Fort Detrick
Area B - Groundwater Remedial Investigation Work Plan

Fort Detrick Restoration Advisory Board Meeting
September 22, 2010
Fort Detrick, Maryland

History/Status

- Numerous groundwater investigations have occurred at Area B since 1977
- The Ft. Detrick partnering team has held ongoing technical meetings to identify the data needs to define the nature and extent of groundwater contamination and assess risk
- The Area B Groundwater RI Work Plan has undergone several reviews and revisions and was issued as Final in July 2010

Work Plan Objectives

- **Objective A: Confirm Groundwater Flow Direction**
  - The overall groundwater flow directions within the shallow and deep flow components and in wet/dry seasons will be established so that the adequacy of the well network can be evaluated and improved as needed
- **Objective B: Determine Depth of Contamination and Groundwater Flow**
  - The depth of contamination and the extent to which groundwater underflows Carroll Creek will be determined
- **Objective C: Establish Appropriate Monitoring Network**
  - An appropriate monitoring network will be evaluated and developed to characterize the nature and extent of contamination, evaluate risk to on-site and off-site receptors, and monitor the Area B disposal areas (B-2, B-3, B-6, B-8/10/11, and B-18)

Work Plan Objectives (Continued)

- **Objective D: Obtain Appropriate Analytical Data Set**
  - A current, representative data set that evaluates site-specific contaminants and meets risk assessment data quality objectives will be collected
- **Objective E: Assess Vapor Intrusion**
  - Identify what buildings may pose a vapor intrusion risk and collect samples to assess such risk

Major Activities in Work Plan

- Horizontal Flow Meter Survey
- Spring/Seep Sampling
- Focused Dye Trace Study
- Drive Point Technology (DPT) Sampling and Piezometer Installation
- Installation of New Wells
- Borehole Logging of New Wells and Select Existing Wells
- Monitoring of Water Levels
- Groundwater Sampling (Two Events)
- Surface Water and Sediment Sampling (Two Events)
- Vapor Intrusion Sampling
- Partnering with regulators throughout the entire process

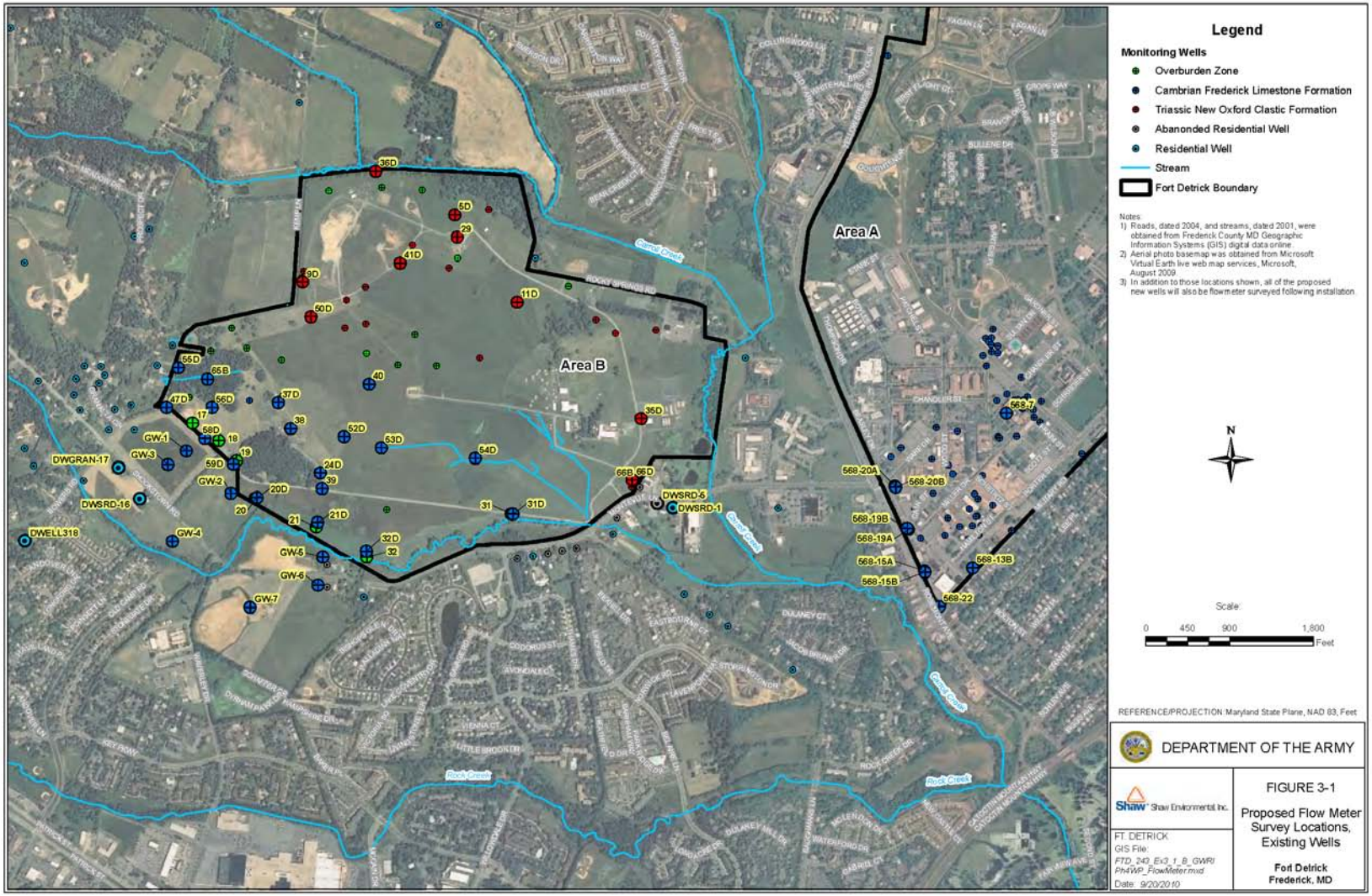
Activities in Order of Implementation and Seasonal Consideration

Order	Proposed RI Activities	Timeframe
1	Existing well reconnaissance surveys, repairs, redevelopment	as soon as possible
2	Horizontal flow meter surveys in existing wells and boreholes	wet season/late winter
3	Spring/seep reconnaissance survey and sampling	wet season/late winter
4	Focused dye trace	wet season/late winter
5	DPT sampling and piezometer installation	spring-summer
6a	New well drilling, testing, installation	spring-summer
6b	Borehole logging and testing (existing wells)	concurrent with well drilling
7	Water level monitoring (first synoptic event)	following well installation
8a	Groundwater and spring sampling (round 1)	late summer/fall
8b	Surface water and sediment sampling (round 1)	concurrent with groundwater sampling
9	Vapor intrusion sampling	concurrent with groundwater sampling
10	Water level monitoring (second synoptic event)	late winter-spring
11a	Groundwater and spring sampling (round 2)	late winter-spring
11b	Surface water sampling (round 2)	concurrent with groundwater sampling

