

**Standard Operating Procedures
for
GROUNDWATER SAMPLING USING PASSIVE DIFFUSION SAMPLERS**

I. Purpose

This Standard Operating Procedure (SOP) is written to enable the field project team to perform groundwater sampling using a Passive Diffusion Samplers as supplied by EON Products, Inc. This SOP is to be used in conjunction with ASTM Method D 4448-01, Standard Guide for Sampling Ground-Water Monitoring Wells.

II. General Materials Requirements

- Site-Specific Health and Safety Plan (SSHSP);
- Job Hazard Assessment;
- Personal protective equipment (PPE) in accordance with SSHSP;
- Air monitoring equipment, if required in the SSHSP;
- Site Access: agreements, photo identification, property owner contacts, keys, tools, etc.
- Site Documentation: Site map with sampling locations, list of wells to be sampled, field
- Logbook, Monitoring Well Sampling Forms, Well Construction Diagrams, etc.;
- Water level indicator and other instrumentation as required to meet site Data Quality Objectives (DQOs)
- Decontamination supplies;
- Laboratory-supplied containers with proper preservation;
- Chain-of-Custody forms; and,
- Coolers/shipping containers, ice and packing media.
- Deionized water travel blanks provided in sampler membrane materials when pre-filled samplers are used.

III. Diffusion Sampler Function

Diffusion sampling is based on the underlying principle that there is constant, mostly horizontal flow from the aquifer through the saturated screened interval and that this flow, along with molecular diffusion, causes water within the saturated well screen to have the equivalent contaminants and concentrations as the surrounding aquifer.

The diffusion sampling device consists of one or more semipermeable membranes formed into a tubular shape, sealed at the bottom and filled with laboratory-grade deionized (DI) water. The top is typically manufactured with a nozzle for filling the sampler with the DI water however, some diffusion samplers are “prefilled” with DI

water by the manufacturer and sealed at both ends. The sampler is then suspended in the saturated screen zone of the monitor well using a suspension tether assembly and left in place for chemical equilibration to occur.

When the sampler is installed, a concentration gradient will exist between the contaminants outside the sampler and the DI water inside. Because the membrane is semipermeable, certain molecules pass through the membrane without restriction, so that during the residence time, the concentration gradient causes molecules to flow in or out of the sampler until chemical equilibrium is reached. When sufficient time has elapsed for equilibration, the device is then removed from the well, and the water within the sampler is transferred to the appropriate laboratory container and analyzed by standard laboratory methods. The user should consult with the manufacturer to select the appropriate sampler with membranes suitable for the compounds being sampled.

IV. Diffusion Sampler Installed Depth

One or more passive diffusion samplers are suspended at predetermined depths in the saturated screen to intercept groundwater flow and produce a representative sample of the contaminants and their concentrations at that depth. If it is known that the aquifer adjacent to the saturated screen is somewhat homogeneous and the contaminants are not stratified, then a single sampler can be used to represent the entire saturated screen length. In the absence of those conditions or other knowledge about the well and contaminants, a single sampler should not be used to represent a vertical interval of more than about five feet. Wells having longer saturated screens or unknown stratification may be profiled using several samplers at intervals across the screen length for sampling specific intervals or to determine future placement of one or more samplers. Diffusion sampler depth setting is typically referred to by the mid-point of the sampler.

V. Diffusion Samplers Filled with Deionized Water

Passive diffusion samplers are available pre-filled with laboratory-grade deionized water from the supplier or may be ordered empty for filling by the user. Some laboratories provide laboratory-grade water for the user to fill empty samplers before deployment and

some laboratories may provide PDBs pre-filled with laboratory-grade water. If samplers are purchased empty, consult the manufacturer's filling instructions.

A Fill Water Travel blank, constructed from the sampler membrane materials and the same lot of DI water used to fill the samplers, should be ordered or produced and accompany the samplers from the point of filling to the project site. A spare sampler may also be used to contain a travel blank. Because diffusion samplers will come to equilibration with the surrounding groundwater, low concentrations of diffusible compounds that may be in the sampler or fill water prior to installation will equilibrate with the surrounding groundwater. There are several compounds, including acetone, MTBE and butanone compounds, that may not equilibrate when using a single membrane polyethylene diffusion sampler for VOCs. In these cases, and for general data quality reporting, a certificate of analysis of the lot of water used to fill the samplers and a fill/travel blank representing any compounds that enter the sampler during transportation and storage and are in the sampler at the time of deployment. Travel blanks should be sampled at the project site during the deployment process. Typically, one sampler per site per round of deployment is used.

