ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

NORTHROP GRUMMAN

Groundwater Monitoring Plan Addendum

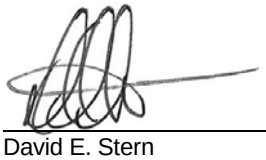
Operable Unit 2

Northrop Grumman Systems Corporation, Bethpage, New York.

December 19, 2012

ARCADIS

Melissa Reindl
Project Scientist



David E. Stern
Senior Hydrogeologist

Mike Wolfert
Project Director

Groundwater Monitoring Plan Addendum – Operable Unit 2

Northrop Grumman Systems Corporation, Bethpage, New York

Prepared for:
Northrop Grumman Systems Corporation

Prepared by:
ARCADIS of New York, Inc.
Two Huntington Quadrangle
Suite 1S10
Melville
New York 11747
Tel 631 249 7600
Fax 631 249 7610

Our Ref.:
NY001496.0312.GWMH2

Date:
December 19, 2012

1.0 Introduction

This addendum to the Groundwater Monitoring Plan (Plan), prepared by ARCADIS of New York, Inc. (ARCADIS) on behalf of Northrop Grumman Systems Corporation (Northrop Grumman), is associated with Operable Unit 2 (OU2) of the Northrop Grumman Systems Corporation site, located in Bethpage, New York (Site). This Plan represents an update to the Groundwater Monitoring Plan that was originally submitted in 2001 and revised in 2006. The revised Plan has been approved by the New York State Department of Environmental Conservation (NYSDEC) (ARCADIS Geraghty & Miller, Inc. 2001; 2006). Specifically, this addendum incorporates the use of HydraSleeve™ as a "no purge" method to conduct the environmental effectiveness monitoring activities associated with OU2. This addendum was prepared in response to the NYSDEC's conditional approval of the use of the HydraSleeve™, dated August 1, 2012.

1.1 Background

The former Grumman Aerospace Corporation (now the Northrop Grumman Corporation) facility (New York State Superfund Site ID# 1-30-003A) had been situated on 500 acres in east-central Nassau County, in the Hamlet of Bethpage, Town of Oyster Bay, New York. The original site had been bounded by Stewart Avenue to the north, Central Avenue to the south, Route 107 to the southwest, South Oyster Bay Road to the west, and various residential and commercial areas to the east. Northrop Grumman currently occupies several individual parcels distributed over the original 500 acres formerly comprising the Grumman Aerospace Corporation facility. Areas owned by Northrop Grumman include acreage north of the former NWIRP Bethpage facility, the property occupied by the two on-site treatment systems, and the recharge basins located at the southern and western end of the Site. The Site with well locations is shown on **Figure 1**.

Groundwater beneath the Northrop Grumman and NWIRP sites is impacted by VOCs in excess of NYSDEC Standards, Criteria, and Guidance Values (SCGs), as documented in the Remedial Investigation Report (Geraghty & Miller, Inc. 1994). The OU2 groundwater remedy summarized herein was included in the Record of Decision (ROD) to address the on-site portion of VOCs in groundwater that are associated with the Northrop Grumman and NWIRP sites. This remedy consists of the ONCT treatment systems (Towers 96 and 102) and five recovery wells, as follows: Wells 1 and 3 (associated with Tower 96) along with Wells 17, 18, and 19 (associated with Tower 102). These five wells in combination pump a total of 3,800 gallons per minute to Towers 96 and 102, where VOCs are removed via air stripping and then the VOCs in

the air stream are filtered using vapor phase granular activated carbon (VPGAC). At Tower 96, potassium permanganate impregnated zeolite polishing is also performed (following VPGAC filtering) before discharge to the atmosphere. Treated water is discharged predominantly to the South Recharge Basins, with remaining water used as makeup to the local Calpine facility and to the West Basins (**Figure 1**).

2.0 Scope

The Plan set forth the well evacuation (i.e., purging) and groundwater sample collection protocols utilized for the groundwater monitoring program. By this addendum, the purge methods for monitoring wells will be replaced by use of the HydraSleeve™ sampler. The use of the HydraSleeve™ sampler during the routine environmental effectiveness monitoring program will result in comparable representative samples while also reducing the sampling equipment needed to perform the work, producing less purge water, reducing the volume of water to be disposed of off-site, and shortening the time required to complete sampling rounds. Purging/ sampling methods for OU2 outpost wells (dedicated pump/packer system) and remedial wells (direct collection via sample tap) as described in the Plan will not be modified.

2.1 Sampling Method

For the groundwater monitoring program, a standard two-inch diameter HydraSleeve™ will be used, which has the capacity to hold approximately 1 Liter of water. The HydraSleeve™ will be set to collect the groundwater sample from the center of the well screen. **Table 1** provides the depth at which the HydraSleeve™ will be placed in each monitoring well. The analytical results from the Hydrasleeve method will be compared to the average purged concentration of VOCs obtained over the prior year. Should the results of analysis of samples obtained using the Hydrasleeve method indicate VOC concentrations that are not similar to the average purged VOC concentration; then the well will be profiled using a series of Hydrasleeves that will be placed at discrete vertical intervals in the well screen. Based on the results of the profiling, during the next scheduled sampling round, the HydraSleeve will be placed at the depth corresponding to the highest VOC concentration.

ARCADIS will follow the Groundwater Sampling with HydraSleeves™ – Standard Operating Procedure (Attachment 1), to deploy and sample the HydraSleeves™. Once sampling is complete, a new HydraSleeve will be connected to the dedicated tether and remain secured inside the well casing. The wells will be locked when sampling is completed. Information pertinent to the sampling activities will be recorded, as described in the Quality Assurance Project Plan (QAPP). Decontamination

activities as well as handling of investigation derived waste will follow the protocol outlined in the QAPP.

2.2 Sample Analysis

As shown in **Table 1**, groundwater monitoring is presently conducted at 54 well locations (**Figure 1)** as part of environmental effectiveness monitoring. Additionally, **Table 1** summarizes the locations and analyses to be performed on each sample. Analytical methods will remain the same as described in the QAPP.

2.3 Health and Safety Plan

The health and safety procedures, as detailed in the Site-Specific Health and Safety Plan (ARCADIS 2011), will be followed for work carried out according to this Plan.