Horizontal Flow Meter Survey

- Conducted to determine the direction and magnitude of groundwater flow through existing and proposed new wells (Objective A)
- Information is expected to help bound uncertainties regarding groundwater flow and potential contaminant transport directions, most notably along the southern Area B boundary
- Surveys will be conducted using a colloidal borescope flow meter
  - This tool is capable of providing high resolution determinations of both velocity and direction of groundwater flow and can be used in both open holes and completed wells with 2-inch or greater diameter casing/screens
- Surveys would be conducted early in the RI field program, after redevelopment of the existing wells but prior to the drilling of new wells
- Surveys conducted in off-site residential wells and select Area A wells are expected to contribute to the evaluation of Carroll Creek as a discharge boundary to off-site flow (Objective B)

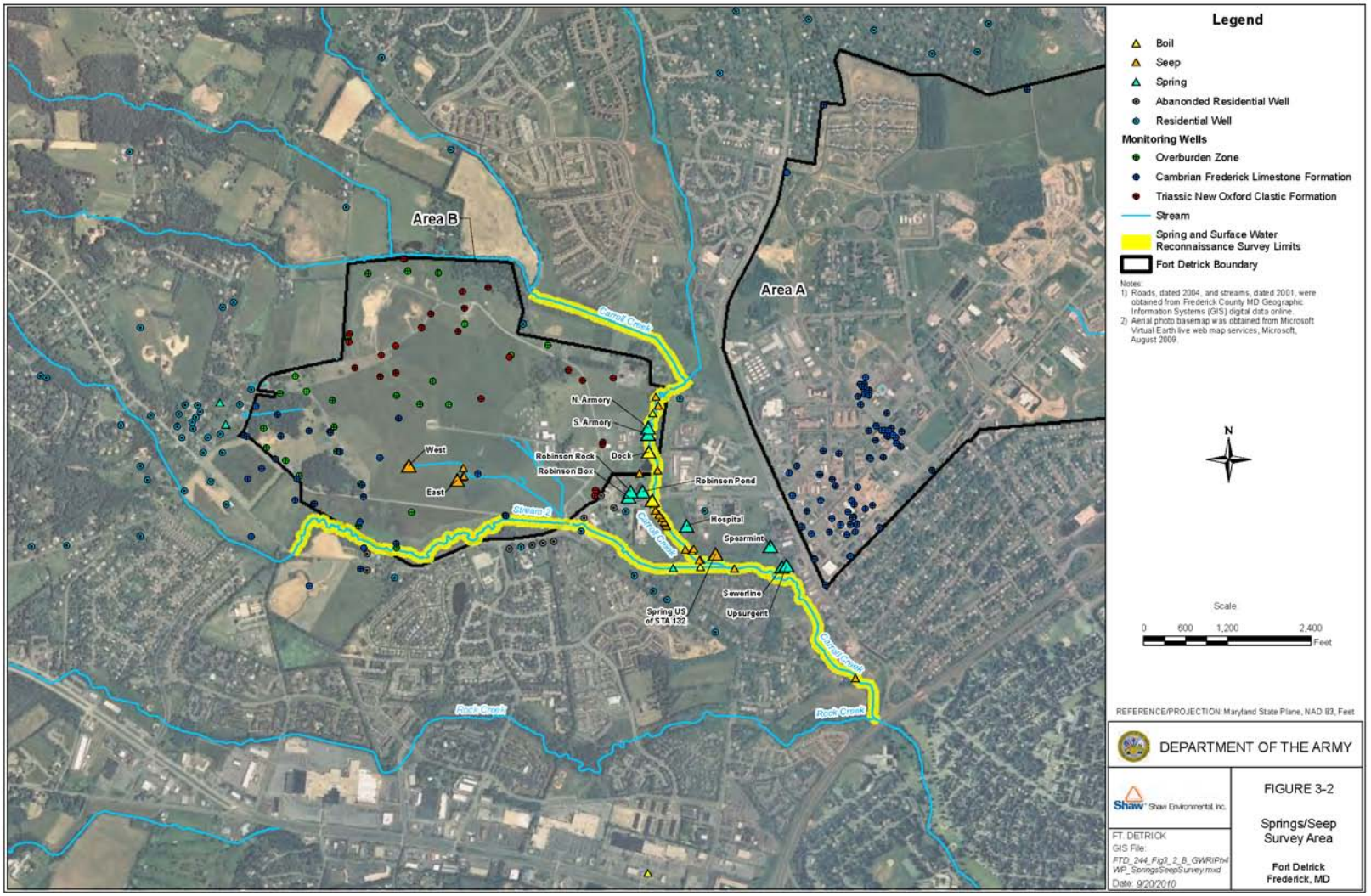
Horizontal Flow Meter Survey Locations



Spring/Seep Recon and Sampling

- The stretch of Carroll Creek to the east of Area B is believed to be a major discharge area for groundwater from Area B
- An initial reconnaissance/sampling effort is proposed to evaluate the level of contamination in previously un-sampled groundwater discharge locations
- The work will be performed by traversing the stream segments, identifying and recording the locations of seeps and springs, and documenting the discharge rate and the field parameters [pH, specific conductance, temperature, turbidity, dissolved oxygen (DO), and redox]
- Upon completion of the reconnaissance, up to 25 locations will be sampled. The objectives of this activity are to:
  1) Further bound the nature and extent of VOC plumes discharging to surface water such that risk can be evaluated (Objective C).
  2) Help constrain the area of potential vapor intrusion concern (Objective D).
  3) Identify and refine locations for monitoring in conjunction with proposed or future dye tracing (to support Objectives A and B).
  4) Provide data for a rough estimate of contaminant mass flux discharge to Carroll Creek to assess whether or not there is underflow of contaminant (Objective B).