VI. Diffusion Sampler Residence Time Requirements

The required sampler residence time requirement is made up of two components; the well must first stabilize and return to its natural flow conditions after being disrupted by the installation of the sampler, followed by the sampler contents coming into chemical equilibrium with the surrounding groundwater. It is generally accepted that two weeks is the minimum residence time to cover installation and equilibration when sampling for VOCs and 3 weeks when sampling for metals, inorganics and other compounds. There has not been shown a maximum residence time, as the diffusion process maintains a dynamic equilibrium, keeping the sampler at the same concentrations as the surrounding groundwater even as changes in the aquifer occur.

For cost savings and logistics, samplers can be installed during one event and left in place until the next sampling event and then removed, sampled and replaced for the next event.

Samplers have been used successfully in this manner with sampling intervals longer than one year. Because the diffusion process requires some time and occurs at differing rates for each compound, the acquired sample will represent the chemistry of the past few days in residence, to about one week prior to removal of the sampler from the well.

VII. Diffusion Sampler Installation Assemblies

Dedicated sampler suspension tether assemblies can be made to order by the PDB supplier such as EON Products in Atlanta, Georgia (800-474-2490), are re-usable and remove the time and effort required to measure and construct these cleanly in the field. Because the assemblies are a one-time investment, with only the disposable samplers requiring replacement, it is recommended that dedicated PDB assemblies (tethers, reels, and weights) be purchased ready-made from the supplier.

- A. To ensure that project deadlines are met, contact the sampler and tether-assemblies supplier as far in advance as possible, preferably at least two weeks before the planned PDB deployment date. If this is the first use of diffusion samplers in any well, deploy the samplers in the wells at least two to three weeks (depending on sampler type and contaminants of interest) before the planned sampling date.
- B. To order pre-made PDB assemblies, provide the supplier with the following information:
 - a. Well identification (ID)
 - b. Well diameter
 - c. Total depth of well at the time of installment
(feet below Top of casing (ft bTOC))
 - d. Screened interval (ft bTOC)
 - e. Number of samplers per well and desired sampling depths of each
 - f. Ship-to address and purchase order number (project number)
- C. Each standard dedicated diffusion sampling assembly, as provided by the supplier, should include the following:
 - a. diffusion sampler bag (disposable)

- i. select prefilled with Lab grade DI water by manufacturer, or
 - ii. unfilled for filling by the lab or
 - iii. for filling by the sampling team
- b. stainless steel weights with split ring connectors
- c. tether made of braided polypropylene rope on a plastic reel
- d. embedded stainless steel connection rings at sampler depths-2 per sampler.
- e. aluminum tag with well ID inscribed
- f. snap connectors
- g. cable ties
- h. well caps (optional: prepared with rings from which to suspend tethers in the well)
- i. discharge tubes (disposable)
- j. deionized water (for unfilled samplers)
- k. deionized water travel-blank (for prefilled samplers, minimum one per shipment)
- l. Deionized water certificate of analysis for water used to fill the samplers.

VIII. Filling and Transporting Passive Diffusion Samplers

- A. All sampler bags should be filled at a single time to save time and minimize the potential for contamination, before mobilizing to the various wells for deployment
- B. Wear disposable, powder-free latex or nitrile gloves.
- C. If the samplers are not pre-filled, fill the sampler with laboratory-grade deionized water and follow the manufacturer's instructions for filling the samplers so that the sample bag is expanded to its maximum capacity. Remove visible air pockets. Air (headspace) is of little concern provided sample volume is adequate.

- D. Filled sample bags should be placed in a clean poly bag and the poly bags placed in a clean cooler with a tight-fitting lid, for transportation to and on the site to reduce potential contamination.
- E. From the point the samplers are filled with DI Water, the travel blank should travel with the samplers at all times. The project manager should decide at which location on-site the blank should be

IX. Installing Suspension Tethers and Diffusion Samplers

If the suspension tether has already been installed and is in use in the well, go to the section **X. Retrieving and Sampling Diffusion Samplers** for information on removing installed samplers before installing new samplers. If the suspension tether is new and hasn't been previously installed, follow the manufacturer's directions to;