2.4 Reporting

As with previous environmental effectiveness sampling events, the data will be validated (per the requirements of the QAPP), tabulated, evaluated for representativeness, and added to the existing database. The validated data will be compared to results from previous sampling events through graphs and/or statistical methods. The findings will be summarized and reported in the ongoing quarterly and annual Groundwater Monitoring Reports.

3.0 References

ARCADIS Geraghty & Miller, Inc., Inc. (ARCADIS) 2001. Groundwater Monitoring Plan, Operable Unit 2- Northrop Grumman Corporation, Bethpage, New York. Site # 1-30-003A. May 2001.

ARCADIS of New York, Inc. (ARCADIS) 2006. Petition for Modification to the OU2 Groundwater Monitoring Plan, Northrop Grumman Corporation, Bethpage, New York. Site # 1-30-003A.

Northrop Grumman Systems Corporation (Northrop Grumman) 2011. Correspondence from J. Cofman (Northrop Grumman) to Steve Scharf (NYSDEC), Subject: Hydrasleeve "No Purge" Sampling Methodology. September 2011.

Table

Table 1. Well Network and Proposed HydraSleeve Setting for the Groundwater Monitoring Program, Operable Unit 2
Northrop Grumman Systems Corporation, Bethpage, New York

Well ID	Well Diameter (inches)	Depth to Screen Top (ft bls)	Depth to Screen Bottom (ft bls)	Screen Length (ft)	Well Depth (ft)	Well Casing/ Screen Materials	Hydrasleeve Sample Depth (ft bls)	Proposed Analysis[1][2][3]
MW-1GF	4	48	58	10	58	Sch. 40 PVC	53	Cd/Cr
MW-2GF	4	49	59	10	59	Sch. 40 PVC	54	Cd/Cr
PLT1MW-04	2	41.5	56.5	15	56.5	Sch. 40 PVC	49	Cr
PLT1MW-05	2	38	58	20	58	Sch. 40 PVC	48	Cr
PLT1MW-06	2	47	62	15	62	Sch. 40 PVC	55	Cr
GM-13D	4	200	210	10	210	Sch. 40 PVC	205	VOC
GM-15S	4	70	80	10	80	Sch. 40 PVC	75	VOC/Cr
GM-15I	4	95	105	10	105	Sch. 40 PVC	100	VOC
GM-15D	4	332	342	10	342	Sch. 80 PVC	337	VOC
GM-15D2	4	536	556	20	556	Sch. 80 PVC	546	VOC
GM-17SR	4	60	70	10	70	Sch. 40 PVC	65	VOC
GM-17I	4	100	120	20	120	Sch. 40 PVC	110	VOC
GM-17D	4	278	298	20	298	Sch. 80 PVC	288	VOC
GM-18S	2	63	67	4	67	Steel	65	VOC
GM-18I	4	95	105	10	105	Sch. 40 PVC	100	VOC
GM-18D	4	290	300	10	300	Sch. 80 PVC	295	VOC
GM-33D2	4	500	520	20	520	Sch. 80 PVC	510	VOC
GM-20I	4	95	105	10	105	Sch. 40 PVC	100	VOC
GM-20D	4	216	226	10	226	Sch. 80 PVC	221	VOC
GM-21S	2	63	67	4	67	Sch. 40 PVC	65	VOC
GM-21I	4	130	140	10	140	Sch. 40 PVC	135	VOC
GM-21D	4	278	288	10	288	Sch. 80 PVC	283	VOC
GM-34D	2	309	319	10	319	Sch. 80 PVC	314	VOC
GM-34D2	4	510	520	10	520	Sch. 80 PVC	515	VOC
GM-35D2	4	510	530	20	530	Sch. 80 PVC	520	VOC