Springs/Seep Survey Area

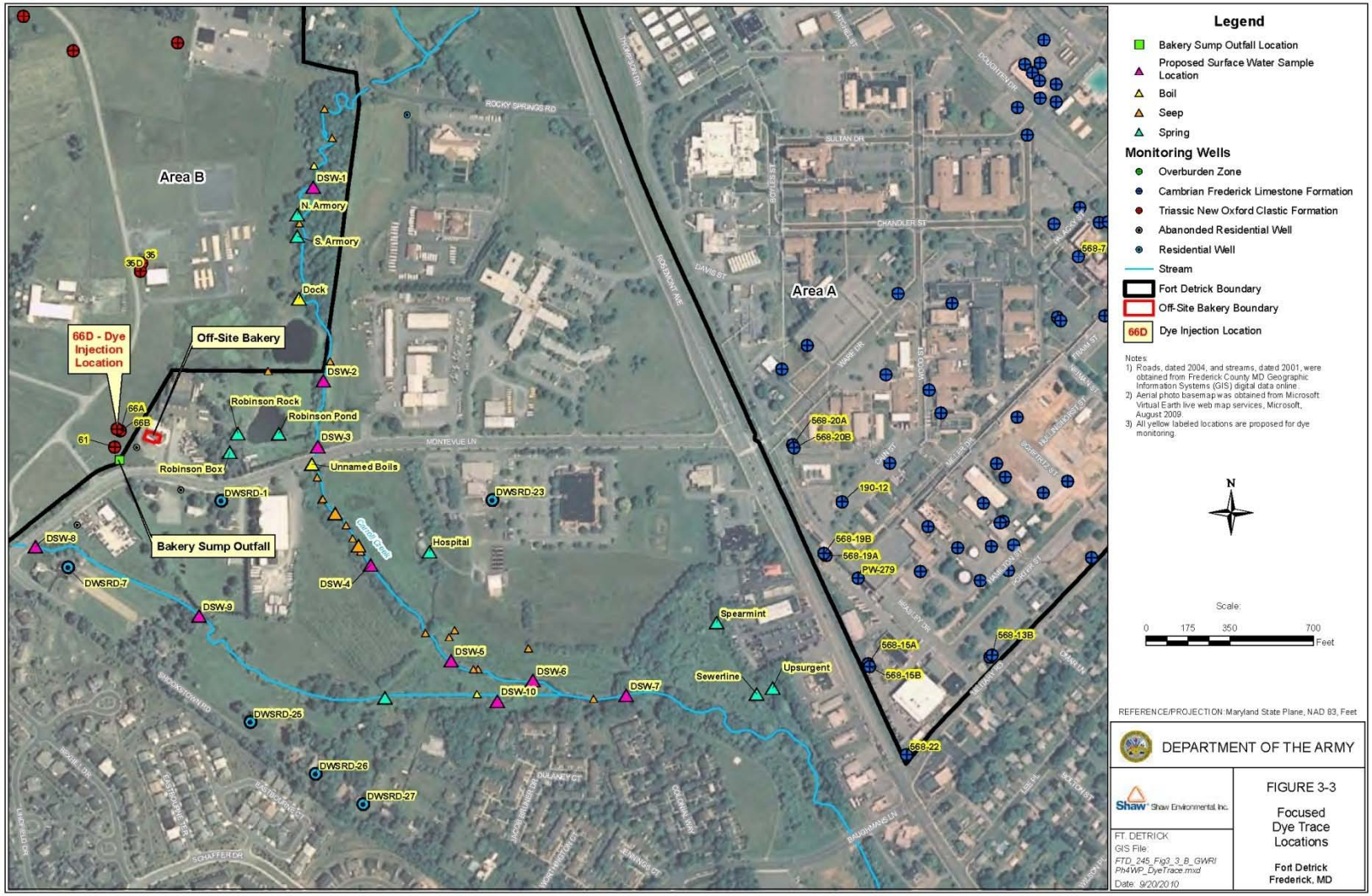


Focused Dye Trace Study

- Dye tracing will provide valuable information regarding the nature and extent of contamination (vertical and lateral) and the nature of the hydrogeologic framework
- Dye tracing from source areas will provide the most robust documentation of the nature of the flow system, and the fate and transport of contaminants dissolved in groundwater
- Initial injection will occur in recently installed deep well BMW66D. It is expected that tracing from this location to downgradient springs, Carroll Creek, and wells both on Area B as well as to the east of Carroll Creek will serve to refine the Conceptual Site Model (CSM) and achieve the following technical objectives:

1) Document groundwater flowpaths from deep karstic intervals and groundwater discharge to springs, surface water, and other shallow wells (Objective A).
2) Assess the role of Carroll Creek as a discharge boundary to off-site groundwater flow and contaminant transport associated with deep groundwater flow (Objective B).
3) Document the degree of hydraulic interaction between Area B and Area A groundwater, if any.

