National Aeronautics and Space Administration

FINAL WORK PLAN
FOR THE NORTHERNMOST A2/B1 AQUIFER
PLUME DEFINITION ASSESSMENT

NASA AMES RESEARCH CENTER
Moffett Field, California

NASA Ames Research Center
Moffett Field, CA

June 2014

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Plume Definition Assessment

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Moffett Field, California

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1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) Ames Research Center (Ames) Environmental Management Division along with Earth Resources Technology, Inc. (ERT), NASA Ames' environmental support contractor, has prepared this Work Plan for the Northernmost A2/B1-Aquifer Plume Definition Assessment. This document describes the activities that will be conducted to achieve the following objectives:

- Conduct Cone Penetrometer Testing (CPT) in the vicinity of NASA well 14D25A2 to define the A2/B1-aquifer channel boundaries,
- Collect Hydropunch grab-groundwater samples to delineate Volatile Organic Compound contamination in the A2/B1 aquifer,
- Install one A2/B1-aquifer groundwater monitoring well, and
- Evaluate the hydraulic containment and plume stability in this area.

This work is being conducted in response to EPA's request based on the recommendations provided in *Final Grab-Groundwater Assessment and Proposed Well Installations* (Geosyntec, 2013). A further discussion of the background of this proposed work is provided in Section 3.0 – Project Background.

Although not part of the objectives under this work plan for A2/B1 Aquifer characterization, the CPT sampling will also be used to better define the A1 aquifer in the vicinity of extraction wells NASA-1A and NASA-2A to support evaluation of A1 aquifer optimization efforts. A1 aquifer groundwater samples will also be collected at select locations to help define the A1 aquifer plume boundaries. The results of this supplemental sampling will be provided to the Agencies (EPA and RWQCB) in a separate Technical Memorandum.

Additional reconnaissance sampling will also be conducted under this mobilization to provide data for evaluation of vapor intrusion near the FEMA Warehouse (Building N144), and to characterize a potential, low-level groundwater source area near extraction well NASA-3A. The sampling detail and results will be submitted to the Agencies in a separate Technical Memorandum.

2.0 SITE DESCRIPTION

2.1. Site Location

NASA Ames is a federal aerospace facility located near the southern end of the San Francisco Bay and the northern end of Santa Clara County (Figure 1). NASA Ames is approximately 40 miles south of San Francisco and adjacent to the cities of Mountain View and Sunnyvale, California. NASA Ames consists of the Ames Campus Area and the former Naval Air Station Moffett Field (Figure 2).

2.2. Site Sampling Area

The study area lies in the east-central portion of NASA Ames (Figure 3), along the southern perimeter of the FEMA Warehouse. Included in Figure 3 are A2/B1-aquifer monitoring wells 14D25A2 and WU4-19, as well as CPT-40, which are referenced by Geosyntec (Geosyntec, 2013).

The study area lies within Areas of Responsibility AR-4-A2 and AR-5-A2, and is immediately down-gradient of Area of Responsibility AR-3-A2. The Areas of Responsibility were established as part of the *Allocation and Settlement Agreement for MEW Remedial Program Management between the National Aeronautics and Space Administration and Fairchild Semiconductor Corporation, Raytheon Company, and Intel Corporation* (1998). As specified in the Agreement, NASA is responsible for the source removal, source control, and groundwater extraction in the A2/B1 aquifer in Areas of Responsibility AR-4-A2 and AR-5-A2. The Middlefield-Ellis-Whisman (MEW) companies are responsible for the groundwater extraction in the A2/B1 aquifer in AR-3-A2, while NASA maintains responsibility for the source removal and source control of any additionally identified sources.