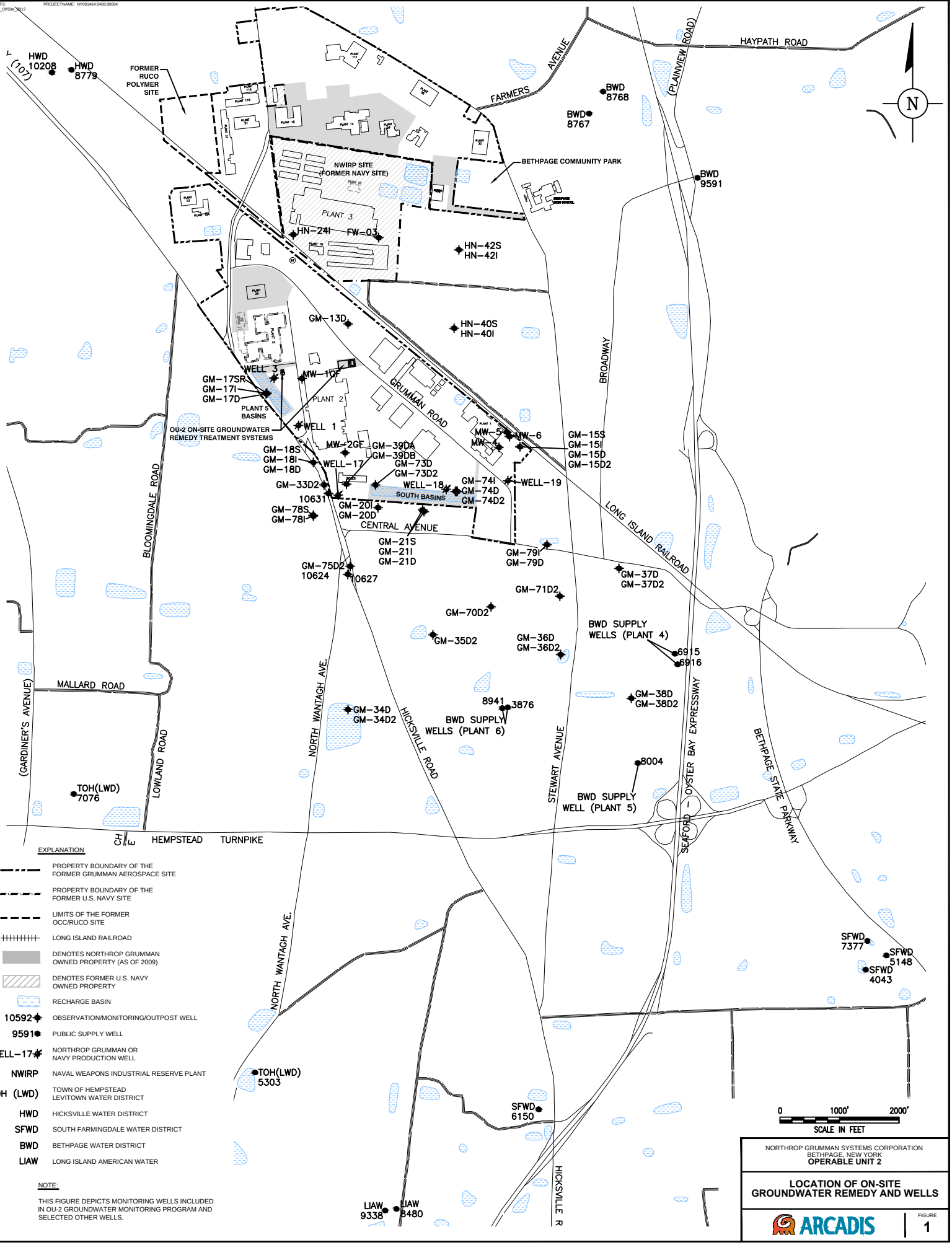
See notes on last page

Table 1. Well Network and Proposed HydraSleeve Setting for the Groundwater Monitoring Program, Operable Unit 2
Northrop Grumman Systems Corporation, Bethpage, New York

Well ID	Well Diameter (inches)	Depth to Screen Top (ft bls)	Depth to Screen Bottom (ft bls)	Screen Length (ft)	Well Depth (ft)	Well Casing/ Screen Materials	Hydrasleeve Sample Depth (ft bls)	Proposed Analysis[1][2][3]
GM-36D	4	204	214	10	214	Sch. 80 PVC	209	VOC
GM-36D2	4	520	540	20	540	Sch. 80 PVC	530	VOC
GM-37D	4	242	262	20	262	Sch. 80 PVC	252	VOC
GM-37D2	4	370	390	20	390	Sch. 80 PVC	380	VOC
GM-38D	4	320	349	29	340	Sch. 80 PVC	335	VOC
GM-38D2	4	475	495	20	495	Sch. 80 PVC	485	VOC
$GM\text{-}39D_A$	4	262	282	20	282	Sch. 80 PVC	272	VOC
$GM\text{-}39D_B$	4	410	420	10	420	Sch. 80 PVC	415	VOC
GM-70D2	4	310	330	20	330	Sch. 80 PVC	320	VOC
GM-71D2	4	444	464	20	464	Sch. 80 PVC	454	VOC
GM-73D	4	401	411	10	411	Sch. 80 PVC	406	VOC
GM-73D2	4	532	552	20	552	Sch. 80 PVC	542	VOC
GM-74I	4	94	114	20	114	Sch. 40 PVC	104	VOC
GM-74D	4	295	305	10	305	Sch. 80 PVC	300	VOC
GM-74D2	4	542	562	20	562	Sch. 80 PVC	552	VOC
N-10624	2	190	194	4	194	Steel	192	VOC
N-10627	4	230	295	65	295	Sch. 80 PVC	263	VOC
GM-75D2	4	505	525	20	525	Sch. 80 PVC	515	VOC
GM-78S	4	60	70	10	70	Sch. 40 PVC	65	VOC/Cd/Cr
GM-78I	4	90	110	20	110	Sch. 40 PVC	100	VOC/Cd/Cr
GM-79I	4	170	180	10	180	Sch. 40 PVC	175	VOC
GM-79D	4	280	290	10	290	Sch. 80 PVC	285	VOC
HN-24I	4	148	158	10	158	Sch. 40 PVC	153	VOC
FW-03	2	49	64	15	64	Sch. 40 PVC	57	VOC
HN-40S	4	49	59	10	59	Sch. 40 PVC	54	VOC
HN-40I	4	108	118	10	118	Sch. 40 PVC	113	VOC
HN-42S	4	50	60	10	60	Sch. 40 PVC	55	VOC
HN-42I	4	100	110	10	110	Sch. 40 PVC	105	VOC
N-10631	2	63	67	4	67	Steel	65	VOC/Cd/Cr

1 VOCs: TCL VOCs using NYSDEC ASP 2000 Method OLM 4.3
2 Cd: Cadmium using USEPA Method 6010
3 Cr: Chromium using USEPA Method 6010

Figure



EXPLANATION

- PROPERTY BOUNDARY OF THE FORMER GRUMMAN AEROSPACE SITE
- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY SITE
- LIMITS OF THE FORMER OCC/RUCO SITE
- LONG ISLAND RAILROAD
- DENOTES NORTHROP GRUMMAN OWNED PROPERTY (AS OF 2009)
- DENOTES FORMER U.S. NAVY OWNED PROPERTY
- RECHARGE BASIN
- 10592 OBSERVATION/MONITORING/OUTPOST WELL
- 9591 PUBLIC SUPPLY WELL
- WELL-17 NORTHROP GRUMMAN OR NAVY PRODUCTION WELL
- NWIRP NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
- TOH (LWD) TOWN OF HEMPSTEAD LEVITOWN WATER DISTRICT
- HWD HICKSVILLE WATER DISTRICT
- SFWD SOUTH FARMINGDALE WATER DISTRICT
- BWD BETHPAGE WATER DISTRICT
- LIAW LONG ISLAND AMERICAN WATER

NOTE:

THIS FIGURE DEPICTS MONITORING WELLS INCLUDED IN OU-2 GROUNDWATER MONITORING PROGRAM AND SELECTED OTHER WELLS.

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK
OPERABLE UNIT 2

LOCATION OF ON-SITE GROUNDWATER REMEDY AND WELLS

ARCADIS

FIGURE 1

ATTACHMENT 1

Groundwater Sampling with HydraSleeves™ – Standard Operating Procedure

ARCADIS
Infrastructure, environment, buildings

Imagine the result

Groundwater Sampling with HydraSleeves™ – Standard Operating Procedure

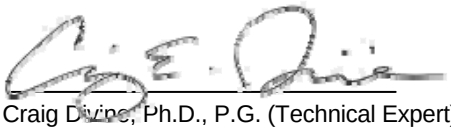
Rev. #: 2

Rev Date: February 2011

Approval Signatures

Prepared by:  Date: 2/2/11

Erika L.W. Carter, Ph.D.