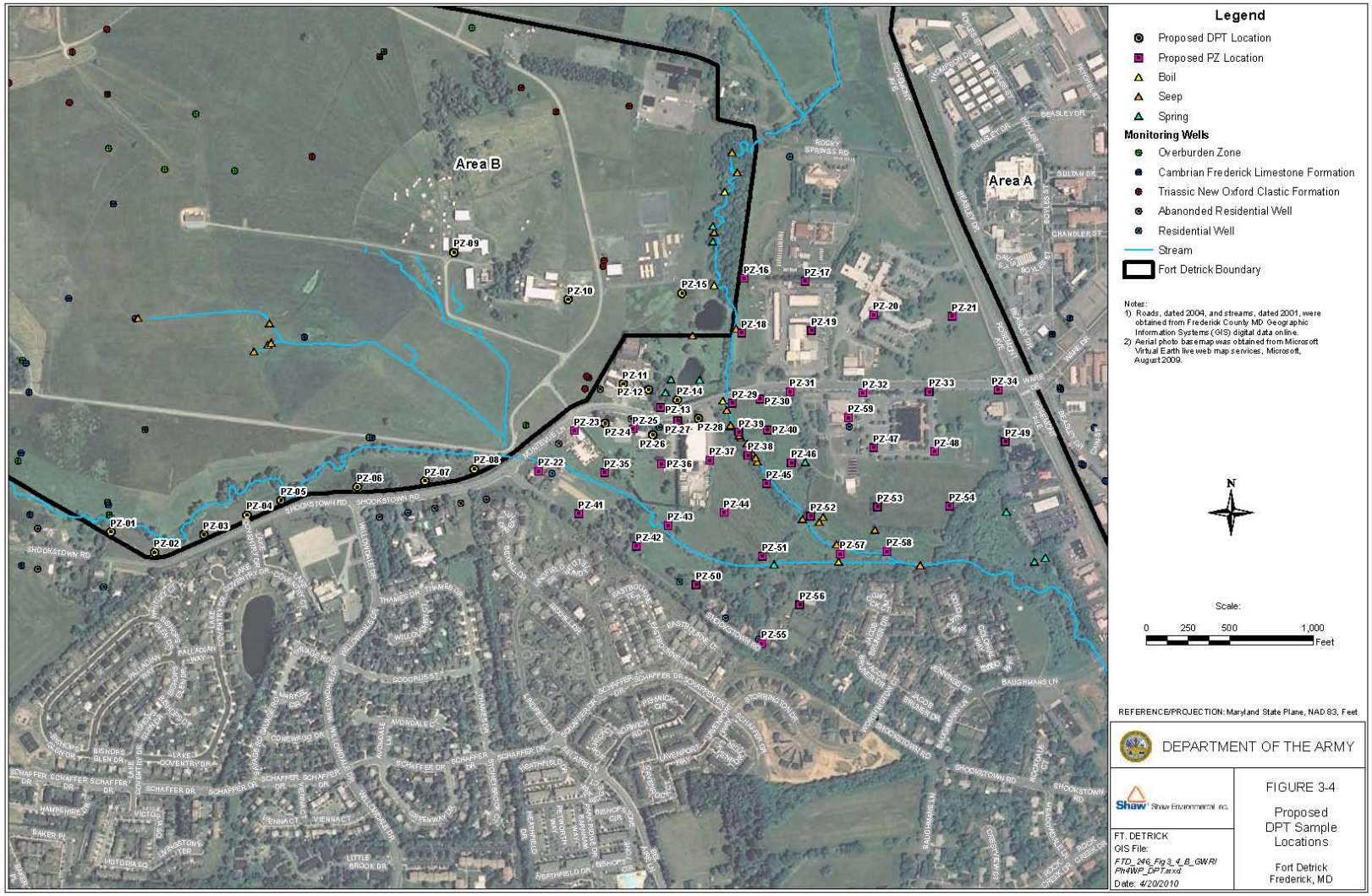
Focused Dye Trace Locations



DPT Sampling and Piezometer Installation

- Shallow groundwater sampling using DPT has been demonstrated as an effective method for conducting rapid assessments of the nature and extent of shallow (overburden) groundwater contamination
- It is expected that the DPT task would be completed early in the investigation so as to support other planned investigation components
  - Given that the bulk of the sampling locations are located off site on either private or municipal property, access agreements will need to be pursued early to facilitate completion of this work in a timely fashion
- DPT methods are proposed to achieve the following technical objectives:
  1) Document shallow groundwater concentrations along the southern Area B boundary to evaluate the potential for risks associated with vapor intrusion in the adjacent residential areas (Objective E).
  2) Document shallow groundwater concentrations in the vicinity of buildings within Area B, in order to evaluate the potential for risks associated with vapor intrusion (Objective E).
  3) Delineate the nature and extent of contamination and obtain head data within the Carroll Creek floodplain between Area B and Area A (Objectives B and C).Assess the role of Carroll Creek as a discharge boundary to off-site groundwater flow and contaminant transport associated with deep groundwater flow (Objective B).

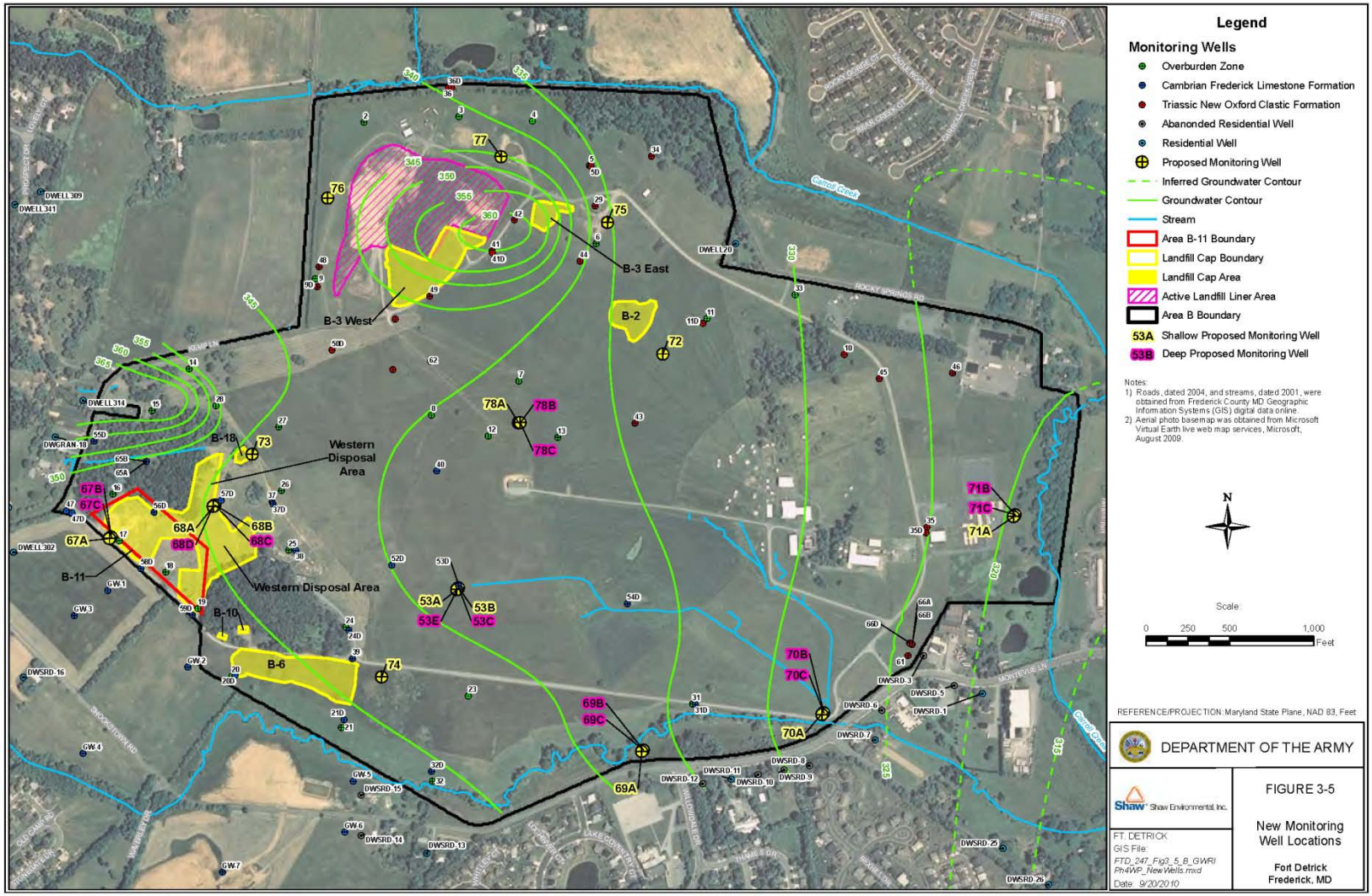
Proposed DPT Sampling Locations



New Well Drilling, Testing, and Installation

- New wells will be installed at 13 locations (29 completions); two additional locations (6 completions) are reserved and to be determined based upon field data obtained as the drilling progresses
  - The wells will be drilled as either single wells (shallow) or wells with two (nested) completions within deeper boreholes as warranted and appropriate
  - There will be 35 well completions at 15 locations if all planned and contingency wells are utilized
- The new well drilling will consist of:
  - Six single-completion-interval shallow bedrock wells at 6 locations, completed to depths ranging from 85 to 115 ft in depth.
  - Five well clusters at five locations, each consisting of a 325-deep borehole with two nested completions and a single-completion-interval shallow bedrock well
  - Two well clusters at two locations, each consisting of a 325-ft deep borehole with two nested completions and two nested completions in shallow bedrock
  - Two contingency well locations consisting of a 325-deep borehole with two nested completions and a single-completion-interval shallow bedrock well