Figure 1
Site Location Map

Figure 2
Aerial View of NASA Ames Research Center

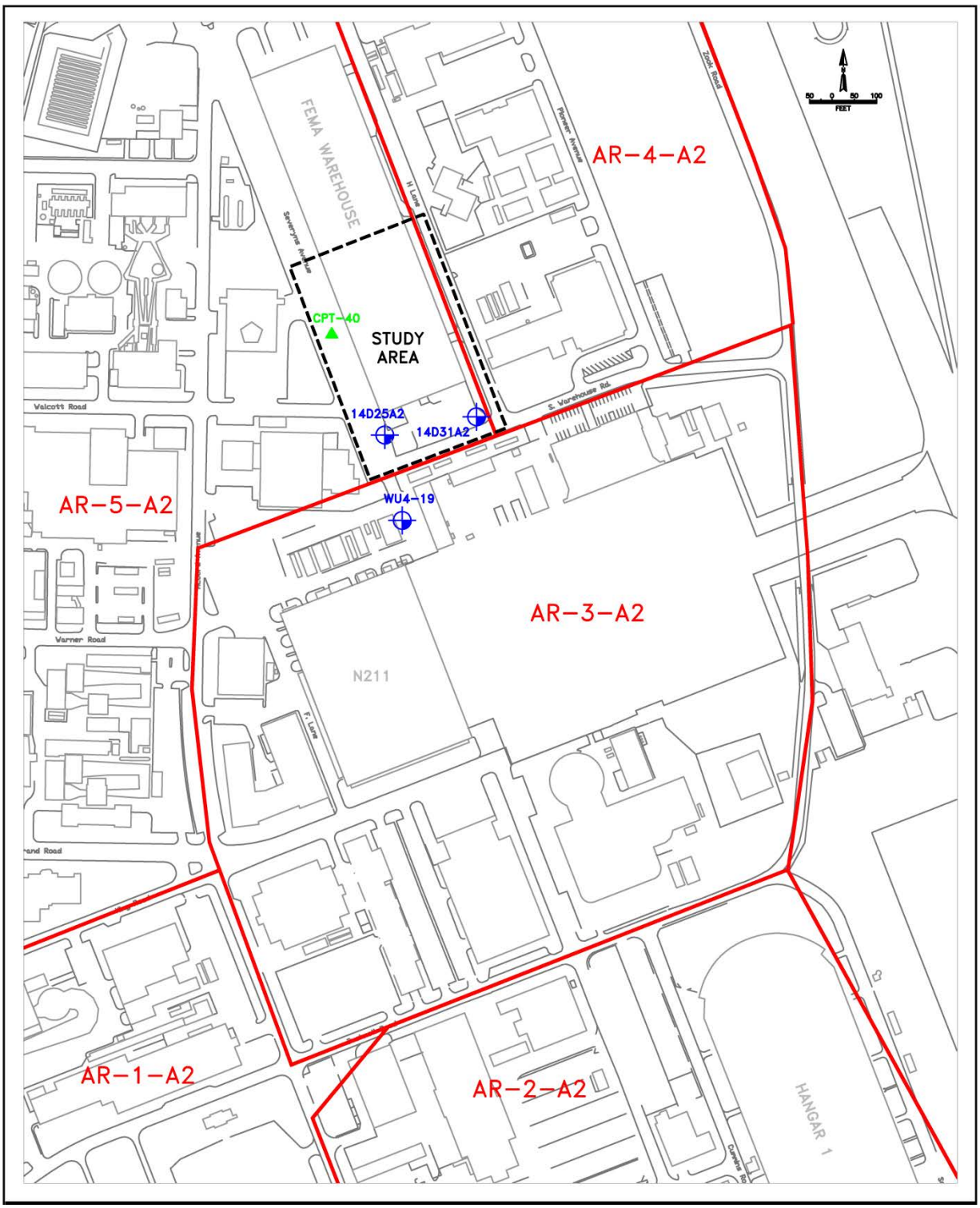

Figure 3
Study Area Location Map

3.0 PROJECT BACKGROUND

Information on the site background and Regional Groundwater Remediation Program (RGRP) remedy is included in the *Work Plan for Hydraulic Containment of Groundwater Plume, Middlefield-Ellis-Whisman Regional Groundwater Remediation Program, Mountain View, California* (Geosyntec, 2012a) and is not repeated herein. The Project Background presented below applies only to the history relevant to the proposed installation of the NASA A2/B1-aquifer groundwater monitoring well.

In response to EPA's 12 March 2012 letter (EPA, 2012a) to the RGRP, Navy, and NASA, Geosyntec Consultants prepared the *Work Plan for Hydraulic Containment of Groundwater Plume (Geosyntec, 2012a)*. The work plan was prepared to address the EPA's issues of hydraulic capture and stability of the volatile organic compound (VOC) groundwater plume in the A2/B1 aquifer identified in the *Second Five-Year Review Report for MEW* (EPA, 2009).

In an EPA 27 September 2012 letter (EPA, 2012b) responding to the *Work Plan for Hydraulic Containment of Groundwater Plume*, EPA requested that the work plan be amended to include the installation of monitoring and extraction wells to address data gaps identified in various areas. In November 2012, Geosyntec submitted an *Amendment to the Work Plan for Hydraulic Containment of Groundwater Plume* to EPA (Geosyntec, 2012b).

As part of the *Amendment to the Work Plan*, a cone penetration testing (CPT) and grab-groundwater sampling program was proposed to identify locations for the installation of additional monitoring wells. EPA approved the *Amendment to the Work Plan* in a letter dated 15 November 2012 (EPA, 2012c), and the CPT and grab-groundwater assessment scope of work was implemented between November 2012 and February 2013.

The findings of the grab-groundwater sampling program were provided in the *Final Grab-Groundwater Assessment and Proposed Well Installations* (Geosyntec, 2013). The evaluation of hydraulic containment at the northernmost toe of the plume in the A2/B1 aquifer in NASA's area of responsibility indicated the presence of TCE at elevated concentrations in the vicinity of well 14D25A2 (Figure 4). The investigation showed that concentrations of TCE in existing A2/B1-aquifer wells 14D25A2 and WU4-19 were 120 µg/L and 100 µg/L, respectively. A grab-groundwater sample collected from CPT-40 installed during the investigation did not contain detectable concentrations of TCE.

Based upon the findings presented in the report (Geosyntec, 2013), the installation of a NASA A2/B1-aquifer monitoring well was recommended. The recommended well is referred to as "NASA-6-A2." In their 30 July 2013 letter comments on the report (EPA, 2013), the EPA reiterated that the installation of this well was critical for demonstrating hydraulic containment in the A2/B1 aquifer.

