminants

SUBJECT: NWSC Crane Old Rifle Range (Site 07)
RFI Phase III Groundwater [illegible]

COMPUTED BY: DATE:
CHECKED BY: DATE:

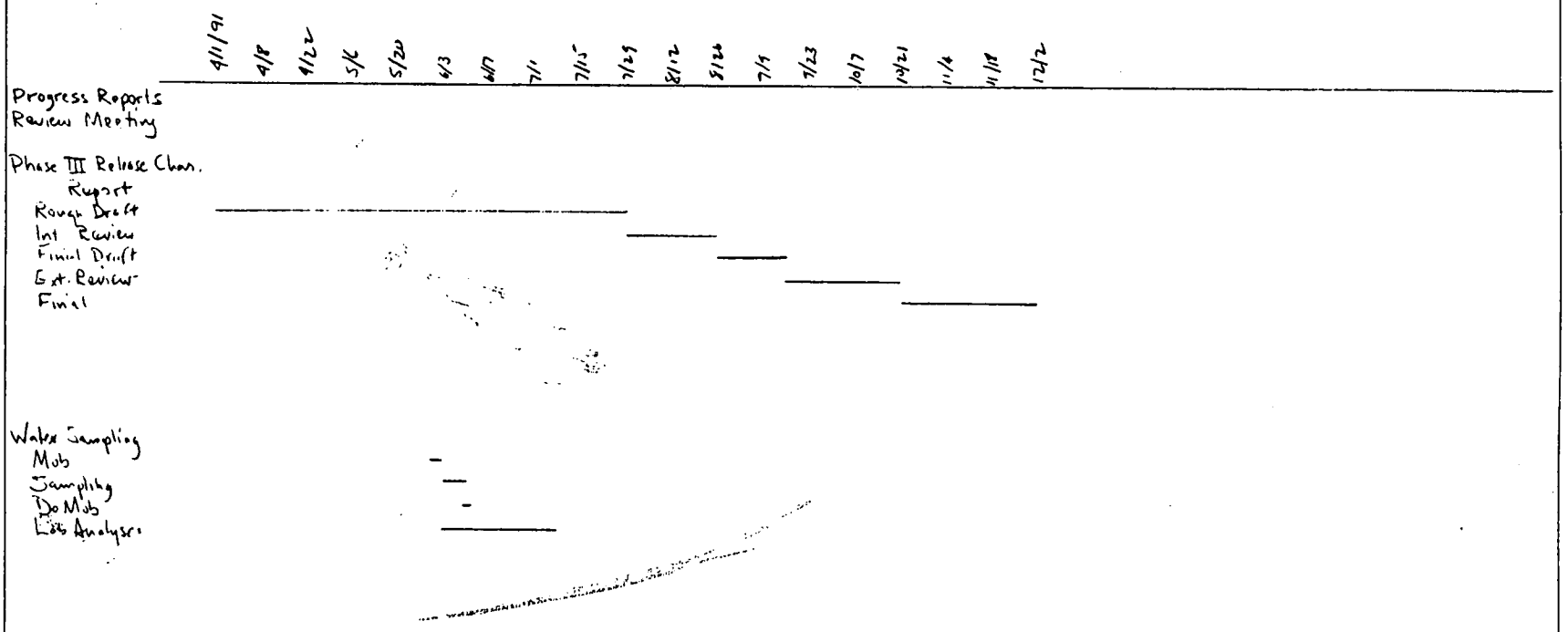



WES FORM NO. 1253A
DECEMBER 1964



FIGURE 3

| SUBJECT: | COMPUTED BY: | DATE: |
|---|---|---|
| OLD RIFLE RANGE (SITE 07) (CON'D) | CHECKED BY: | DATE: |




WES FORM NO 1253A
DECEMBER 1964



FIGURE 3 (CONT'D)

released by boring operations. The presence of volatile organic compounds in the air at the drill locations will be continuously monitored using a photoionization organic vapor detector and a combustible gas detector. Dust will not be released by drilling operations because drilling is done with water.