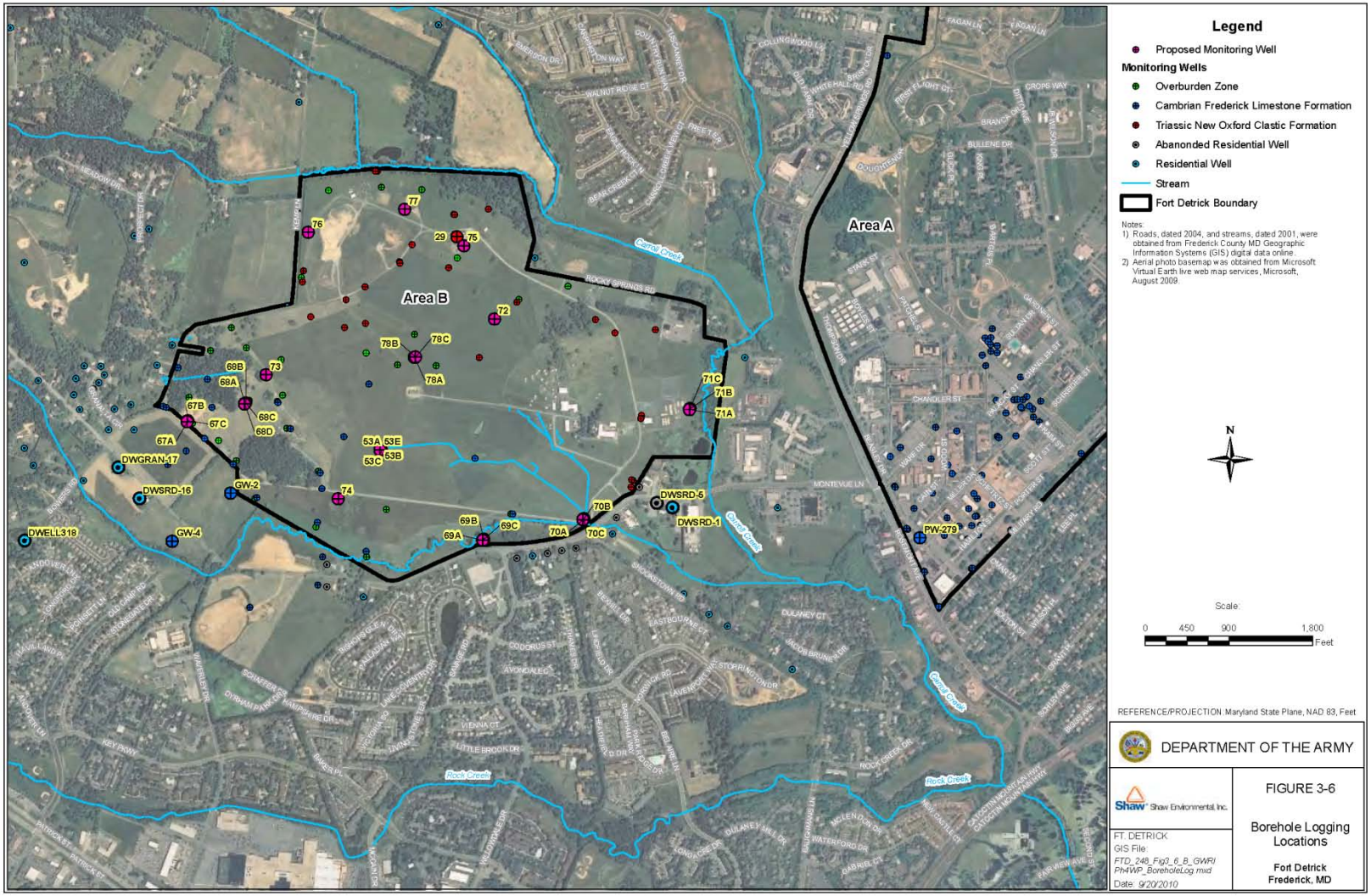
New Monitoring Well Locations



Borehole Logging and Testing

- Borehole logging and testing will be conducted in all new wells and select existing wells. The logging and testing will be done in order to:
  - Evaluate water-bearing intervals in new boreholes to select intervals for monitoring and monitoring well design so that an appropriate monitoring network can be established (Objective C).
  - Obtain the maximum amount of subsurface information possible from each existing or new bedrock open-hole interval. This will provide valuable information regarding the nature of the bedrock aquifer (Objectives A and B).
- The tools selected for this effort have been demonstrated to be effective in the recent drilling performed in 2008 and represent a consensus reached with the Fort Detrick Technical Team.
  - The characterization tools will include gamma ray, 3-arm caliper, fluid resistivity, fluid temperature, full waveform sonic, oriented optical or acoustic borehole televiewer (depending on water clarity), ambient and stressed hydrophysical testing, and wireline packer testing and sampling of identified flow zones [VOCs, Total Dissolved Solids (TDS), and chloride]
- The data acquired using this approach and combination of tools allows for identification of discrete, transmissive, water-bearing zones to a resolution of 0.1 ft, provides estimates of transmissivity of the flow zones, and provides screening-level water quality data with which to select specific completion intervals