Reviewed by:  Date: 2/2/11

Craig Divine, Ph.D., P.G. (Technical Expert)

I. Scope and Application

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the deployment of HydraSleeves™ and subsequent collection and documentation of groundwater samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all groundwater samples. The details within this SOP should be used in conjunction with site-specific work plans.

The HydraSleeve™ groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a groundwater sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. The HydraSleeve™ is placed within the screened interval of the monitoring well, and a period of time is allocated for the well to re-equilibrate following HydraSleeve™ down-hole deployment. The sealed HydraSleeve™ can be activated and removed for sample collection within several hours to several months. When activated, the HydraSleeve™ collects a sample with no drawdown and minimal agitation or displacement of the water column. Once the sampler is full, the one-way reed valve collapses, preventing mixing of extraneous, non-representative fluid during HydraSleeve™ recovery from the well.

Use of this SOP will provide samples for Level III and Level IV analytical data for use in risk assessments, site characterizations, evaluation of remediation alternatives, engineering design of remediation activities, and in support during remediation activities.

II. Personnel Qualifications

All personnel shall meet the requirements of the site-specific Health and Safety Plan (HASP).

The Project Manager is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Field Manager is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Manager is also responsible for implementation of corrective action (e.g., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field personnel assigned to collect groundwater samples are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. Field staff shall have prior experience in groundwater sampling. The determination of placement of the HydraSleeve™ in the monitoring well shall be made by a qualified geoscientist. All staff are responsible for reporting deviations from procedures in the Field Activity Daily Log, and to the Field Manager or Project Manager.

III. Equipment List

There are three main steps for collecting groundwater samples with HydraSleeves™: 1) assembly and deployment of the HydraSleeve™, 2) collecting the groundwater samples after the equilibration period, 3) and pouring the groundwater samples into containers. The equipment needed for each step is listed below.

Equipment needed for assembly and deployment of the HydraSleeves™:

- Appropriate personal protective equipment (PPE)
- Well location maps and table identifying HydraSleeve™ deployment locations/depths
- Well keys
- Flame ionization detector (FID) (as appropriate)
- Photoionization detector (PID) (as appropriate)
- Electronic water-level indicator, 0.01 ft accuracy
- Oil/water interface probe (as appropriate)
- Plastic sheeting to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
- Appropriate size HydraSleeves™ for the wells being sampled. Some examples are provided below. Check the manufacturer's website for additional options:
    - 2-L 2" HydraSleeve™ SuperSleeve (SS) (1.9" OD, 60" long; volume of 2 liters; requires special 2-piece top weight) for 2" Schedule 40 wells

  - 1-L 2” HydraSleeve™ (1.75” OD, 36” long; volume of 1 liter) for 2” wells
  - 1.5” HydraSleeve™ (1.5” OD, 30” long; volume of 625 mL) for 1.5” wells
  - 1” HydraSleeve™ (1” OD, 48” long; volume of 325 mL) for wells less than 1.5”

- 1/8-inch diameter braided polypropylene rope (for tethers)
- Weights (stainless steel or other inert material) to anchor HydraSleeves™ in wells (note special weights are required for SuperSleeve-style HydraSleeves™)
- Cable ties to anchor HydraSleeves™ to tether
- Measuring tape
- Cutting implement, such as scissor or knife
- Approved site-specific workplan, Field Sampling Plan (FSP), and HASP

Equipment needed for collection/dispensing of groundwater samples:

- Appropriate PPE
- Planned Sample Table (PST), sample labels, and Chain of Custody forms (COC)
- Sample bottles, coolers, ice
- Blank collection field forms
- Well keys, site maps, and sample list
- Electronic water-level indicator, 0.01 ft accuracy
- Oil/Water interface probe (as appropriate)
- Decontamination equipment

- Plastic sheeting to protect all down-hole sampling equipment from contact with potentialsources of contamination.
- Bucket or other container to hold extra groundwater
- Additional HydraSleeves™ and zip ties to deploy for the next sampling event, as appropriate
- Approved site-specific workplan, FSP, and HASP

Unless otherwise specified in the site-specific workplan, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated last.

IV. Cautions

Selection of the appropriate size HydraSleeve™ depends on sample volume requirements, well diameter, and the length of the saturated screened interval (which dictates the maximum distance allowed over which to pull and fill the HydraSleeve™). The largest HydraSleeve™ (60-inch) holds 2 liters of sample; the smallest holds 325 mL of sample. The sample volume requirements must be verified with the laboratory before deploying the HydraSleeve™ samplers. The HydraSleeve™ sampler is designed for single use (deployment and sample collection) only; tethers and weights should be reused after proper decontamination.

According to the manufacturer, HydraSleeve™ has been used successfully with no equilibration period at some sites for some analytical parameters. HydraSleeve™ does not require dissolved compounds to diffuse across a membrane as in the case of polyethylene diffusion bag (PDB) samplers (ITRC, 2004). Because the HydraSleeve™ mechanically obtains a “core” of the water column, rather than relying on diffusion through a membrane, the HydraSleeve™ sampler can be retrieved shortly after deployment in many cases. One way to conservatively estimate the maximum required equilibration period is to estimate the flush-out period for the well based on the Darcy velocity within the formation (hydraulic conductivity times gradient) (Attachment B). It should be noted, however, that representative groundwater sampling may occur with a shorter flushing period, or no flushing period, if the well contains minimal accumulated silt and care is taken to minimize well disturbance during HydraSleeve™ deployment. Site-specific testing versus another accepted groundwater sampling method can be performed at a subset of wells – preferably spanning a range of hydraulic conductivity, geologic materials, and chemical concentrations – to verify that the HydraSleeve™ device produces samples similar to those obtained from the other accepted method.

V. Health and Safety Considerations

The HASP will be followed at all times. Appropriate personal protective equipment (PPE) will be worn at all times. Other safety considerations include exposure to contaminated groundwater or non aqueous phase liquid (NAPL) and using sharp cutting tools (scissors, knife).

VI. Procedure

Field personnel will perform deployment of the HydraSleeves™ in accordance with the following procedures.