(10). Chain-of-Custody Forms and Procedures. Chain-of custody is described in section d. (QA/QC).

(11). Decontamination Procedures. Decontamination procedures for water sampling are described in detail in Part I of section d (QA/QC). Decontamination of the drilling and coring equipment will consist of steam- cleaning the drilling rig and appurtenances before the start of a new boring. In addition, the down-hole equipment such as drill rods, rock bits, and core barrels will be steam-cleaned after sealing of a ground-water zone and before advancing through the aquiclude to the next aquifer.

(12). Documentation. Ground-water sampling logs will be kept as described in the QA/QC document. Soil and rock sampling logs will be kept for each borehole and well as the borehole is advanced. Figures 4, 5, and 6 are examples of soil sampling, rock sampling, and well installation logs typically prepared during field operations. All sampling activities, methods, and analytical results will be presented in written reports at the end of the RFI for the ORR.

(13). Calibration of Field Devices. Calibration of the air-monitoring devices is described in the Health and Safety Plan (part f. of this document).

(14). Sample Preservation. Ground-water sample preservation methods are described in the QA/QC document. Soil and rock core samples collected for geologic analysis are stored in lidded jars and wooden core boxes respectively.

c. RFI Phase III Construction Plan.

(1). Objective of Construction of Monitoring/Sampling Wells. Monitoring wells will be installed in and around the Old Rifle Range Area to provide monitoring of ground water and samples for chemical analysis. Wells also provide access to aquifers for determining the aquifer parameter needed to calculate the rate and extent of contaminant movement. Wells will be positioned to define and intercept contaminant transport paths and to describe and monitor flow away from the ORR. Wells will be constructed with materials and methods designed to prevent addition of contaminants to the well environment and cross-contamination of individual aquifers.

(2). List of Equipment. Drilling of all well borings will be with a truck-mounted Failing 1500 hydraulic drill rig or equivalent. Flight augers or hollow stem augers will advance the hole through soil overburden until rock is encountered. Diamond-impregnated HQ-sized wireline core bit and barrel will drill and retrieve the core samples. Standard rotary rock bits will be used to advance the boring in a non-sampled borehole (only the first and deepest well boring of a cluster of wells is cored and logged). A stainless steel bailer will be used to develop the well after the screen and casing are emplaced and grouted.

(3). Construction Materials. The well riser pipe will consist of standard 2-in. I.D. Schedule 40 PVC flush-fit threaded casing. Well screen will consist of 5-ft, 10-ft, or 20-ft lengths of 2-in., 0.020-in. slotted PVC. If ground-water sample analysis shows potential for problems with the use of PVC at the ORR area,

other material, such as teflon or stainless steel, will be used. Aquifer zones will be sealed off and casing emplaced using Portland cement with a bentonite seal. Siliceous coarse sand, certified clean and shipped to the site in sealed bags, will be used to fill the annulus around the screen in the aquifer zones and serve as a filter pack for the well.

(4). Construction Locations. Locations and depths of wells were presented in section b.5. of this document.

(5). Construction Schedule. The well installation is scheduled to start in March 1990.

(6). Construction Procedures. Wells will be bored and emplaced in the following manner. Prior to the start of drilling and between setups at each of the boring sites the drill rig and drilling tools will be steam-cleaned. After setup, the soil zone in each of the core borings will be sampled with a folding auger or hollow-stem auger down to refusal (top of rock). If the depth to refusal is less than approximately 11 ft (the depth needed to start coring with the HG wire line core barrel), a 2-ft-long NX core barrel will be used to sample the rock to 11 ft. Remaining cores will be obtained with the wireline rig. A surface casing will be installed from approximately 6 inches above the ground surface to just below top of rock to prevent caving of the soil portion of the boring and to serve as surface protection. The surface casing will consist of 8-in. or 10-in. casing as needed and will extend well below the freeze depth.