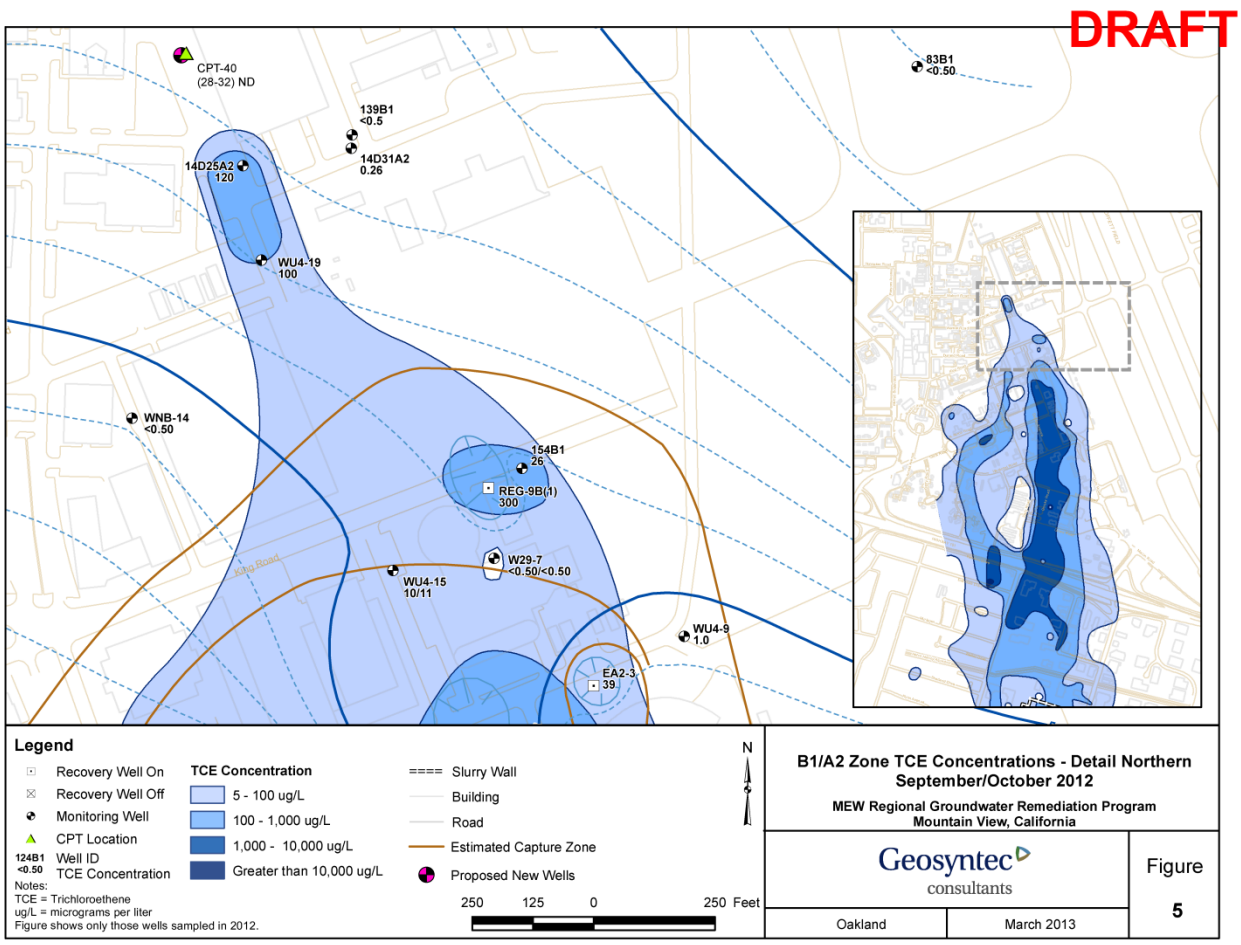

Figure 4
Geosyntec Reference Map
(Geosyntec, 2013)

4.0 SUBSURFACE ENVIRONMENT

4.1. Geologic Setting

NASA Ames lies at the northern end of the Santa Clara Valley along the southwestern rim of San Francisco Bay. The Santa Clara Valley is located between the Santa Cruz Mountains to the west and the Diablo Range to the east. The area is underlain by a sequence of Pliocene-Pleistocene and Upper Quaternary unconsolidated sediments up to 1,500-feet thick. The sediments were derived from the Santa Cruz Mountains and deposited in alluvial, estuarine and sublittoral environments. Additionally, fine-grained sediments were transported and deposited by waters of the San Francisco Bay.

The study area is underlain by channel, crevasse splay, and floodplain deposits. The subsurface geology consists primarily of clay, silty clay, clayey sand, and sand. Black clayey marsh sediments extend approximately nine feet below ground surface. The marsh sediments are underlain by interbedded deposits of unconsolidated clay, silt, sand, and gravel. The interbedded channel deposits are coarse grained, discontinuous, and of varying thickness. The channel deposits may pinch out into crevasse splay and floodplain deposits (TTEMI, 2004).

4.2. Hydrogeologic Setting

Underlying NASA Ames are alluvial or fluvial aquifers separated by lower permeability silts and clays. These aquifers are divided into two sequences based on the location of a laterally-extensive clay layer which separates the shallower, unconfined or semi-confined sequence ("A" and "B" aquifers) from the deeper, confined sequence ("C" and "Deep" aquifers).

The A1 aquifer consists of stringer-like alluvial channel deposits composed of sand and gravel inter-bedded with fine-grained flood plain deposits. These channel deposits, oriented generally south to north, provide complex pathways for groundwater and contaminants. Although the degree of channel continuity has not been definitively determined, the depositional environment of the A1-aquifer materials has been interpreted to be a low-lying flood basin subject to periodic flooding events. The A1-aquifer extends from a depth of approximately 5 feet to 25 feet below ground surface (bgs).

The A1 aquifer is separated from the A2/B1 aquifer by a discontinuous, lower permeability horizon located between 25 feet and 30 feet bgs. Subsequent to deposition of these discontinuous aquitard materials, a cemented caliche horizon formed at the top of the aquitard that, in turn, provided increased resistance to future scouring flood events. The caliche zone marks the top of this horizon, and although it is not a hydraulic boundary, where present, it is useful in delineating the A1-A2 boundary (PRC, 1997).

The A2/B1 aquifer appears to have the same depositional environment as the A1 aquifer. The A2/B1 aquifer extends between depths of approximately 30 feet to 50 feet bgs.

4.3. Physical Conditions

Based on the geologic logs of locations 14D25A2, 14D31A2, and CPT-40, three separate course-grained channel deposits are present in the upper 40 feet of sediment within the study area. The channel deposits are as follows:

- A 2- to 5-foot-thick sand to gravelly sand encountered between 9 and 14 feet bgs is present at all three locations.
- A 5-foot- thick sand and gravel encountered between 22 and 27 feet bgs is present only at location 14D25A2.
- A 4- to 9-foot-thick sandy gravel to gravelly sand encountered between 28 to 38 feet bgs is present at all three locations.

Prior to groundwater extraction, the depth to first encountered groundwater (A1 aquifer) typically ranged from 5 to 7 feet bgs. Recent depth-to-water measurements to first encountered groundwater range from 9 to 15 feet bgs. Vertical gradients between the A1 aquifer and A2/B1 aquifer were determined using the November 20, 2012 groundwater elevation data. A local upward groundwater gradient of 9.60 feet exists between the A2/B1 aquifer and the A1 aquifer (well pair 14D25A2/14D26A1). This well pair is located within 10 feet of extraction well NASA-1A. Prior to groundwater extraction, this well pair indicated a local upward gradient of about 1.0 feet. While well 14D26A1 experienced a noticeable response to initiation of pumping, well 14D25A2 exhibited little response.