Preliminary Site Activities

1. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Activity Daily Log and brought to the attention of the Field Manager or Project Manager.

2. Equipment will either be new or decontaminated in accordance with SOPs prior to use.

3. Lay out plastic sheeting and set up monitoring and sampling equipment.

4. Don appropriate PPE.

5. If specified in the site-specific workplan, measure volatile organic compounds (VOCs) at the rim of the unopened well with a PID and FID and record the reading in the field logbook.

6. Observe if any air is flowing into or out of the casing (e.g., bubbles, hissing sounds). In the event such conditions are observed, they should be noted on the HydraSleeve™ Field Form (Attachment A).

7. Remove well cap.

8. If specified in the site-specific workplan, measure VOCs at the rim of the well with a PID and FID instrument record the reading in the field logbook.

9. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Record all measurements from this mark.

10. If specified in the site-specific workplan, determine if non-aqueous phase liquid (NAPL) is present in the well using an oil/water interface probe in accordance with SOPs. If NAPL is present, record the depth to NAPL and static water level on the HydraSleeve™ Field Form. A HydraSleeve™ will not be deployed nor will samples be collected from wells where NAPL is present. If NAPL is not present, measure the static water level followed by the total depth of the well with an electronic interface probe, and record the measurements on the HydraSleeve™ Field Form.

11. Measure and record the depth to water and the total depth of the groundwater monitoring well (to 0.01 ft) in all wells to be sampled. Care should be taken to minimize disturbance to the water column and to any particulates attached to the sides or at the bottom of the well.

12. Determine the total depth of the well. Compare the measurement of the total depth of the well with the previous measurement and check against the well construction logs to determine the percent of screen occluded by sediment (if any). If more than 20 percent of a well screen is occluded by sediment, the well will not be sampled until it is re-developed.

Assembly and Deployment of Standard HydraSleeves ™

1. Begin assembling the HydraSleeve™ by removing the HydraSleeve™ from the package and grasp top to “pop” open (Figure 1). Squeeze side fins together at top to bend reinforcing strips outward (Figure 2). Attach rope to hole at top of HydraSleeve™ (using cable ties) (Figure 3). Fold the two holes at bottom of HydraSleeve™ together and attach weight (using zip tie) (Figure 4). Sampler is ready to insert into the well at the predetermined depth specified in the site-specific workplan (Figure 5).

Figure 1

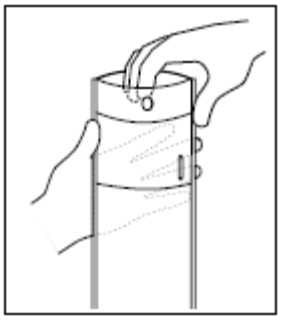


Figure 2

Figure 3

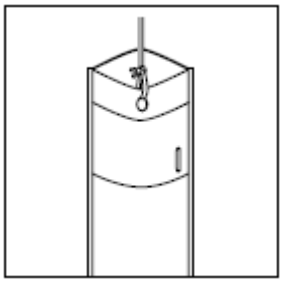


Figure 4

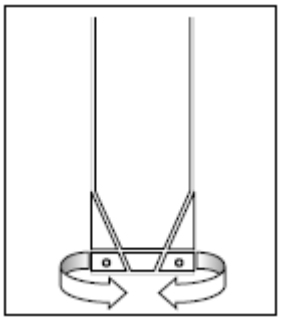
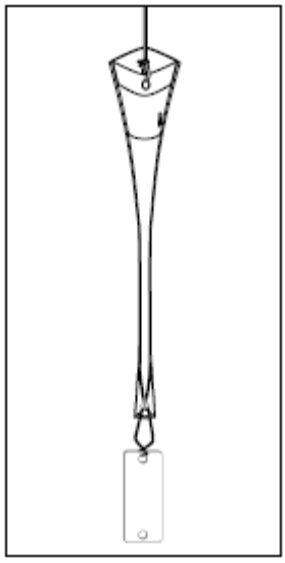


Figure 5



2. Two methods of deployment can be used. Either way, the top of the HydraSleeve™ will be positioned below the midpoint of the saturated screened interval by a distance approximately equal to 0.75 times the full length of the HydraSleeve™. For example, a 36” HydraSleeve™ will be lowered so that the top of the HydraSleeve™ is approximately 27” below the midpoint of the saturated screened interval. This position is appropriate to collect the groundwater sample from approximately the middle of the saturated screened interval when the HydraSleeve™ is pulled upward.

    a. Bottom Anchor Deployment (preferred). Using the determined well depth, calculate the distance from the bottom of the well to the desired sampling depth (specified on the HydraSleeve™ Field Form. Attach an appropriate length anchor line between the weight and the bottom of the sampler and *slowly* lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth. Attach the suspension line to the well cap to suspend the HydraSleeve™ at the correct depth until activated for sampling. Allow sufficient extra tether length such that if the tether becomes untied from the well cap and the sampler sinks to the bottom it may still be easily retrieved.

    b. Top-Down Deployment. Measure the correct amount of suspension line needed to "hang" the top of the

HydraSleeve™(s) at the desired sampling depth (specified on the HydraSleeve™ Field Form). Once constructed, slowly lower the assembly in the well and attach the suspension line to the well cap to suspend the HydraSleeve™ at the correct depth until activated for sampling. Allow sufficient extra tether length such that if the tether becomes untied from the well cap and the sampler sinks to the bottom it may still be easily retrieved.

3. For wells in which another passive sampling device (e.g., passive diffusion bag [PDB]) is to be used concurrently, the HydraSleeve™ should be suspended from the same line directly beneath the other passive sampler. If the top-down deployment method is used, care should be taken to ensure the weight is not resting on the bottom of the well. If necessary, the weight may be placed at the top of the HydraSleeve™, as described below.

4. For wells with screen lengths less than 10 feet (specified on the HydraSleeve™ Field Form) or where the saturated screen length is less than 10 feet (determined during water level gauging), top-down deployment will be used as described above with the exception of the placement of the weight. The weight for these wells will be placed on the top of the HydraSleeve™ as shown in the figure below (Photo 1). The hanging clip is inserted locking the top of the HydraSleeve™ and the weight together. The tether will be attached to the apex of the clip, as shown below (Photo 2).