Drill cuttings will be removed by circulating clean water in a steel mud pan sealed around the surface casing. Cuttings will be distributed about the borehole on the ground unless sampling or other monitoring indicates the presence of elevated contaminant levels in the soil or rock. Contaminated cuttings will be placed in drums and treated as hazardous waste. The mud pan will be cleaned and refilled from the water truck as necessary. In borings penetrating more than one aquifer, the upper aquifer will be sealed off before advancing the boring. PVC casing will be grouted a few feet into the aquiclude stratum (usually shale) underlying the upper zone and allowed to set overnight. Down-hole drilling equipment will be steam-cleaned before advancing into the next aquifer zone. In well borings penetrating three aquifer zones, typically an 8-in. surface casing will be followed by 6-in. casing in the next deeper zone and finally an open hole in the lower zone in which the 2-in. casing and screen are set. Well screens will be set at the base of the well in lengths dependent on aquifer thickness. PVC riser pipe attached to the well screen will extend through the protective casing to approximately 2.5 ft above the ground. The annulus of the screened section of the well and the entire thickness of the aquifer zone (the formation producing water) will be backfilled with siliceous sand. The sand will be poured in slowly from the top of the well and checked for depth periodically with a tape measure. The filter sand will be brought up to the next higher aquiclude and capped with a 3-ft to 5-ft thickness of bentonite pellets as a sealer. This method of well packing assures that no grout will be introduced out into the aquifer and thus prevents potential clogging of the aquifer. The bentonite will be allowed to set 1/2 to 1 hour to allow time for the pellets to swell and form a seal. The well will then be grouted from the bentonite to the top of the ground. The grout will be piped into the well from the bottom up through a 3/4-in. diameter pipe. A PVC vented cap will be placed atop the 2-in. riser. A cylindrical steel well cap with locking lid will be placed over the PVC riser and cemented into the surface casing to protect the well casing.

(7). Rationale for Construction Location. See section b.8. above.

(8). Environmental Conditions. See section b.9. above.

(9). Decontamination Procedures. See section b.11. above.

(10). Documentation. See section b.12. above.

(11). Well Development Procedures. The wells will be developed by alternating a surging and bailing technique. Surging will be done with a stainless steel rod with rubber washers attached at each end. The surging tool will be lowered into the well on 1/8-in. steel cable and pulled up and down to create a surging action in the well. The well will be bailed alternately with a 1-1/8-in. diameter, 5-ft long stainless steel bailer lowered by a stainless steel cable. The bailer will be operated by a portable wire-line winch straddling the well. The well will be bailed until the water from the well becomes relatively clear. Bailed water will be poured onto the ground away from the well casing unless sampling or other monitoring indicates the presence of elevated levels of contaminants in the water. Contaminated water will be placed in drums and treated as a hazardous waste.

(12). Soil Classification and Description of Cores. Soils encountered during drilling will be examined by a certified professional geologist at the site and classified under the Unified Soil Classification System (USCS). Any other characteristics of the soil, such as color, odor, or inclusions will also be noted and logged. Cores will be examined and classified by the geologist and their descriptions logged in a permanent field log (see Figure 4). The geologist will describe the lithology of the sample, grain size, color, texture, odor (if any) and will evaluate its in-situ condition. He (or she) will note the presence of joints and other discontinuities, taking care to describe and measure open discontinuities capable of transmitting ground water. He will also note other descriptive features of the core that allow interpretation of the stratigraphy of the geologic units encountered at the ORR area for correlation from well to well. The geologist will also note the presence of hydrologic indicators such as loss or gain of water during drilling, zones of oxidation in the core, and the presence and condition of potential confining strata such as shales or clays.

(13). Survey Data. All well sites will be surveyed by certified professional surveyors. The top of the casing of every well will be surveyed to determine its elevation (NGVD) and east-west coordinates using the Indiana State Plane Coordinate System. The surveyors will supply WES with all survey data and a table of well elevations and locations.

d. RFI Phase III Quality Assurance/Quality Control (QA/QC) Plans. In preparation.

e. RFI Phase III Data Management Plan.