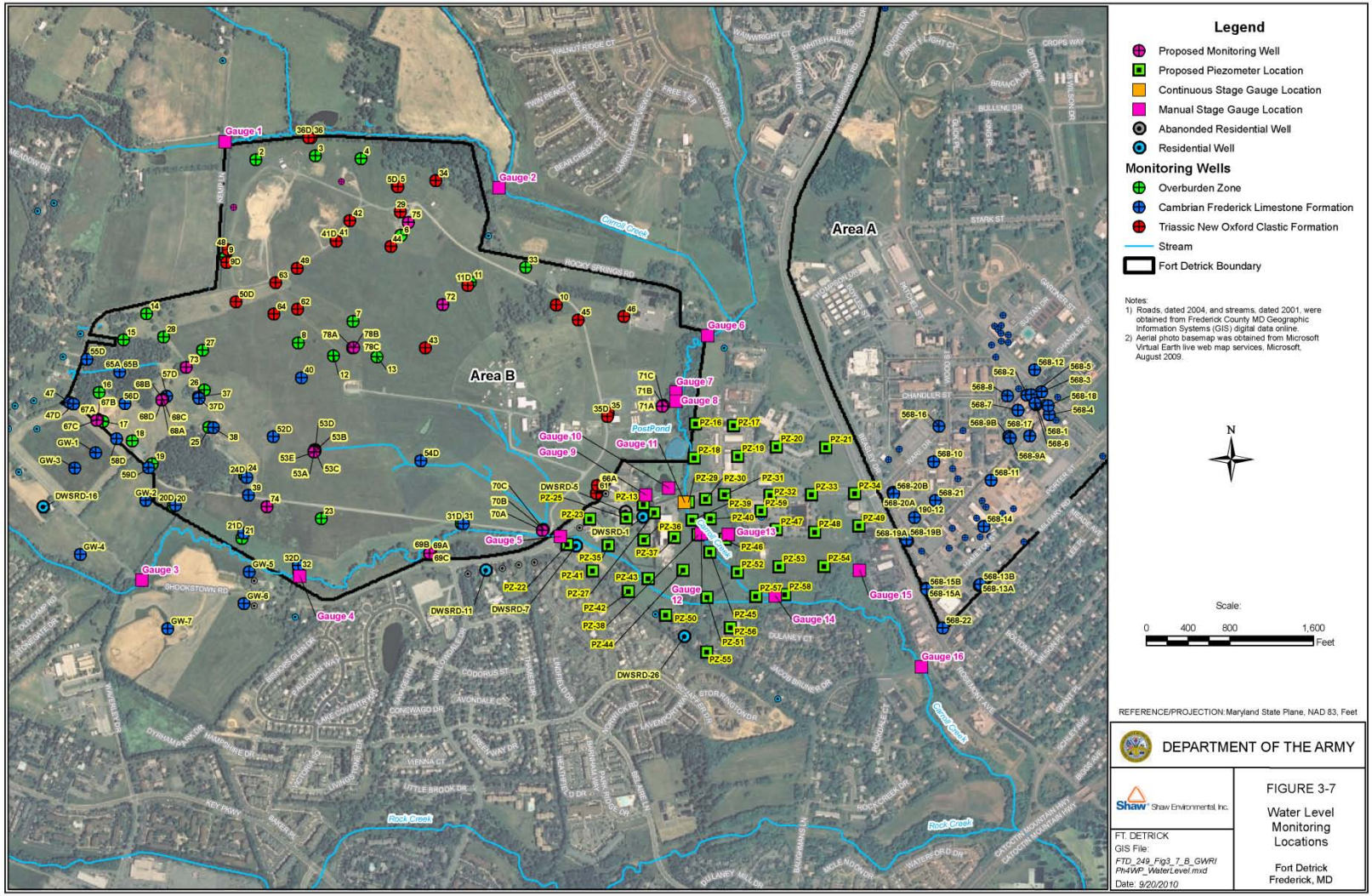
Borehole Logging Locations



Monitoring of Water Levels

- Both synoptic and continuous water level monitoring will be performed to assess the lateral, vertical, and temporal nature of hydraulic head in the aquifer (Objective A), and to assess whether Carroll Creek represents a discharge boundary (Objective B)
- After installation of the new wells is complete, four rounds of synoptic water levels will be collected to create potentiometric maps through various seasons
  - Synoptic water levels will be collected from all Area A and Area B wells , several off-post locations, and newly installed piezometers.
  - The survey will also include stage levels at surface water and spring locations. This will require installation of 16 stage gauges.
- In addition to the manual stage gauges, a continuous stage gauge will be installed in Carroll Creek at the Montevue Lane Bridge
  - Groundwater emerges to the surface at a series of boils within the bed of Carroll Creek at this location, such that surface water stage may likely have a controlling influence on groundwater discharge.
  - The objective is to document the short- and long-term fluctuations in the surface water system through storm events and seasonal variations as it may impact groundwater discharge over the course of a year (i.e., the gauge will be maintained and data recorded for a period of 1 year).

Water Level Monitoring Locations



Groundwater Sampling

- Groundwater sampling will include not only the SL packer sampling, DPT sampling, and spring sampling as discussed previously, but also a more robust set of synoptic sampling rounds which will provide data to support the risk assessment and fully define the nature and extent of contamination (Objectives A, B, C, and D)
- To provide data for the risk assessment, two rounds of synoptic groundwater sampling will be performed. The first round of sampling will occur during the spring after installation of the proposed new wells in order to assess conditions during the wet season. The second round will occur in the fall to assess conditions during the dry season.
- A total of 91 Area B wells will be sampled twice as part of the RI. This includes the 35 proposed new wells (including the 2 contingent well clusters), and 56 existing wells. Additionally, 10 off-post residential wells, and 9 known springs and up to 9 springs or seeps to be determined based on the spring recon sampling results will be sampled
- Samples will be analyzed for either a “standard” suite or an “expanded” suite depending on the locations proximity to source areas

Groundwater Sampling (Continued)

Standard Suite

A total of 56 Area B wells (22 new wells and 34 existing wells), 10 off-post wells, and up to 18 springs will be analyzed for the standard suite. The standard suite of analytes will include:

- VOCs to include:
  - TCL VOCs + 20 Tentatively Identified Compounds (TICs) (EPA Method 8260B).
  - Freons [1,1,2-trichlorotrifluoroethane (Freon 113), dichlorodifluoromethane (Freon 12), and trichlorofluoromethane (Freon 11)] (EPA Method 8260B). The latter two of these freons have commonly been detected in Area B groundwater and may serve as a plume tracer (EPA Method 8260B).
  - 1,2,3-Trichloropropane (EPA Method 8260B).
- TCL SVOCs + 20 TICs (EPA Method 8270C).
- Bis(2-chloroisopropyl)ether [EPA Method 8270C Selective Ion Monitoring (SIM)].
- TCL Pesticides/polychlorinated biphenyls (PCBs) (EPA Method 8081A/8082).
- Chlorinated Herbicides and Pichloram (EPA Method 8151A).
- TAL Metals (EPA Method 6010B/7470A).
- Off-site wells (including 1, 7, and 12) will also be sampled for BCEE (EPA Method 8270C SIM). To provide data for the risk assessment, two rounds of synoptic groundwater sampling will be performed. The first round of sampling will occur during the spring after installation of the proposed new wells in order to assess conditions during the wet season. The second round will occur in the fall to assess conditions during the dry season.