Photo 1

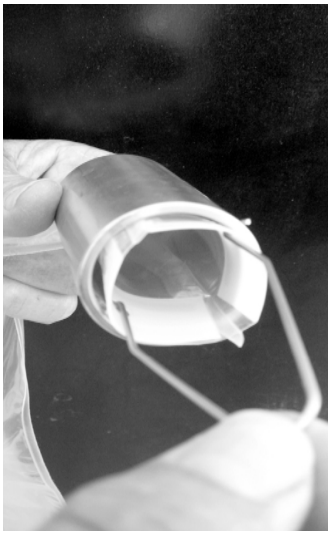
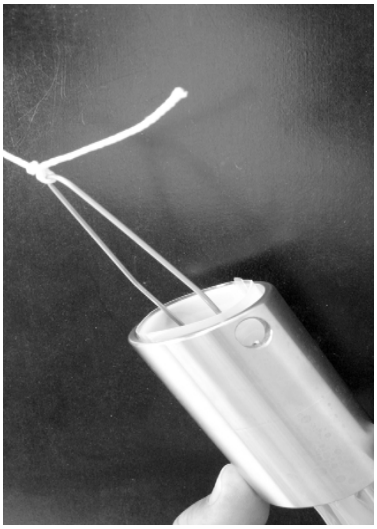


Photo 2



5. At this point deployment is complete. The well must be allowed time for the stabilization of well water and formation water following any disturbance caused by the sampler deployment before groundwater samples can be collected. The manufacturer's recommended deployment time is hours to months. The time shall be specified in the site-specific workplan. The maximum deployment time at the site will be one year.

6. After the equilibration period is complete; the groundwater samples are ready to be collected for analysis.

Assembly and Deployment of SuperSleeve-style HydraSleeve™ SS

1. Begin assembling the HydraSleeve™ by removing the HydraSleeve™ SS from the package and attaching the bottom weight (Photos 3 and 4). Fold the two holes at bottom of HydraSleeve™ together. Open prongs of bottom weight clip by squeezing. Insert reusable weight clip through holes and attach the bottom weight.

Photo 3

Photo 4

2. Attach the top weight as follows: Insert the open (check valve) end of the HydraSleeve™ SS through the bottom of the stainless steel portion of top weight until about 1/2 inch of the open sleeve protrudes above the female threads. Thread stainless steel weight (female thread) onto PVC top piece (male thread) locking the top of the HydraSleeve SS between the threads (Photo 5).

Photo 5

3. Attach rope to top weight (using cable ties).

4. Sampler is ready to insert into the well (Photo 6). Lower the HydraSleeve SS into the well until the bottom weight touches the bottom. Provide enough slack to allow the top weight to fully compress the sampler into the bottom of the well. For example, the 2-liter HydraSleeve™ SS (5-feet long) will compress to within 2 feet of bottom of a 2-inch well screen in about 4 hours. The 2-liter HydraSleeve™ SS requires about 5 feet of water over the top of the sampler to completely fill; thus it should not be used in wells with shorter than a 10-ft saturated screen length.

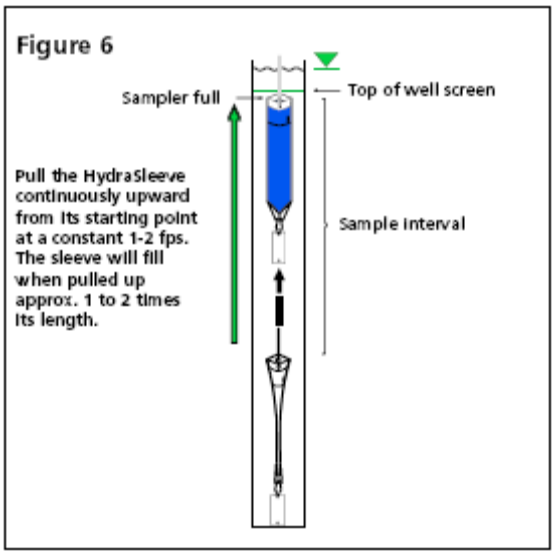
Photo 6

Collecting Groundwater Samples from HydraSleeves™

1. Conduct the Preliminary Site Activities detailed above with the following exception: The depth to groundwater should be collected prior to retrieval of the HydraSleeve™, while the total well depth should be collected only after the HydraSleeve™ has been retrieved from the well.

2. The Continuous Pull method is preferred and will be used for the majority of the wells. If the well to be sampled has a saturated screen length less than 10 feet in length, the Short Strokes method may be used. However, to minimize disturbance of well sediments, a preferable alternative is to use a top-weighted HydraSleeve deployment method (standard style HydraSleeve™ or SuperSleeve). The HydraSleeve™ Field Form will state the screen length and sample collection method for each well.

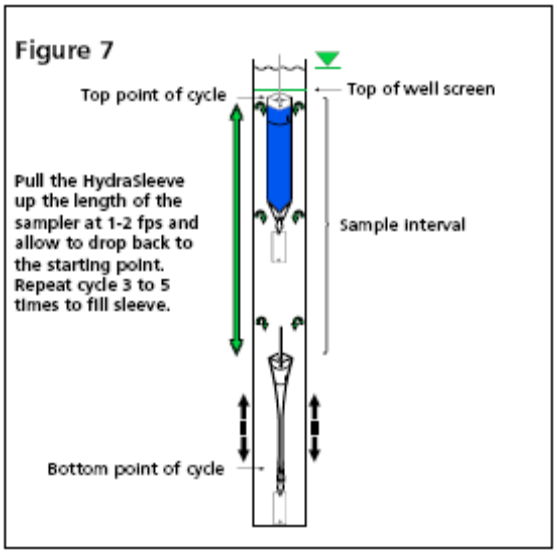
   a. Continuous Pull method – The HydraSleeve™ must move upward at an approximate rate of one foot per second or faster (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve. The total upward distance the check valve must travel to fill the sample sleeve is about 1 to 2 times the length of the sampler. For example, a 36-inch HydraSleeve™ needs a total upward movement of 36 to no more than 72 inches to fill. Pull the HydraSleeve™ continuously upward from its starting point at a constant 1 to 2 feet per second until full. This method usually provides the least turbid samples and is analogous to coring the water column from the bottom up (Figure 6).



b. Short Strokes method – Pull the sampler upward at about 1 to 2 feet per second for the length of the sampler (36 inches) and let it drop back to the starting point. Repeat the cycle 3 to 5 times (Figure 7).