(1). RFI Phase III Data Record. Records of data collected in the field and in the laboratory will be maintained indefinitely for the Old Rifle Range RFI in a dedicated file at WES. Some duplicate records will be maintained at the NWSC. Field data records will include logs of all borings and the core or other samples extracted from them, well installation logs, results of any aquifer tests performed, memoranda for record of field visits, raw and corrected positioning survey data, and monitoring well sampling activities.

Each sample taken during the investigation will be assigned a unique number corresponding to the well or boring from which it was obtained. Well numbers will identify the SWMU (Old Rifle Range, Site 07) and the particular well in a cluster. An example of a well number would be 07C01P2, which identifies well P2 of cluster C01 of site 07. Water samples will be identified by well number, depth and date sampled. Each water sample will be assigned a laboratory analysis ID number by the contract laboratory.

(2). RFI Phase III Tabular Displays. Tables of data will be prepared for well information and water sampling and analysis events. Well information tables will list well numbers, dates installed, type of boring, total depth, elevation of well casing and ground, depth to screen and screen length, and identification of aquifer. Water level measurements for dates measured for each well will be tabulated. Tabulated water sampling data will include site, well number, date and depth sampled and laboratory analysis results for each parameter tested.

(3). RFI Phase III Graphical Displays. Graphical displays will include site maps showing well locations, topographic maps of the site, water table or piezometric surface contour maps of the aquifers encountered, contour maps of pertinent geologic structure, maps of ground-water contamination distribution in sampled aquifers, and other maps as needed. Line or bar graphs will be constructed to show variations in water or piezometric levels for different aquifers, for different wells, and for different dates. Graphs will also be constructed showing distribution of contaminant concentrations for different aquifers, wells and dates. Other graphs will be constructed as necessary.

f. RFI Phase II Health and Safety Plan.

**Background.** An initial assessment study of the NWSC conducted in 1981 to identify potential contamination sources determined that past activities at the NWSC have resulted in possible contamination of soil and ground water by potentially hazardous chemicals in several areas of the facility. The chemicals, by their presence in the soil and ground water, present a potential hazard to personnel conducting RFIs. RFI activities will require drilling of subsurface borings, installation of wells, and sampling of soils, rock and ground and surface waters. The health and safety plan is intended to (a) describe field activities to identify potential hazards associated with each activity, (b) insure safety consciousness by each individual involved with the field activities, (c) control exposure to potentially hazardous chemical compounds by specifying protective gear and monitoring procedures commensurate with the anticipated risk, and (d) provide emergency procedures in the event of unanticipated high contaminant concentrations, incident response, control and disposal of generated waste materials.

**Drilling and Well Installations.** Drilling and well installation operations will require a combination of up to four steps:

Step 1. Step 1 drilling will consist of dry auger boring using an Iwan or flight type auger. The drilling operation will extend to rock, to the water table, to unstable soil or to some other change of condition that requires a different drilling technique. Step 1 operations should produce no appreciable dust and no liquid splash hazard. The operators will contact the drilled soil with their hands in removing the soil from the auger. The operators will be near the freshly cut and disturbed soils and thus could be subjected to the release of residual chemical vapors.

Step 2. Step 2 drilling will be by the air rotary method by which

the material drilled is cut by the rotation of a cutter or bit while compressed air is pumped down through the drill pipe to cool the bit and remove the cuttings. The air escapes through the annulus of the drilled hole and carries the cuttings to the surface. Since rotary drilling requires fluid circulation, compressed air will be used instead of a liquid in Step 2 to reduce the risk of injecting contamination into the soils if site conditions require. Step 2 drilling will produce significant dust, but the dust ingestion and inhalation problem will be mitigated by an air jet eductor at the top of the boring which will draw much of the dust away from the drill operators. The air jet eductor will be positioned so as to blow the dust downwind from the operators. Step 2 drilling can submit the operators to chemical vapors released from the disturbed soils. However, the hazard is mitigated by dilution in the injected air and the effect of the air jet eductor.