5.0 SAMPLING RATIONALE

As part of the work performed under Geosyntec' s *Work Plan for Hydraulic Containment of Groundwater Plume for the RGRP (Geosyntec, 2012a)*, one A2/B1-aquifer CPT boring (CPT-40) was logged and sampled in the vicinity of NASA well 14D25A2. The grab-groundwater sample data was supplemented with groundwater samples collected from nearby A2-aquifer wells 14D25A2, 14D31A2, and WU4-19, and 139B1.

The findings of the investigation were presented in *the Final Grab-Groundwater Assessment and Proposed Well Installations* (Geosyntec, 2013). Based on the results of the investigation, an area of elevated TCE concentrations was mapped between wells WU4-19 and 14D25A2 (previous Figure 4). The groundwater collected from CPT-40 did not contain detectable concentrations of TCE, although other VOCs were reported at sub-MCL concentrations. The report recommended the installation of an A2/B1-aquifer groundwater monitoring well in this area, referred to as "NASA-6-A2."

Even though there is no known NASA source for the contamination present in the A2/B1-aquifer well 14D25A2, and that NASA does not agree with the TCE concentration contouring in the vicinity of this well, NASA will install an A2/B1-aqufier well hydraulically down-gradient of groundwater monitoring well 14D25A2.

However, NASA does not concur that the proposed location (Geosyntec' s CPT-40) is the most appropriate location for the proposed A2/B1-aqufier well. Although the depth and thickness of the encountered sand units present at CPT-40 and 14D25A2 are similar, NASA believes that the absence of TCE at CPT-40 suggests that the sand unit between the two locations may not be continuous or hydraulically connected. Typically, TCE concentrations would not be expected to diminish from 120 µg/L to below detection over such a relatively short distance (approximately 250 feet) without the presence of significant modifying factors (e.g., co-metabolism with petroleum hydrocarbons).

Therefore, NASA will complete eight (8) CPTs to better determine the most appropriate location for an A2/B1-aquifer monitoring well hydraulically connected to the A2/B1-aquifer channel deposits present in 14D25A2. NASA will also collect grab-groundwater samples from the CPT locations where A2/B1-aquifer sand units are encountered.

5.1. Sampling Objectives

The objectives of this investigation are to:

- Conduct Cone Penetrometer Testing in the vicinity of NASA well 14D25A2 to define the A2/B1-aquifer channel boundaries.
- Collect Hydropunch grab-groundwater samples to delineate VOC contamination in the A2/B1 aquifer.
- Install one A2/B1-aquifer groundwater monitoring well at appropriate location.
- Evaluate the A2/B1-aquifer plume boundaries in this area.
- Evaluate the hydraulic containment of groundwater flow in this area.

5.2. Sampling Strategy

The following sections describe the sampling strategy that will be used to achieve the project's objectives. Groundwater samples will be collected in accordance with the procedures described in Section 6.0 – CPT/Hydropunch Field Methods and Procedures. The analytes for all samples are provided in Section 5.5 – Analysis of Samples.

5.2.1. Target Aquifer Depth

Based on the geologic logs of locations 14D25A2, 14D31A2, and CPT-40, a 4- to 9-foot-thick sandy gravel to gravelly sand channel deposit is present at all three locations from 28 to 38 feet bgs (A2/B1 aquifer).

5.2.2. Target Sampling Locations

Figure 5 was created to assist with determining the most appropriate locations for sampling. On Figure 5, the estimated boundaries of the A1-aquifer channel deposits (EKI, 1994) have been combined with the A2/B1-aquifer potentiometric surface map (Geosyntec, 2013).

In general, the occurrence of the A2/B1-aquifer channel deposits does not necessarily coincide with upper channel sequences (offset or cross-cutting relationships have also been observed at NASA Ames). However, as indicated in Figure 5, the orientation of the A2/B1-aquifer flow direction derived from the equipotential lines (northeasterly) coincides with the orientation of the A1-aquifer channel deposits. This suggests that the orientation of the A2/B1-aquifer channel deposits will be similar to the orientation to the A1-aquifer zone channel deposits.

Based on these observations, eight (8) CPT/Hydropunch locations (Figure 6) are proposed to better define the boundaries of the channel deposits and VOC plume in the A2/B1 aquifer. CPT logging will extend to a depth of 45 feet bgs at each location. Hydropunch grab-groundwater samples will be obtained from the first water-bearing zone in the A2/B1 aquifer based on the CPT geologic logging. Additional prominent water-bearing zones (based on grain size and layer thickness) also will be sampled.

5.3. Groundwater Monitoring Well Installation

Based on the findings of this investigation, along with information collected from previous investigations, NASA will determine the most appropriate location for the installation of the A2/B1-aquifer groundwater monitoring well. Prior to finalizing the location of the monitoring well, NASA will provide the Agencies (EPA and RWQCB) with the CPT/HydroPunch data and schedule a teleconference to discuss the proposed well location.

The well will be installed in accordance with the procedures provided in Section 7.0 – Monitoring Well Field Methods and Procedures.

5.4. Contingency Sampling

NASA understands that the findings of this investigation may not provide conclusive results as to the boundaries of the leading edge of the VOC plume in groundwater in the A2/B1aquifer. An assessment of the hydraulic containment of groundwater flow may also not be possible. If the need for additional investigation is indicated, NASA will prepare a separate Work Plan for EPA review.

5.5. Analysis of Samples

Groundwater samples will be analyzed for Volatile Organic Compounds (VOCs) using EPA Method 624 by California Laboratory Services, a California state-certified laboratory.

5.6. Sample Quality Assurance/Quality Control

Quality Assurance/Quality Control samples will be collected at the following frequencies:

- One field blank per 20 field samples (or fraction of) collected.
- One field duplicate sample per 20 field samples (or faction of) collected.
- One trip blank per each shipment to laboratory.