- a. Unpackage the spooled tether. The weights should be attached to the ring on the leading end of the rope. If not, find the correct weight and attach.
 - b. Find the Well ID Tag located on the spooled tether. Match the ID tag to the well ID.
 - c. Place the weighted leading end of the suspension tether into the well and slowly lower until a small diameter (~.50-in) stainless steel ring is located on the tether. A second ring should be located further up the rope at a distance slightly more than the length of the sampler.
- F. Use a Zip-Tie to attach the bottom ring or loop on the sampler to the lower of the two rings embedded in the tether. Use a Zip Tie to attach the loop near the top of the sampler to the upper stainless-steel ring on the tether. Repeat the sampler attachment process for each set of rings on the tether if more than one sampler is used in the well. Optionally trim the excess zip-tie. Do NOT hold the sampler over the well before attaching zip-ties to prevent accidental loss down the well)
 - G. Once all the samplers are securely attached to the tether rings continue to lower the tether into the well until the black snap connector is located on the tether. It is usually clipped to the spool.

- H. Hold the tether or otherwise secure it so that it cannot slip free down the well and move the snap connector from the spool to the ring on the underside of the well cap.
- I. If there is extra tether rope past the snap connector, place the rope in the well so it hangs alongside the tether. The excess can be zip-tied to the tether if preferred. The extra length allows for field lowering the assembly if the well depth or sampler location is deeper than reported. When the well cap is installed the stainless-steel weight will typically be resting on the well bottom and the sampler will be in the desired position within the screened interval.
- J. More than one sample bag may be deployed in-line along a single tether assembly to allow samples to be collected from discrete depths within the screened interval. In wells larger than two inches, samplers may be placed side by side to obtain more volume if duplicates are needed and the volume of the selected sampler is not adequate. A heavier weight will be needed to hold multiple sample bags in place.
- K. If the well has become silted such that the actual total depth is less than the total depth when the well was installed, the portion of the pre-made tether between the weight and the sample bag can be shortened by creating several small loops and securing them with a cable tie. DO NOT cut the tether to shorten it, because the full length will be needed if the well is redeveloped and restored to its original depth.
- L. Record the water level and the date, time, and depth of sampler installations in the field notebook. Note any occurrences during deployment.

X. Retrieving and Sampling Diffusion Samplers

- A. To avoid loss of analytes, do not retrieve the PDB unless you are ready to sample it immediately. Samples should be decanted into laboratory containers immediately upon retrieval.

- B. Remove the sample bag from the well by reeling the tether onto the dedicated reel. Secure the rope and/or reel so that the weighted tether and samplers do not spool back down the well. This can be done by tying off the rope to the casing or hanging some types of spools on the top of the casing or using a tripod assembly over the well. Small leaks do not interfere with the results provided there is adequate sample volume. Users should make efforts to protect themselves from contact with contaminated samples and spray.
- C. Remove the sampler from the tether by carefully using a small snipping tool to cut the zip-ties that hold the sampler to the rings on the tether. Be careful to not let anything touch the area of the sample bag where you intend to insert the discharge tube.
- D. Open one end of the plastic wrapper containing the discharge tube and, leaving this wrapper on the tube, puncture the upper part of the sample bag (similar to using a “juice-box), It may help to hold the sampler at the upper white nozzle area to reduce squeezing.
- E. Remove the plastic wrapper from the discharge tube and let the straw purge for a second or two and then fill the laboratory-supplied containers in the usual manner, manipulating the sample bag to start and stop flow as needed.
- F. If VOCs and other compounds are collected from the same sampler, fill the VOC containers first.
- G. Collect field duplicates as needed by filling a second set of laboratory-supplied containers immediately after collecting the first set.
- H. Prepare and ship all samples as usual to meet standard lab requirements.
- I. Dispose of the remaining water in the PDB as directed by the project manager.
- J. At the project manager’s discretion, new sample bags for the next sampling event may be deployed at this time to avoid an additional mobilization.

XI. Decontamination and Disposal

- A. If new sample bags are not deployed during the sampling event the dedicated suspension tether assemblies may be left in the well or, if the project manager does not want to leave the dedicated tether assemblies in the well, reel the entire assembly onto the dedicated reel (having marked the reel with the well ID using an engraver or marker) and secure the tether with cable ties. At the project manager's discretion, segregate secured assemblies in plastic bags by level of contamination. It may be desirable to rinse the tethers with DI water however the use of cleaning agents is discouraged because of the potential for carry-over into the well upon the next installation. ONLY a tether in the well originally designated for that specific tether.
- B. Dispose of the spent PDB in the same manner as other disposable items such as latex gloves, tubing, etc., or as directed by the project manager.