Step 3. Step 3 drilling will be by the wet (water) rotary method, which is similar to Step 2 drilling except that the fluid is liquid and the working conditions are somewhat different. Dust problems are eliminated and some vapors are absorbed in the fluid. There is, however, a liquid splash and spill hazard. Chemical compounds in the fluid are somewhat diluted but can contact operators' skin.

Step 4. Step 4 operations will not involve drilling or other disturbing of the in situ materials. Step 4 will consist of the installation of monitoring wells and will entail setting well casing, placing filter materials, bentonite seals, and grouting of previously drilled borings. None of the potential hazards associated with Steps 1, 2, and 3 are anticipated. However, it is possible that vapor released from the subsurface soils will be present at the top of the boring and operators could contact and/or inhale the vapors.

**Other activities.** Other field activities that could expose personnel to contaminants include well sampling, well testing, and surface water sampling and flow measurement. Well sampling requires removal of several bore quantities of water from the well, the retention of a sample of the ground water entering the well, and preparation of the sample for shipment to the laboratory for analysis.

Well testing requires measuring the rate of flow of water being withdrawn from or injected into the aquifer through the well, for example by pumping tests or by slug tests, for the purpose of determining aquifer flow parameters. Well testing may also require measurement of water levels in monitoring wells near the pumping well. Because personnel may contact withdrawn ground water and be exposed to vapors emanating from the wells, potential splash and vapor ingestion hazards exist similar to those of Step 3 drilling operations.

Additional flow measurement may be required whereby surface waters in streams and water issuing from springs are sampled and the rate of flow determined. Concentrations of contaminants in surface waters will be decreased by dilution. Some dilution and aeration will also occur in spring fed waters. Field personnel should nonetheless be alert for any signs of contamination such as discoloring of the water or the presence of odors or vapors.

A particular hazard to personnel exists at the Demolition Area as a result of demolition activities there. Explosive destruction of ordnance at the Demolition area produces blast waves and flying debris. All personnel are required to leave the vicinity of the Demolition area during demolition activities. Control of personnel evacuation is the responsibility of the range safety officer at the Demolition area.

Previous laboratory analysis of monitoring wells at the Demolition area has indicated the presence of only minor amounts of some heavy metals in the ground water. Unexpected releases to the air near the boreholes will be monitored

by air monitoring devices as described below. Drilling will not be done in areas with potential buried unexploded ordnance or other hazardous materials.

**General Personnel Safety.** The monitoring and precautionary measures specified in the following paragraphs are considered reasonable and prudent for general field investigations planned for the RFI. Each employee will have a comprehensive physical examination within the 12 months preceding his/her field involvement to provide background information. Upon completion of the project, or annually, whichever occurs first, each employee will have a routine physical examination. Physical examinations will consist of the following:

a. Comprehensive Physical Examination. Basic health history, basic physical examination, routine EKG, chest X-ray, pulmonary function, audio testing, eye evaluation, hemoccult, Chem-screen 26, CBC w/differential, acetylcholinesterase activity, heavy metals in blood to include lead, cadmium, mercury, arsenic, chromium, and strontium; urinalysis.

b. Routine Physical Examination. Basic physical examination, resting EKG, chest X-ray, pulmonary function, SMA-26, urinalysis, audiometric.

**Air Monitoring.** The most common halogenated organic compounds in industrial use and OSHA allowable inhalation limits are listed in Table 3 (OSHA Safety and Health Standards 29CFR 1910).

Table 3. Limits of Exposure and Detection for Common Organic Solvents.

| Solvent | Maximum Allowable* Exposure, 8 hrs. | Sensitivity** Photoionization | Detection*** Limit |
|---|---|---|---|
| Benzene | 10 ppmHigh | 5 ppm | |
| 1,1 Dichloroethane | 100 ppm | High | - |
| 1,2 Dichloroethane | 200 ppm | High | - |
| Methylene Chloride | 500 ppm | High | 100 ppm |
| Trichloroethylene | 100 ppm | High | 2 ppm |

* OSHA Safety and Health Standards (29 CFR 1910) OSHA 2206

** HNu Model PI-101 with 11.7 ev lamp, HNu Systems, Newton, Mass.

*** Draeger Detector Tubes, National Draeger Inc., Pittsburg, PA

Air monitoring efforts will concentrate on monitoring for organic solvents and combustible gas. The presence of dust will be determined visually.