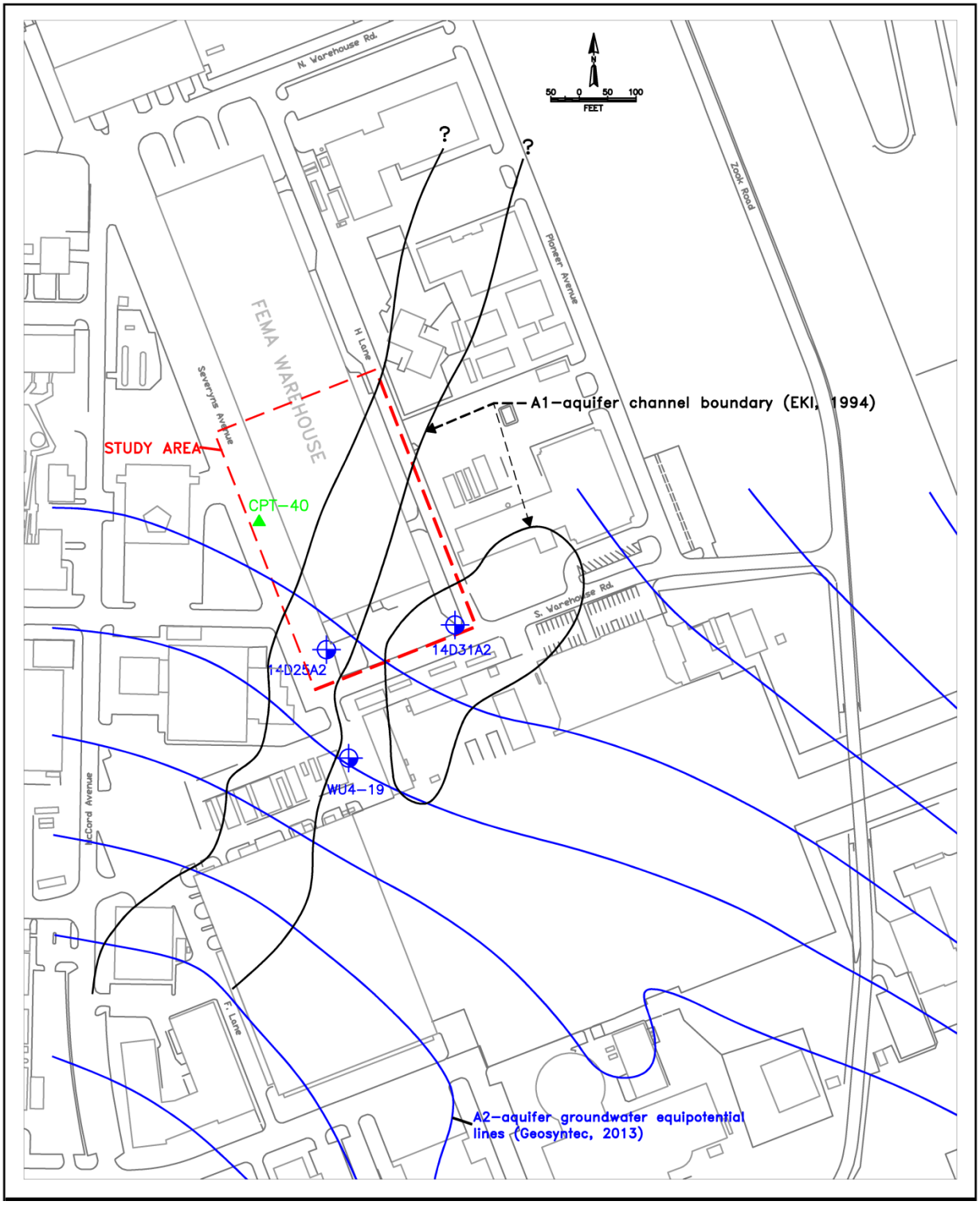

Figure 5
Study Area Channel Deposit and Groundwater Equipotential Map

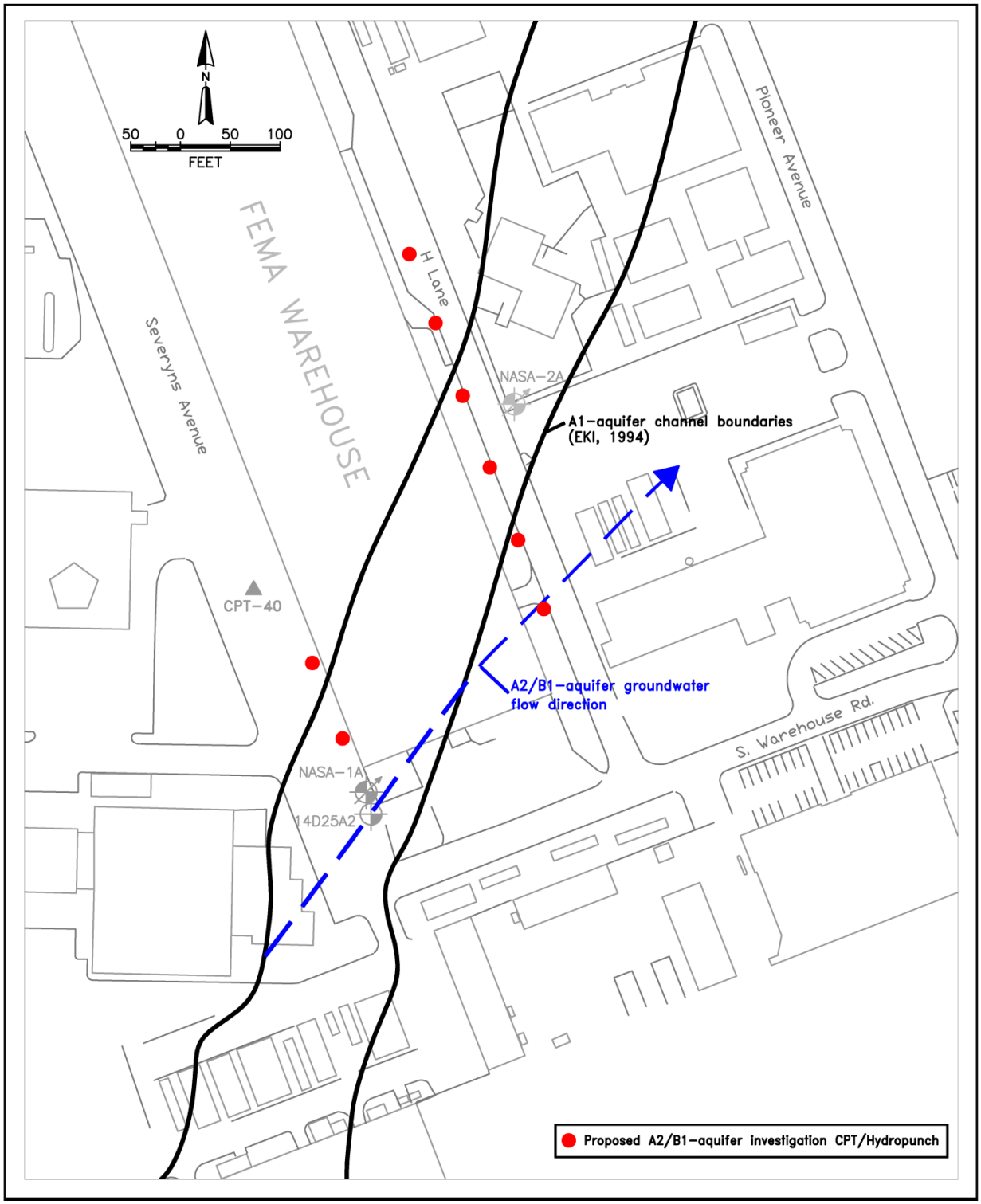

Figure 6
Proposed Sample Location Map

6.0 CPT/HYDROPUNCH FIELD METHODS AND PROCEDURES

6.1. Pre-Field Activities

Prior to the start of field activities the following will be performed.

- Internal NASA permits will be obtained.
- The work area will be reviewed for existing and potential hazards.
- A project-specific Health & Safety Plan will be developed.
- A subsurface utility survey will be conducted and all utilities will be marked.
- Daily tailgate safety briefings will be conducted with project workers and visitors.

6.2. CPT Logging

CPT logging will consist of collecting continuous geologic information. CPT logging will be conducted from surface grade to 45 feet bgs. After completing a CPT boring for geologic information, the boring will be backfilled with bentonite/cement grout from the bottom of the boring using the CPT rods in accordance with Santa Clara Valley Water District (SCVWD) requirements.

6.3. HydroPunch Sampling

At each location where a CPT boring for geologic logging is placed, a second CPT boring using Hydropunch sampling equipment will be advanced to obtain grab-groundwater samples. Groundwater samples will be obtained from the first water-bearing zone in the A2 aquifer based on the CPT geologic logging. Additional prominent water-bearing zones in the A2 aquifer (based on grain size and layer thickness) may also be sampled. The Hydropunch sample locations will be moved approximately three feet from the initial CPT boring in order to avoid grout slurry infiltration from the adjacent boring. After completing the groundwater sampling, the boring will be backfilled with cement/bentonite grout from the bottom of the boring using the CPT rods.

6.3.1. Collection of HydroPunch Groundwater Samples

Groundwater samples will be collected from each Hydropunch location using the following procedure:

- Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting groundwater samples at each location.

- CPT equipment will be used to drive the Hydropunch sampling system to the desired sampling depth. The Hydropunch sampling system consists of a stainless steel or PVC slotted screen interval, typically 12 to 24 inches in length, attached to a metal, conical drive tip.

- When the Hydropunch sampler reaches the sampling depth, the drive casing will be retracted, thereby exposing the Hydropunch screen interval to saturated formation.

- Over a 10-minute period, groundwater will be allowed to flow through the screen interval and into the annulus of the drive casing.

- A decontaminated stainless steel bailer will be used to retrieve groundwater samples. The bailer will be gently lowered into the well to reduce the potential for aeration of water.