XII. Other Considerations

- A. Select the sampler type for sampling the contaminants of concern (CoCs). Single membrane passive diffusion bag samplers are only viable for VOCs. Multi-membrane samplers will provide reliable samplers for virtually any CoC however, verify specific CoCs with the manufacturer.
- B. Select the sampler size to fit the well diameter, saturated screen and sample volume requirements. If adequate sample volume may be difficult to acquire, ask the laboratory for the Minimum Volume Requirements to meet the site Data Quality Objectives. In most cases the laboratory will be able to perform the analyses with significantly reduced sample volume.
- C. If there is any question regarding the integrity of the sample when collected, a new PDB should be deployed at that time so that a new sample could be provided to the laboratory two or three weeks later if the laboratory data are questionable.

VII. References

EON Products, Inc.

Phone: (800) 474-2490

Web: www.eonpro.comEmail:

Email: Info@eoonpro.com

- Equilibrator™ Diffusion Sampler Instructions
- Discharging a Sample from the Equilibrator™ Passive Diffusion Sampler

United States Geologic Survey (USGS)

- User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells. (2001)

Interstate Technology Regulatory Council (ITRC)

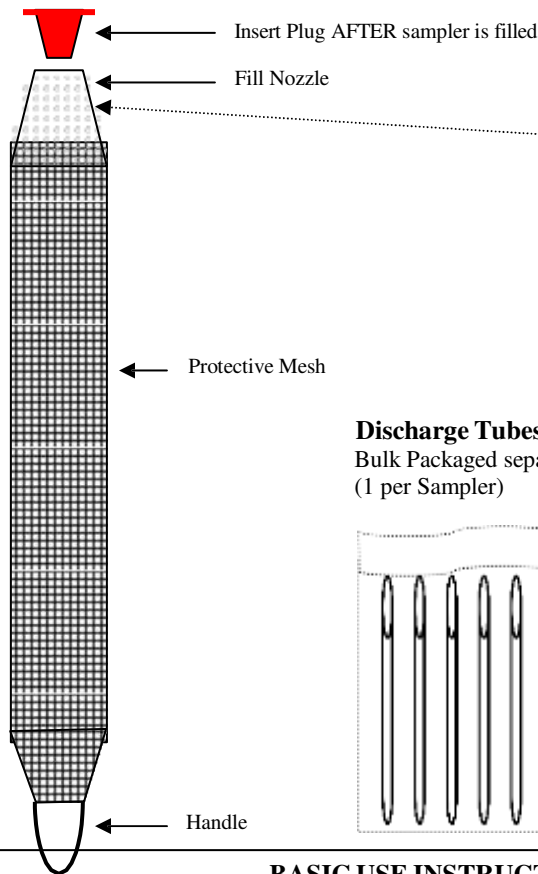
Passive Sampling team

- **Tech-Reg Document**
Technical and Regulatory Guidance Document for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater (2002)
- **Technology Overview**
Technology Overview of Passive Sampler Technologies (2006)

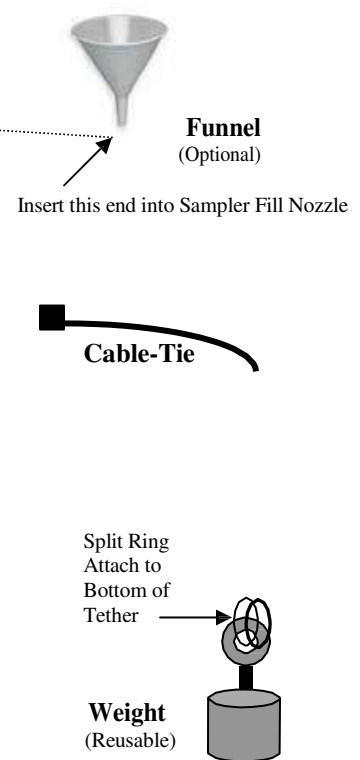
EQUILIBRATOR™

Diffusion Sampler Instructions

Equilibrator Sampler



Accessory Items



Plug is packaged in wrapper with Sampler



Discharge Tubes
Bulk Packaged separately
(1 per Sampler)