The presence of volatile organic compounds in the air at the drill location will be continuously monitored using a photoionization organic vapor detector (HNu Systems Model 101, Hazardous Waste Detector) and a combustible gas detector (Neotronics Meter, EXOTOX Model 40-OFH).

The photoionization unit is a non-specific detector that can semiquantitatively determine the concentration of a broad range of potentially hazardous organic compounds in the air. The unit will be calibrated relative to benzene concentration or to standards traceable to benzene. The unit will be set to provide an audible alarm at 75 percent of the threshold limit value (TLV) for benzene. The photoionization unit will be calibrated in accordance with manufacturer's recommendation and checked periodically for proper operation.

The combustible gas/respirable air unit is a catalytic and thermal conductivity unit that measures the concentration of flammable gas, hydrogen sulfide and oxygen levels in the air. The combustible gas sensor is calibrated on methane and will provide an alarm at 25 percent of the lower explosive limit (LEL) of methane in air. The combustible gas/respirable air unit will be calibrated before field work is started and semiannually throughout the period of use as recommended by the manufacturer.

a. Specific monitoring. The concentration of three common solvents (benzene, methylene chloride, and trichloroethylene) in the air will be determined at the drilling location at the beginning of the morning and afternoon work periods using colorimetric monitoring devices (detector tubes). The limits of detection of the colorimetric tubes are at or below 50 percent of the TLV in all cases. Records of readings will be maintained and correlated with readings from continuous monitoring devices.

b. Control of particulates. Dust generated from off-site locations could move over the drilling locations and other field activity areas intermittently. Dust will be generated by Step 2 drilling operations also on an intermittent basis. Monitoring for intermittently occurring particulates is of limited value. The effects of Step 2 drilling-generated dust will be mitigated by the use of an air jet eductor. Efforts to avoid ingestion of significant amounts of dust will include:

a. Physically avoiding the main stream concentration of dust.

b. Wetting down the work area as feasible.

c. Injecting water into drilling air stream if necessary.

d. Discontinuing work when dust cannot be adequately controlled.

e. Respirators with organic vapor cartridges and dust filters will be accessible at the drill location for each worker.

c. Action levels. In the event air monitoring indicates levels of combustible gas or organic vapors that exceed the action levels (Table 4), work will be suspended and the work site evacuated. A Crane NWSC industrial hygiene specialist will be brought onsite to define the specific hazard and specify necessary protective measures which will be implemented before work is resumed.

Table 4. Action Levels for Air Monitoring Instruments.

| Instrument | Level | Rationale |
|---|---|---|
| Photoionization | 40 ppm Benzene equivalent | 80 percent of OSHA threshold level for benzene, 8-hr exposure |
| Combustible gas | 1.25 percent methane, equiv. | 25 percent LEL* methane |

* Lower Explosive Limit

To permit a safe and orderly shutdown of operations and evacuation of the crew from the site, respirators with particulate filters and organic vapor cartridges will be issued and fitted by NWSC to each worker. Each respirator will be individually fitted to the crew member to whom it is issued. Respirators will be checked for serviceability, readiness and accessibility. Respirators will be kept in sealed plastic (Ziplock) bags.

**Limiting skin contact.** All persons involved in handling soil samples or equipment contaminated with soil from the work site will wear rubber gloves, safety-toe rubber boots, disposable coveralls, hard hats and safety glasses or face shields. Higher levels of protective clothing, such as Levels A, B, or C, will be issued and worn if or when working conditions require them. Protective equipment will be inspected daily. Worn or damaged equipment will be cleaned and discarded or disposed of as contaminated waste.