- The water samples will be retrieved and inspected for floating product, sheen, emulsion, color, sediment, and clarity. The samples then will be gently poured into laboratory-certified clean sample containers and inspected for air bubbles (as required), which would allow volatilization to occur.

- The samples then will be labeled and promptly placed in iced storage.

- All sampling equipment will be decontaminated with a steam cleaner, followed by a rinsing with tap water before initial use and between borings.

6.4. Field Documentation

During sampling activities, the following information will be documented in a field logbook. The logbook will be used to record sufficient information so that someone can reconstruct the sampling without reliance on the collector's memory. Documentation in the field logbook will be completed legibly in permanent ink. The logbook will contain the following minimum information:

- Sample point designation.
- Sample point location.
- Sample identification number.
- Duplicate sample identification number, if applicable.
- Date and time sampled.
- Name of sample collector.
- Number and type of sample containers.
- Depth to water on day sampled.
- Method of sampling (bailing, pumping, etc.).
- Extraordinary circumstances (if any).
- Deviations from prescribed sampling methodology.

6.5. Sample Containers and Preservation

Table 1 lists the sample containers and preservative requirements recommended for the samples collected during the investigation. All sample containers will be laboratory-certified clean and will be stored away from sources of contamination until ready for use.

Table 1
Sample Containers and Preservatives Requirements

Sample Type	Analysis	Container	Preservative
Groundwater	VOCs	40-ml VOA w/Teflon septa	Cool (4ºC) HCl[1] No headspace

[1] Unpreserved VOA vials may be used if the groundwater reacts with the preservative.

Upon collection, samples will be placed in iced coolers maintained at 4ºC (40ºF). Periodically, throughout the day, the samples will be transferred to a refrigerator and maintained at 4ºC (40ºF).

6.6. Sampling Labeling and Chain of Custody Procedures

The purpose of these procedures is to assure that the integrity and traceability of samples are maintained during their collection, transportation, and storage before analysis. Each sampling event requires the use of a chain-of-custody (COC) to document the sequence of custody exchanges from the time the sample is collected to the time it is received by the laboratory. The COC procedures outlined in this section comply with the requirements outlined in *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (EPA, 2001). In addition, other site-specific requirements established in the *Unified Quality Assurance Project Plan (UQAPP), Middlefield-Ellis-Whisman Study Area, Mountain View and Moffett Field, California* (Canonie, 1991) are included.