Groundwater Sampling (Continued)

Expanded Suite

Wells located near sources (former disposal sites) will also include an expanded list of non-standard compounds. A total of 34 Area B wells (12 proposed new wells and 22 existing wells) will be sampled for the expanded suite. The expanded suite includes the standard suite plus the following :

- Non-TCL chemicals positively detected in soil at concentrations in excess of USEPA Region 3 screening values
  - DBCP (EPA Method 8260B)
  - EDB (EPA Method 504.1/8011)
  - BCEE (EPA Method 8270C SIM)
- Select herbicides based on records of significant disposal quantity, lack of previous testing, availability of risk and/or regulatory levels, and availability of laboratory analytical capability
  - Dalapon (EPA Method 8151A)
  - Diquat (EPA Method 549.2)
  - Fenuron, Diuron, and Monuron (EPA Method 8321A)
  - Simazine (EPA Method 8270C SIM or 525.2)
  - Endothall (EPA Method 548.1)
- Dioxins/Furans Standard Target List (EPA Method SW-846 8290)
- Other chemicals, including:
  - Gross Alpha and Gross Beta (EPA Method 900.0); per EPA Region III request
  - TDS (EPA Method 160.1) is also analyzed with Gross Alpha and Gross Beta per method requirements
  - Boron (EPA Method 6010B); based upon reported disposal in the WDA
  - Bromide (EPA Method 9056) and Bromate (EPA Method 300.1B); bromine/bromide/ bromated based upon reported disposal of bromine

Groundwater Sampling (Continued)

Expanded Suite (Continued)

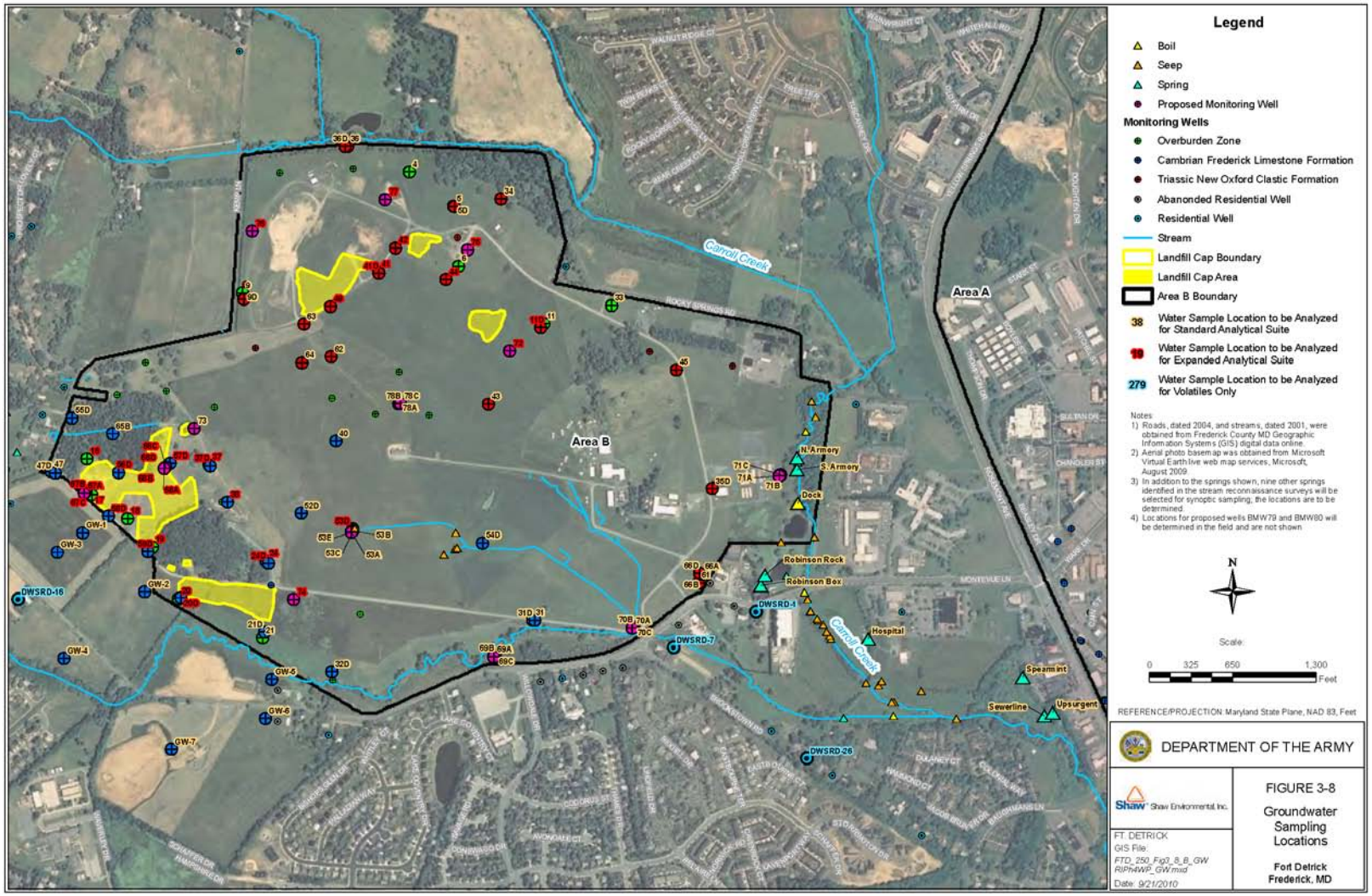
- Other Chemicals (Continued)
  - 1,4-Dioxane (EPA Method 8270C SIM)
  - Cyanide (EPA Method 9012).
  - 1,2,4-Trichlorobenzene (EPA Method 8270C – TCL listed compound) based on its use to make herbicides and as a solvent
  - 1,4-naphthoquinone (EPA Method 8270C)
  - 1,2,4-trimethylbenzene (EPA Method 8260B)
  - 1,2,3-trichlorobenzene (EPA Method 8260B)

Hydrogeochemistry Suite

Samples from select wells will also be analyzed for geochemical parameters. The intent of these samples is to document the hydrogeochemistry of the groundwater in order to evaluate whether there is stratification or other water chemistry patterns indicative of relative residence time and/or distinct flow conditions.

- This suite includes:
  - Anions (chloride, nitrate/nitrite, and sulfate) (EPA Method 9056).
  - TDS (EPA Method 160.1).
  - Cations (calcium, magnesium, potassium, and sodium) (EPA Method 6010B); will be obtained from the full TAL metals analysis performed on all samples.
  - Alkalinity (Hach 8203); will be measured in the field. The major anions bicarbonate and carbonate will be obtained from speciation of alkalinity based upon the field pH of the sample.