**Decontamination.** All tools and equipment contaminated by material from drill locations will be cleaned with high-pressure hot water or steam and/or commercial washing compounds and water when removed from that location. The intention is to limit the spread of contamination and prevent cross-contamination from one site to another. Wash water and waste from contaminated sites will be retained for disposal. Wash water and wastes will be tested for contaminants and disposed of in compliance with local requirements.

Well casings and screens and sampling and pumping apparatus will be thoroughly cleaned using high pressure hot water or steam before they are installed or placed in a boring. Filter material used will be clean natural gravel and/or sand that has been tested or certified to assure that no contaminants are introduced into the borings.

Hole No. WES-3-VFZ-87

| DRILLING LOG | Division: US Army | Installation: NWSC | Sheet 1 of 1 sheets |
|---|---|---|---|
| 1. Project: Hydrogeologic Stdy, ABG | | 10. Size and Type of Bit: 7" Splitspoon + Auger | |
| 2. Location (Coordinates or Station): ABG Valley Fill | | 11. Datum for Elevation Shown (TBM or MSL): | |
| 3. Drilling Agency: WES | | 12. Manufacturer's Designation of Drill: Failing 1500 | |
| 4. Hole No. (As shown on drawing title and file number): 3-VFZ | | 13. Total No. of Overburden Samples Taken: Disturbed | Undisturbed |
| 5. Name of Driller: Dan Taylor | | 14. Total Number Core Boxes | |
| 6. Direction of Hole: ☐ Vertical ☐ Inclined ____ Deg. from vert. | | 15. Elevation Ground Water | |
| 7. Thickness of Overburden: 7.5 | | 16. Date Hole: Started 6/23/87 | Completed 6/23/87 |
| 8. Depth Drilled into Rock: | | 17. Elevation Top of Hole: 581.5 | |
| 9. Total Depth of Hole: 7.5 | | 18. Total Core Recovery for Boring: % | |
| | | 19. Signature of Inspector: Geologist R.W. Hunt | |

| Elevation (a) | Depth (b) | Legend (c) | Classification of Materials (Description) (d) | % Core Recovery (e) | Box or Sample No. (f) | Remarks (Drilling time, water loss, depth of weathering, etc., if significant) (g) |
|---|---|---|---|---|---|---|
| | 0–1.5 | | Clayey silt, w/ ss pebbles + frags, m-d Br, firm, sl moist - dry | | 1 | Samples were put in qt Jars |
| | 1.5–3.0 | | | | 2 | |
| | 3.0–4.5 | | Increase in ss frags below 3.0, + moist. Blk coal? flakes between 4.0 + 4.5 | | 3 | |
| | 4.5–6.0 | | Weathered Big cliffy ss w/ silty clay + clayey silt in eroded open jts, moist | | 4 | |
| | 6.0–7.5 | | | | 5 | |
| | 7.5–8 | | Bot. Depth. 7.5' (Refusal on Top of Big cliffy SS) | | | |

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Figure 4

Hole No. WES-3-C1-86

| DRILLING LOG | DIVISION US Navy | INSTALLATION Crane In | SHEET 1 OF 10 SHEETS |
|---|---|---|---|
| 1. PROJECT NWSC Groundwater Study | | 10. SIZE AND TYPE OF BIT | |
| 2. LOCATION (Coordinates or Station) ABG Geologic Studies | | 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) | |
| 3. DRILLING AGENCY WES | | 12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500 | |
| 4. HOLE NO. (As shown on drawing title and file number) WES-3-C1-86 | | 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED | |
| 5. NAME OF DRILLER Dan Taylor | | 14. TOTAL NUMBER CORE BOXES | |
| 6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT. | | 15. ELEVATION GROUND WATER | |
| | | 16. DATE HOLE: STARTED Aug 2, 1986 COMPLETED Sept 29 1986 | |
| 7. THICKNESS OF OVERBURDEN 4.2 | | 17. ELEVATION TOP OF HOLE 624.8 | |
| 8. DEPTH DRILLED INTO ROCK | | 18. TOTAL CORE RECOVERY FOR BORING % | |
| 9. TOTAL DEPTH OF HOLE 197.2 | | 19. SIGNATURE OF ~~MANAGER~~ Geologist Richard W. Hunt | |