BASIC USE INSTRUCTIONS* (Fig 1)

- 1. Fill the Sampler with deionized water** until the entire assembly is completely full of water. To use the funnel, insert the tip into the Sampler and pour deionized water into the tube. Fill the Sampler until water rises and stands at least two inches up the funnel to expand the Sampler to its maximum capacity. **Gently squeeze and add more water to expand the membrane and remove air pockets. Repeat as needed until completely full.** Disclosure Statement – When filling the Sampler, we recommend that you hold the Sampler firmly at the top as close to nozzle tip as possible to prevent unnecessary stress on inside poly bag which could cause a leak to develop.
- 2. Insert the Plug firmly into the Sampler,** until the rim of the plug is as close to the nozzle as possible.
- 3. Attach a Weight to the bottom of the Tether or Hanger.**
- 4. Attach the Equilibrator(s) to the Tether line.** If installing on a factory prepared tether, locate the small (1/2" diameter) stainless steel rings that are attached to the Tether line. The rings will be separated by approximately 2/3 the length of the sampler. Use a Cable-Tie through the lower of two adjacent rings and through handle. Use a second Cable-Tie through upper of two adjacent rings and through a section of mesh below the fill nozzle in the softer part of the filled sampler. Tighten the Cable-Ties and snip off excess. Continue with each Sampler. If the factory did not prepare the Tether, then securely attach the Sampler(s) to the tether using cable ties at the intended location(s).
- 5. Lower the Tether with Sampler(s) attached into the well.** Locate Sampler(s) below the water surface, in the screen flow zone of the well. Attach the top of the suspension cord to a well cap or other secure location at the top of the well. Leave Sampler in place for a time suitable for equilibration, a minimum of 2 weeks required.
- 6. Upon retrieval: Discharge sample immediately** to avoid loss of volatile compounds. Select a point on the Sampler near the handle/bottom of sampler. Press one end of the Discharge Tube firmly into the clear polyethylene membrane at a downward angle until it pierces the membrane. **Discharge small amount to waste to purge discharge tube.**

*Contact EON for detailed installation information and for factory prepared Tethers.

800-474-2490

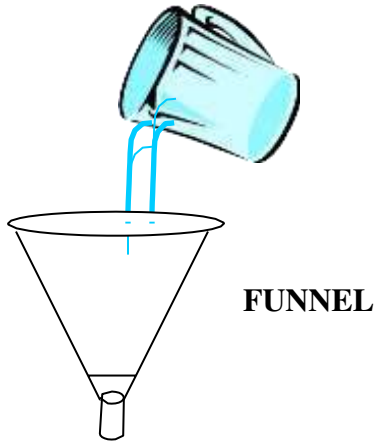
EQUILIBRATOR™

Diffusion Sampler Instructions

STEP 1

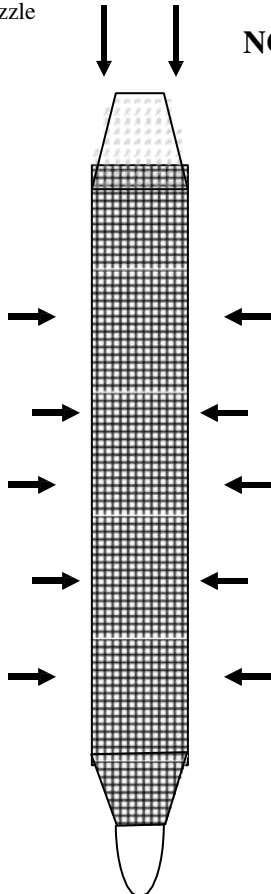
STEP 2

2. Pour DI Water into Sampler



1. Insert Fill Funnel into Sampler Nozzle

NOZZLE



3. Squeeze Sampler & release multiple times to release air and expand volume. Add water & repeat as needed to fill.

1. Press Plug firmly into nozzle



PRESS PLUG INTO NOZZLE UNTIL RED RIM TOUCHES WHITE NOZZLE

1. Fill the Sampler with deionized water until the entire assembly is completely full of water. To use the Funnel, insert the short nozzle into the Sampler and pour deionized water into the tube. Fill the Sampler until water rises and stands at least two inches up the funnel to expand the Sampler to its maximum capacity. **Squeeze the Sampler several times and add more water. Repeat as needed to expand the membrane and remove air pockets.** Fill to top of nozzle, leaving a meniscus.