6.6.1. Sample Labeling

To prevent sample misidentification, sample containers will be labeled before or immediately after sampling with self-adhesive labels. The labels will be sufficiently durable to remain legible even when wet and will contain the following information written in waterproof ink:

- Client and project number.
- Sample location.
- Sample identification number.
- Date and time sample was collected.
- Preservative used.
- Initials of sample collector.
- Analyses required.

6.6.2. COC Procedures

After the samples are collected and labeled, they will be maintained under COC procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a COC record, which includes instructions to the laboratory for analytical services. Information contained on the COC record will include:

- Client name/address.
- Project name/identification number.
- Project Manager name and phone number.
- Signature of sampler(s).
- Date and time sampled.
- Sample identification number.
- Number and type of sample containers.
- Sample matrix.
- Analyses required.
- Remarks, including preservatives, special conditions, or quality control measures.
- Turnaround time and person to receive laboratory report.
- Destination laboratory.
- Release signatures of sampler(s) and signatures of all people assuming custody.
- Condition of samples when received by laboratory.

6.7. Handling, Storage, and Transportation

Immediately following collection, samples will be placed in a clean chest that contains blue ice and will be transported to the laboratory as soon as practical. Samples that are not transported immediately will be securely stored and maintained at 4°C (40°F), until the next scheduled pickup occurs.

Samples always will be accompanied by a COC. When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC. Samples will be packaged properly for shipment and dispatched to the laboratory for analysis.

The sample custodian at the laboratory will receive and assume custody of samples delivered by courier. The sample custodian will verify the following:

- All samples are present.
- All samples are in good condition.
- All samples are accompanied by a COC.
- The sample identification is complete and corresponds to the COC.

6.8. Equipment Decontamination

Equipment used during the installation of CPT borings and the collection of Hydropunch samples will be decontaminated to prevent cross-contamination. All sampling equipment will be decontaminated prior to use and between each sample location. Waste products produced during equipment decontamination (e.g., rinse liquids, solids, gloves, etc.) will be collected and disposed of properly. The following steps will be used to decontaminate all equipment:

- Removed gross contamination from the equipment by brushing and then rinsing with an Alconox/tap water solution.
- Steam machine/pressure washing.
- Final rinse of equipment with tap water.

6.9. Disposal of Investigation-Derived Waste

The decontamination solutions and water will be processed through NASA's groundwater treatment system.

7.0 MONITORING WELL FIELD METHODS AND PROCEDURES

The A2/B1-auqifer groundwater monitoring well will be installed at the most appropriate location based on the CPT/Hydropunch investigation. The well location selection will be based on the CPT/Hydropunch location with the most permeable water-bearing zone and the highest grab-groundwater sample VOC concentrations.

7.1. Pre-Field Activities

Prior to the start of field activities the following will be performed.

- Internal NASA permits will be obtained.
- Well construction permit will be obtained from the Santa Clara Valley Water District.
- The work area will be reviewed for existing and potential hazards.
- A project-specific Health & Safety Plan will be developed.
- A subsurface utility survey will be conducted and all utilities will be marked.
- Daily tailgate safety briefings will be conducted with project workers and visitors.

7.2. Monitoring well Installation

The monitoring well will be drilled and installed by a C-57 licensed drilling contractor using the hollow-stem auger drilling method.

The well will be constructed according to the Santa Clara Valley Water District's *Ordinance 91, Standards for the Construction and Destruction of Well and other Deep Excavations in Santa Clara County* (SCVWD, 1991) and California Department of Water Resources' *Water Well Standards", Bulletin Nos. 74-81 and 74-90* (CDWR, 1981 & 1990).

7.2.1. Drilling

Soil cuttings will be inspected and logged by a California Professional Geologist using the Unified Soil Classification System. The soil will be field-screened using a photoionization detector (PID) and the readings recorded on the boring logs. All down-hole equipment will be decontaminated prior to use.

Soil samples will be collected from the proposed screened interval based on adjacent CPT results. The samples will be collected to verify the presence of coarse-grained materials and for grain-size analysis to ensure that the proper well slot size and sand pack are used. The method of sample collection will be based on the recommendations of the selected drilling subcontractor and the capabilities of their drilling rig.

The screened interval for the monitoring well will be based on the presence of coarse-grained materials as indicated by the adjacent CPT and verified by the collection of soil samples from the targeted interval. The length of the screened interval may be between 5 and 20 feet long.

Based on available lithologic data of nearby A2/B1-aquifer monitoring wells, NASA anticipates the screened interval will be 10 feet long.

The well will be installed through the hollow-stem auger. The well will be constructed of 2-inch diameter Schedule 40 PVC casing with factory-cut, slotted well screen, flush-threaded joints, and a bottom cap. The slot size will be either 0.010 or 0.020 inch, based on the grain size of the permeable material. The annular space between the borehole wall and well screen for each well will be filled with filter-pack sand to a depth of about two feet above the top of the well screen. The filter back will be either #12/16 or #3 sand, based on the grain size of the permeable material.

Centralizers will be used to center the well in the borehole. Approximately 2 to 3 feet of bentonite chips or pellets will be placed above the sand pack and hydrated to provide a seal above the filter pack. The remainder of the borehole will be tremie filled with neat cement to the ground surface in accordance with SCVWD requirements.

After installation, the location and elevation of the new well will be surveyed by a California licensed surveyor. The new monitoring well will be surveyed using the same coordinate system and elevation datum as the existing NASA monitoring well network. Re-surveying of existing monitoring wells in the vicinity of the newly installed well will also be performed.

7.2.2. Well Development

The purpose of well development is to remove the fine-grained materials inside the filter pack and casing, to stabilize the filter pack around the well screen, and to produce representative water samples from the water-bearing zone.