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | 0 | | Ls rk surface (work area) | | | Started Sampling w/an 8" dia Tolling Auger |
| | 1 | | clayey Silt, (ML-CL) yBr - rBr, w/rk frags, firm - v firm, | | | |
| | 2 | | | | | |
| | 3 | | | | | Set 6" dia casing to 4.3' (steel) |
| | 4 | | | | | |
| | 5 | | Sandstone, yBr & lGr, fine grained cross bedded, wea + oxidized, occ soft clay lens, numerous random fractures that are tight to partially open and coated w/ manganese, few frac have a clay filling. Frac are rough & irregular. (Fractures are shown in legend) w/ amount of dip | Run 1 | | Started coring w/ 4 x 5½" dia. Core bbl at 4.2' SS is either Hardinburg or (Penn) |
| | 6 | | | 4.6/5.0 | | Core Recovery — Run length |
| | 7 | | sdy clay, gnGr | 0.4 | | Core loss (or 30..) |
| | | | clay, gnGr, carbonized veins | | | |
| | 8 | | clay lens | | | |
| | 9 | | Shale, olive Gr & yBr, thin bd, fisley, wea (mostly ground away) | 9.2 | | Contact - 8.7' Goiconda Fm |
| | | | | Run 2 | | |
| | 10 | | Limestone brGr, v hard Crystalline Fossils | 9.4/1.2 = 0.8 | | Core bbl shelved ground giving core |

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Figure 5

**DRILLING LOG**

| | |
|---|---|
| DIVISION | |
| INSTALLATION | |
| SHEET | OF SHEETS |
| 1. PROJECT | WELL INSTALLATION |
| 2. LOCATION (Coordinates or Station) | |
| 3. DRILLING AGENCY | |
| 4. HOLE NO. (As shown on drawing title and file number) | WES 03-C1-86 |
| 5. NAME OF DRILLER | |
| 6. DIRECTION OF HOLE | ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT. |
| 7. THICKNESS OF OVERBURDEN | |
| 8. DEPTH DRILLED INTO ROCK | |
| 9. TOTAL DEPTH OF HOLE | |
| 10. SIZE AND TYPE OF BIT | |
| 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) | |
| 12. MANUFACTURER'S DESIGNATION OF DRILL | |
| 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED / UNDISTURBED |
| 14. TOTAL NUMBER CORE BOXES | |
| 15. ELEVATION GROUND WATER | |
| 16. DATE HOLE | STARTED / COMPLETED |
| 17. ELEVATION TOP OF HOLE | |
| 18. TOTAL CORE RECOVERY FOR BORING | % |
| 19. SIGNATURE OF INSPECTOR | |

| ELEVATION a | DEPTH b | LEGEND c | CLASSIFICATION OF MATERIALS (Description) d | % CORE RECOVERY e | BOX OR SAMPLE NO. f | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g |
|---|---|---|---|---|---|---|
| | | | Well No.: WES-3-C1-E6 (Beaver Bend Ls) | | | Date well screen was set: 12/12/86 |
| 627.5 | | | +2.7 | | | |
| 624.8 | | | 0.0' Ground surface | | | |
| | | | Grout mixture | | | Water level just Prior to setting Screen – 109.2' Note: small amount of water was leaking around casing the. ial was sealed in the Elwren Shale at the time of drilling the well. Higher than normal water level was due to this leakage from the Beach Creek Ls. |
| | | | 160.0' | | | |
| | | | Bentonite Pellets | | | |
| | | | 162.0 | | | |
| | | | Filter Pack | | | |
| 450.8 | | | 174.0' | | | |
| | | | Well Screen | | | |
| 440.8 | | | 184.0 | | | |
| | | | Trap | | | |
| | | | 185.0' | | | |
| | | | 197.2' Boring Depth | | | |

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Figure 6

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

J. B. ALLEN
Assistant Public Works Officer

TITLE

5 JUN 1990

DATE

Enclosure (3)