3. If the HydraSleeve™ is retrieved from the well and is not completely full, the sample will not be collected and a new HydraSleeve™ will be deployed. The replacement HydraSleeve™ will be allowed to equilibrate, as appropriate, prior to retrieval. After the equilibration time, the HydraSleeve™ may be collected again.

Figure 7



4. Collect sample parameters in the following order: VOCs (care should be taken to avoid agitation and volatilization of sample during the decanting process), explosives, metals, and other parameters. Samples will be collected and labeled in accordance with SOPs. Types of sample bottles and volume requirements for each analysis are provided in the Quality Assurance Project Plan (QAPP) and site-specific workplan. Metals samples will not be field filtered unless otherwise specified. If field filtering is required for any analyte, sample groundwater to be filtered will be decanted into an unpreserved bottle and filtered using a small hand pump as shown below in Photo 7.

5. The 36-inch long HydraSleeve™ has a capacity of 1 liter, and the largest (60-inch long) HydraSleeve™ SS for a 2-inch diameter well has a capacity of 2 liters. All groundwater samples, including QA/QC samples for a given well will be collected with one HydraSleeve™. If the volume requirement for sample analysis exceeds the capacity of the HydraSleeve™, it is not acceptable to redeploy the same or a second HydraSleeve to fill additional bottles. Rather, sampling of the well must be completely repeated. A larger size HydraSleeve™ must be deployed for the appropriate duration of time, or another approved sampling method (e.g., low-flow) must be used. Complete sample documentation on the Groundwater Sample Log.

6. Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the site-specific workplan.

Photo 7

7. To remove a sample from the HydraSleeve™ with the least amount of aeration and agitation use the short plastic discharge tube (included). First, squeeze the full sampler just below the top to expel water resting above the flexible check valve (Photo 8).

Photo 8

8. Then, push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips (Photo 9).

Photo 9

9. Discharge the sample into the desired container in the order described in step 4 (Photo 10). Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste.

Photo 10

10. To obtain a duplicate/blind duplicate sample, collect a duplicate from the same bag as an original sample and send for analysis with the appropriate labeling.

11. To obtain an equipment blank, pour deionized water into a HydraSleeve and collect the blank using the same method as the samples and send for analysis with the appropriate labeling.

12. Place collected samples immediately in a sample cooler that is already full of ice or ice packs such that the samples are immediately chilled and stored at a temperature of 4 degrees Celsius, in accordance with SOPs.

13. Record depth to groundwater and total well depth.

14. Field parameters will be collected mid-screen from wells specified in the site-specific workplan. Calibrate all field analytical test equipment (e.g., pH, temperature, conductivity, ORP, turbidity, and DO) according to the instrument manufacturer's specifications and SOPs. Daily calibration results will be recorded on the appropriate form(s) as specified by the FSP and site-specific workplans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

15. Field parameter measurements (temperature, specific conductance, pH, DO, and ORP) will be taken after the HydraSleeve™ is removed from the well and the groundwater samples collected. This would occur through the use of a down-hole multi-meter (e.g., a YSI 600XL). Gently lower the probe of the meter down the well until it reaches the middle of the screen (screen intervals are found on the HydraSleeve™ Field Form). Follow the manufacturer’s guidelines on how to determine

stability of parameter readings. Once the meter readings have stabilized, record them on the HydraSleeve™ Field Form. Turbidity will be measured from groundwater taken directly from the HydraSleeve™, after analytical samples have been dispensed.

16. After the groundwater samples and field measurements have been collected, it may be necessary to deploy another HydraSleeve™ in the well for future sampling events (e.g., quarterly, semi-annually, etc.). The site-specific workplan will state if another HydraSleeve™ is to be deployed. The same suspension line will be reused for additional deployment to ensure consistency in the deployment depth. Follow the steps outlined previously in this SOP for deployment instructions.

17. Secure the well.

18. Properly dispose of PPE and disposable equipment.

19. Decontaminate any cutting devices, reusable weights, suspension lines, or sampler attachment mechanisms after each usage in accordance with SOPs.

VII. Waste Management

Any unused water from the PDB sampler and water used to decontaminate cutting devices should be disposed following SOPs and in accordance with local, State, and Federal regulations.

VIII. Data Recording and Management

All data will be recorded on HydraSleeve™ field forms and groundwater sampling field forms. Daily field logs will be maintained. Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with project requirements.

IX. Quality Assurance

Quality assurance procedures shall be conducted in accordance with the site-specific QAPP.

X. References

Cordry, K.E., 2006. HydraSleeve™ Field Manual. Las Cruces, N.M.: GeoInsight, Inc. http://www.hydrasleeve.com/images/stories/support/HydraSleeve_No-Purge_manual_updated.pdf

GeoInsight, Inc. 2010a. Standard Operating Procedure: Sampling Groundwater With a HydraSleeve™. Las Cruces, N.M.: GeoInsight, Inc. http://www.hydrasleeve.com/images/stories/support/HydraSleeve_SOP.pdf

GeoInsight, Inc. 2010b. SuperSleeve Assembly Instructions. Las Cruces, N.M. http://www.hydrasleeve.com/images/stories/support/SSfield_manual.pdf

Interstate Technology and Regulatory Council. 2004. Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater. February.

XI. Attachments

A. HydraSleeve™ Field Form

B. Calculation Of Maximum Required Equilibration Period (Flush-Out Time) Based On Well Geometry And Darcy Velocity

ARCADIS

HydraSleeve™ Field Form

Site: _____

Location: _____

Well ID: _____

Well Type: ☐Monitoring ☐Other: _____

Well Finish: ☐Stick Up ☐Flush Mount

Measuring Pt: ☐Top of Casing ☐Other (specify):_____

Total Depth As Constructed (ft bgs): _____ **Screened Interval (ft bgs):** _____

Well Casing: Diameter: _____ Material: _____

Well Screen: Diameter: _____

Deployment

Date and Time of Deployment: Date: _____ Time: _____

Weather Conditions: _____

Depth to groundwater at time of deployment: _____

Total well depth at time of deployment: _____

Dimensions of HydraSleeve™: Length (in.) _____ Diameter (in.) _____

Deployment Method/Position of Weight:

☐Bottom Anchor: Weight attached to bottom of HydraSleeve™. Weight rests on well bottom.