After a minimum of 72 hours following well installation, the new monitoring well will be developed. Development will consist of a combination of bailing, surging, and pumping. Groundwater quality parameters (temperature, pH, and specific conductance) will be measured during development activities. Development will be continued until the well is judged to be adequately developed and well parameters pH, temperature, and conductivity have stabilized.

7.3. Investigation-Derived Waste

Water generated during the well installation and development activities will be collected in 55-gallon drums and processed through NASA's groundwater treatment system. Soil cuttings will be temporarily stored on-site in 55-gallon drums pending analysis. Following waste profiling, soil cuttings will managed in accordance with NASA's soil reuse policy or disposed of at an appropriate off-site facility in accordance with Federal and State requirements.

7.4. Sampling

The initial groundwater sampling will occur immediately upon completion of well development. Groundwater samples will then be collected from the new monitoring well quarterly for the first year using the same sampling standard operating procedures used for NASA's semi-annual groundwater monitoring program.

8.0 REPORTING

Upon completion of the CPT/HydroPunch investigation field work, NASA will provide the lithologic and groundwater chemical data to the Agencies and schedule a teleconference to discuss the proposed location for the A2/B1 aquifer monitoring well.

A Report of Findings will be prepared to present the results of the CPT/HydroPunch investigation, well completion details, and well sampling results. Recommendations for any additional investigation will also be included in the Report of Findings.

NASA will provide separate Technical Memoranda presenting the details and findings of the supplemental site characterization work conducted under this mobilization. This work includes additional definition of the A1 aquifer channel and plume boundary, evaluation of groundwater vapor intrusion pathways near the FEMA Warehouse, and evaluation of a potential, low-level source area near NASA-3A.

9.0 SCHEDULE

NASA anticipates the following schedule assuming approval of the Work Plan in June 2014 and availability of the drilling subcontractor:

- Agency approval of Work Plan: June 2014
- Field work mobilization: July 2014. NASA will provide 10 days' notice prior to start of field work.
- CPT logging and Hydropunch groundwater sampling and analysis: August 2014
- Review and submittal of lithologic and groundwater chemical data, and teleconference to discuss the A2/B1 aquifer monitoring well location: September 2014
- A2/B1 monitoring well installation: September 2014
- Report of Findings and Technical Memoranda: October 2014

10.0 REFERENCES

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EPA, 2012b. *EPA Response to Work Plan for Hydraulic Containment of Groundwater Plume. Middlefield-Ellis-Whisman Superfund Study Area. Mountain View and Moffett Field, CA.*

EPA, 2012c. *EPA Response and Approval of Amendment to Work Plan for Hydraulic Containment of Groundwater Plume. Middlefield-Ellis-Whisman Superfund Study Area. Mountain View and Moffett Field, CA.*

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ATTACHMENT 1

Response to Comments

NASA Ames Response to EPA Review Comments

Draft Work Plan for the Northernmost A2/B1-Aquifer Plume Definition Assessment, NASA Ames Research Center, Moffett Field, California, December 2013 (ERT, 2013)

EPA Comment 1

Once the hydropunch and CPT data are available, NASA and the regulatory agencies should meet to review the data and discuss the optimum location for a monitoring well or whether additional sampling is warranted. Please add to the work plan a sentence indicating that a teleconference meeting will be scheduled to discuss CPT and hydropunch results prior to installation of a well (Section 5.3) or contingency sampling (Section 5.4).

NASA Response to Comment 1

Section 5.3 is revised to include consultation via teleconference to discuss the proposed monitoring well location.

The contingency sampling discussed in Section 5.4 will only be conducted if the current Work Plan investigation does not provide conclusive results. The need for additional sampling will be proposed in the Report of Findings for the current work. A separate Work Plan for additional sampling, if necessary, will be provided to the Agencies for review and comment.

EPA Comment 2

As indicated in the cover letter, please specify in the work plan how the data will be used to make any potential optimization to NASA's groundwater extraction and treatment system since this work includes geologic characterization and sampling near wells NASA 1A and 2A. During the September 26, 2013 meeting, it was discussed that while pumping has increased in Well NASA 1A, pumping may not be achieving capture zones. For wells NASA 3A and 4A, which are located outside the area of evaluation for this work plan, it was discussed at the meeting that better source identification is needed.

NASA Response to Comment 2

Text has been added to the Introduction (Section 1.0) that outlines the data that will be collected to support NASA's A1 aquifer optimization work concurrent with the A2/B1 aquifer investigation. Text has also been added introducing the reconnaissance sampling being conducted under this mobilization to support NASA's vapor intrusion evaluation near the FEMA Warehouse and evaluation of the potential, low-level source area near NASA-3A. These additional data collection efforts will be addressed under separate Technical Memoranda as stated in the newly added Reporting section (Section 8.0).

EPA Comment 3

Section 5.5. Analysis of Samples. Text indicates that groundwater samples will be analyzed for VOCs using EPA Method 5030/624. Please remove method 5030.

NASA Response to Comment 3

Method 5030 is removed from the text.

EPA Comment 4

Section 6.3. Hydropunch Sampling. Revise text to indicate that grab groundwater samples will be collected from each water bearing unit encountered within the B1/A2 Zone. This will help in selection of the optimum well screen location.

NASA Response to Comment 4

This item is addressed in Section 5.2.2, which states that additional, prominent water-bearing zones will also be sampled. The Earth Resources Technology project geologist will review the CPT logs prior to HydroPunch sampling to determine prominent water-bearing zones. No changes are made to the text of Section 6.3 since it is a more generalized "standard operating procedures" section and does not include that level of detail.

EPA Comment 5

Please add a schedule for the work at the end of the work plan.

NASA Response to Comment 5

Section 9.0 – Schedule is added to the work plan with this information.

EPA Comment 6

Add a section specifying the number and type of quality assurance/quality control samples that will be collected.

NASA Response to Comment 6

Section 5.6 is added to specify the QA/QC samples.

EPA Comment 7

Figure 5 shows a circular area encompassing location 14D31A2. Please clarify if this represents a channel deposit or sand and gravel or something else.

NASA Response to Comment 7

Figure 5 is revised to clarify the boundaries of the sand and gravel deposits.