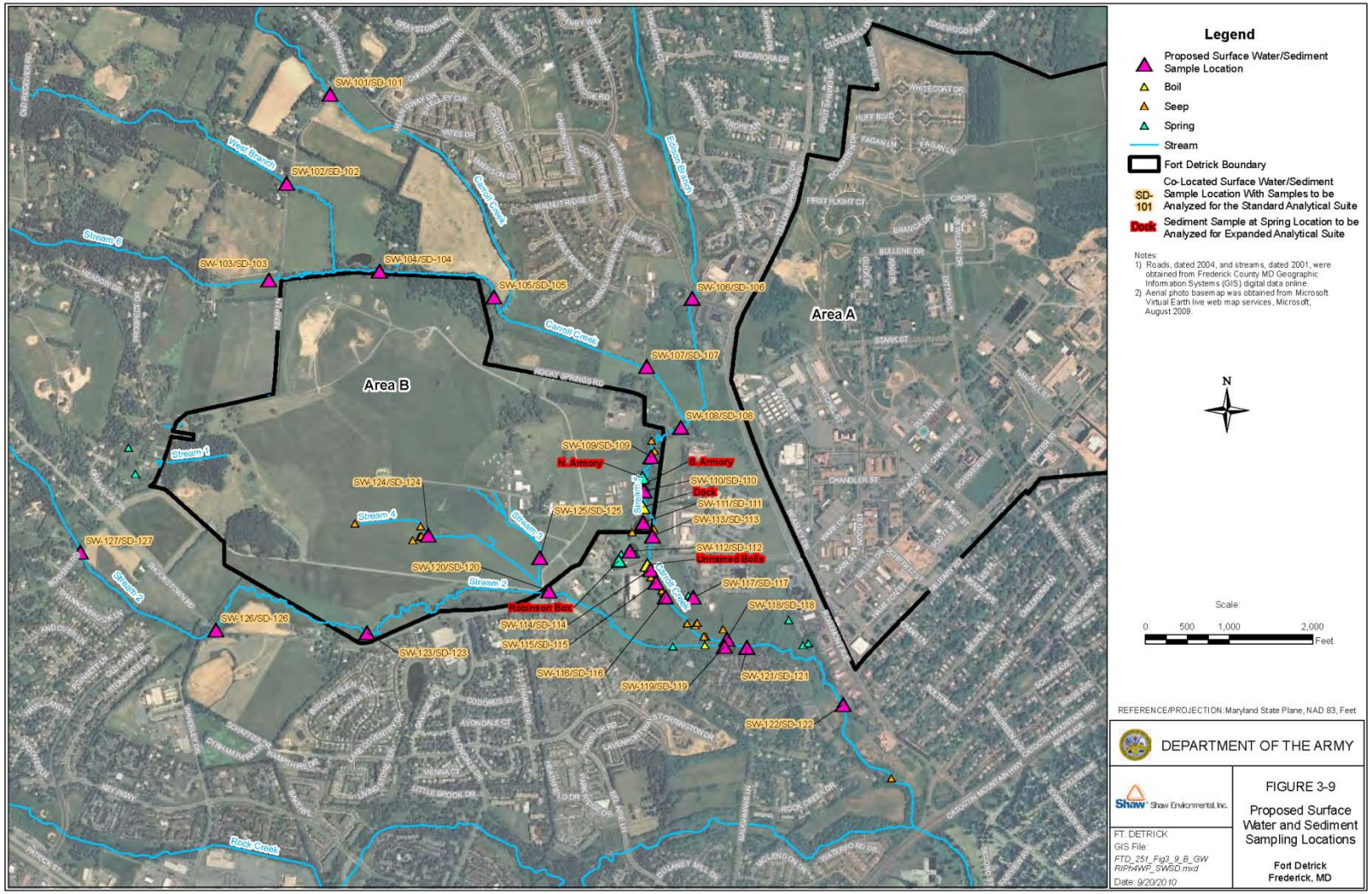
Groundwater Sampling Locations



Surface Water/Sediment Sampling

- Two rounds of surface water and a single round of sediment sampling will be performed to provide data for characterization and the ecological and human health risk assessments
  - Surface water samples will be collected during the same wet and dry timeframes as the groundwater sampling
  - Sediment sampling will be conducted concurrent with one of the two synoptic events
- There will be 27 sets of surface water and sediment samples collected; samples will be collocated as much as possible
  - For these recommended sample locations, 10 are background locations, 6 are on-site locations, and 11 are off-site downgradient locations
- Surface water and sediment samples will be analyzed for the following:
  - TCL VOCs + 20 TICs (EPA Method 8260B)
  - TCL SVOCs + 20 TICs (EPA Method 8270C)
  - Bis(2-chloroisopropyl)ether (EPA Method 8270C SIM)
  - TCL Pesticides/PCBs (EPA Method 8081A/8082)
  - TAL Metals (EPA Method 6010B/7470A/7471A)
  - Robinson Spring and any known boils will also be sampled for BCEE (EPA Method 8270C)
  - Five springs (Robinson Spring, North Armory Spring, South Armory Spring, Dock Spring, and the series of sand boils at the Montevue Lane Bridge footing on Carroll Creek) have been identified for sediment sampling, with samples to be analyzed for the “expanded” suite

Surface Water/Sediment Sampling Locations



Vapor Intrusion Sampling

- A site-specific vapor intrusion assessment utilizing a lines-of-evidence approach will be used for screening and evaluating the potential for vapor intrusion conditions to residential and commercial properties in the vicinity of the PCE and TCE groundwater plume originating from Area B
- The first step in the site-specific vapor intrusion assessment would be to collect soil gas samples through the foundations (i.e., sub-slab) of occupied buildings that are known or suspected to be within 100 ft of the VOC (TCE and/or PCE) groundwater plumes
  - Dependent upon site access to these properties, samples of sub-slab soil gas will be collected from 5 off-site buildings and one on-site Area B building
  - Locations were selected due to the known presence of PCE and TCE in groundwater at Robinson Spring; the investigation will be expanded as necessary as more information is developed
  - For each building being evaluated, at least three samples will be collected, through the foundation, at opposite ends of the building as feasible according to site conditions
  - Soil gas samples will be collected in Summa canisters equipped with flow regulators from temporary soil gas probe points installed through the bottom of the concrete floor
  - The samples will be collected over a 2-hour period and analyzed for the full list of VOCs using EPA Method TO-15
- If the results of soil gas indicate the potential for vapor intrusion into the building then a follow-on investigation involving indoor air samples may be required
  - The determination of how best to proceed with the assessment will be made in consultation with the USEPA regulators, USAEC, and the property owners

Vapor Intrusion Investigation Locations