☐Top-Down: Weight attached to bottom of HydraSleeve™. Weight suspended in well.

☐Top-Down: Weight attached to top of HydraSleeve™. Weight suspended in well.

Deployment Depth (Top of HydraSleeve™) (ft bgs): _____

Retrieval

Date and Time of Retrieval: Date: _____ Time: _____

Total # of days deployed: _____

Weather Conditions: _____

Retrieval Method:

☐ Continuous Pull (preferred)

☐ Short Strokes

Depth to groundwater at time of retrieval (measured before retrieval): _____

Total well depth at time of retrieval (measured after retrieval): _____

Downhole Field Parameters Upon Retrieval:

Temp:_____ **(°C)** **ORP:**_____ **(mV)** **Water quality meter:**_____

pH:_____ **DO:**_____ **(mg/L)** **Serial #:**_____

Turbidity of Groundwater Sample (dispensed from HydraSleeve™):

Turbidity:_____ **(NTU)** **Turbidity meter:**_____ **Serial #:**_____

Notes/Observations:

Field Sampling Technician: Name(s) and Company

Name Company

_____

_____

ATTACHMENT B

CALCULATION OF MAXIMUM REQUIRED EQUILIBRATION PERIOD (FLUSH-OUT TIME) BASED ON WELL GEOMETRY AND DARCY VELOCITY

Example Calculations

Well Diam (inches)	Darcy v (ft/day)	Flush %	Flush Time (hours)
2	0.001	90	458
2	0.01	90	46
2	0.1	90	4.6
2	1	90	0.46
2	10	90	0.05
2	0.001	95	600
2	0.01	95	60
2	0.1	95	6.0
2	1	95	0.60
2	10	95	0.06
4	0.001	90	917
4	0.01	90	92
4	0.1	90	9.2
4	1	90	0.92
4	10	90	0.10
4	0.001	95	1200
4	0.01	95	120
4	0.1	95	12.0
4	1	95	1.20
4	10	95	0.12

General Equation for Flushing Time

t = [0.25 wd / (vd cf)] [-ln (1-f)]

where:

t = maximum required flushing time (hours)

wd = well diameter (inches)

vd = Darcy velocity, Ki (feet per day)

K = hydraulic conductivity (feet per day)

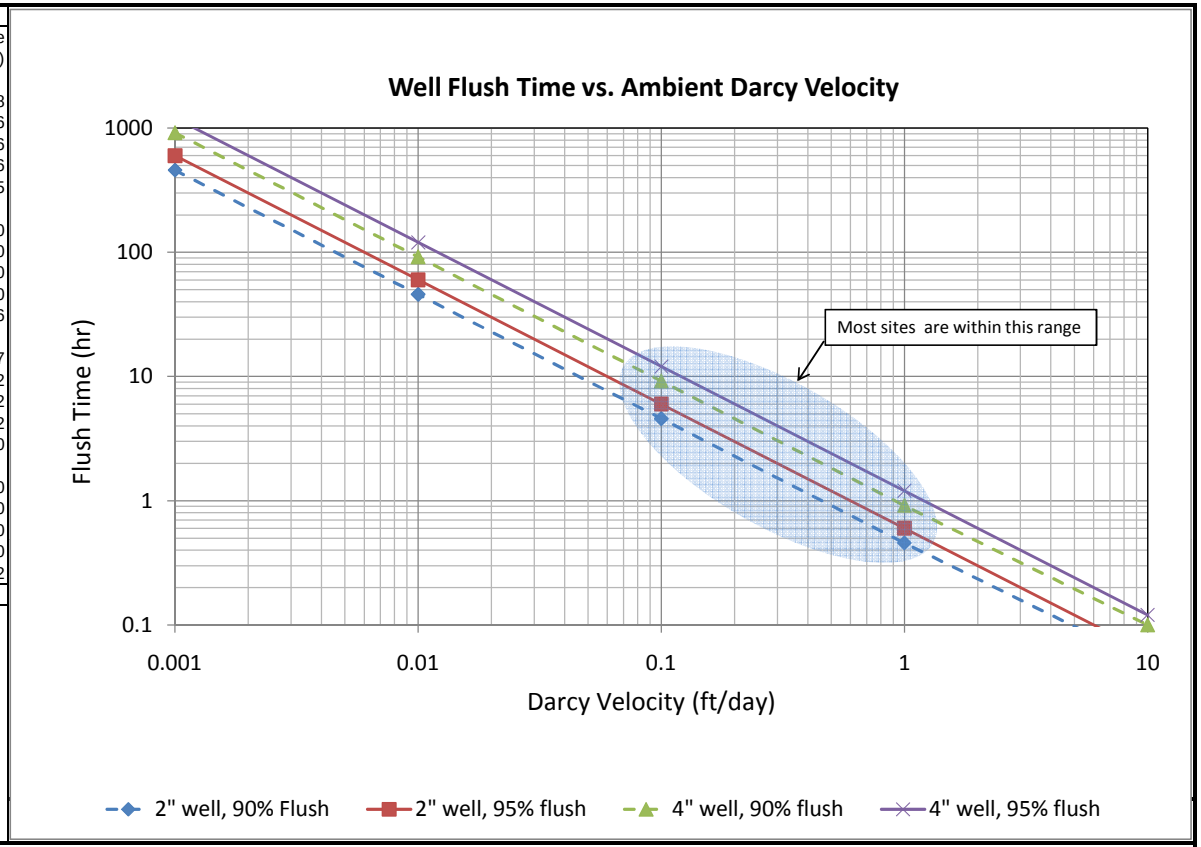
i = hydraulic gradient (dimensionless)

cf = flow convergence factor (typically between 2 and 3)

example calcs. assume cf = 2.5

f = % flush expressed as fraction

(e.g., 95% = 0.95, 90% = 0.90, etc.)



(Based on: Gaspar, E., and M. Onescu. 1972. Radioactive tracers in hydrology. Elsevier Publishing Co., Amsterdam)