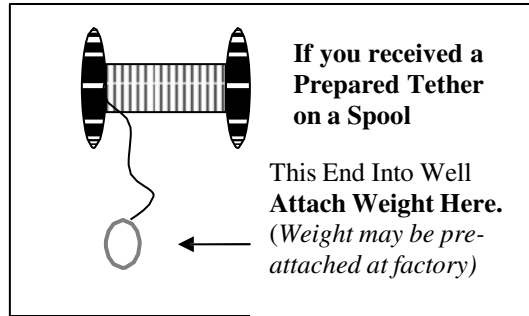
2. Insert the Plug firmly into the Sampler, **until the rim touches the nozzle.**

3. Fill at least two VOA Vials with the DI water used to fill the samplers to use as a **water blank**. (See *Using a Field/Trip Blank*)

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Diffusion Sampler Instructions

Extra Length
of Tether



4. Connect to Well Cap
***This is the Depth Reference Point**

Well ID Tag

3. Attach Cable Tie thru Ring on tether & Ring on Sampler.
RED CAP UP

Stainless Steel
Rings-
Permanent

2. Attach Cable Tie thru Handle and Ring.

Pull tight &
clip excess

Cable-Tie

1. Attach Weight to Ring on the end of the Tether. Allow Weight to rest on the bottom of the well





EQUILIBRATOR™ Diffusion Sampler Instructions

Using a Field/Trip Blank (Prefilled at EON or filled by you)

1. Fill Blank with the **same water** as your samplers at the **same time and place** that you fill them. When EON sends you prefilled samplers and a blank, they have been filled and shipped together. *This will serve as a control for the water in the samplers that you will deploy.*
2. Store and **transport Blanks with the other samplers** prior to installing the samplers. *This increases the control by ensuring that all bags are exposed to the same environmental conditions before deployment.*
3. Once you have arrived at the sampling site, use a discharge straw (See Figure 1) to fill 2 or more VOAs with the water from the Blank **at the site, immediately before deploying the bags.** *This gives you the closest possible representation of the composition of the water in the samplers when they are deployed into the well.*
4. **Send the VOAs to the lab as soon as possible for the same analysis the sampler will undergo when it is recovered**

Why Use a Blank?

Water is called the “Universal Solvent” because virtually anything with which the water comes into contact will dissolve into the water over time. Even the most “pure” deionized water will contain traces of compounds that dissolve from casual contact, even through the air, during manufacturing, transport, and handling.

Passive Diffusion Samplers allow some molecules to readily diffuse and not others. If the water in the sampler has molecules that do not readily diffuse out when the sampler is deployed, those molecules will show up in the lab results if they are on the list of compounds routinely reported. Compounds that readily diffuse will equilibrate to the actual groundwater concentrations.

EON offers a water “Trip Blank” that is filled from the same water lot and is exposed to the same environment as the samplers travelling with it. (See “Using a Field/ Trip Blank” Above)

By comparing the lab results from the Blank (#4 above) with those from the Samplers, you can account for any VOCs (acetone, for example) reported by the lab that are not in the well. This will ensure the most accurate representation of the water composition inside the well. To insure the quality of our water, we send it to an independent lab before filling each bag. It’s smart and easy to use our blank!

***Contact EON for detailed installation information.**

800-474-2490

Discharging a Sample from the Equilibrator™ Passive Diffusion Sampler

EON recommends using 1 sampler with clean water to practice the discharge straw process before sampling in the field

1. Set up the sample bottles in a convenient location for filling.
2. Recover the PDB from the well installation.
3. Locate the polypropylene “Juice Box Straw” provided with the PDB shipment.
4. Grasp the Equilibrator™ firmly but don't squeeze.
5. Press the pointed end of the straw between the black mesh and into the clear membrane. Work the straw tip to puncture the membrane. (Just like a Juice-Box!)
6. Allow the sample to flow through the straw for 1-2 seconds before filling the first bottle.
7. Maneuver the bag and the straw to control the velocity and flow of water into a sample bottle.
8. Do not allow the sample to touch anything other than the sample bottle.
9. Use 1 new straw per PDB to avoid cross contamination.
10. Sample PDBs immediately upon removal from the well.



Hints:

- Immediately after inserting the straw, point it upward along the PDB to reduce the flow.
- Tilting the bag slightly toward horizontal, away from the straw will help control the flow.
- As the sampler empties slight squeezing can help empty the contents.



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