1.1 Background

In previous years, the ITRC Passive Diffusion Sampling Team (later the Passive Sampling team) produced four informational and guidance documents (2001, 2004, 2006, and 2007) that explored the function and use of 12 passive groundwater sampling devices. The team concluded in 2007. In the ensuing years, emerging concerns about high-profile contaminants, interest in reducing purge water volume, sampling cost, and sampling of other media in addition to groundwater has driven interest in passive sampling techniques.

This growing interest in the benefits of passive sampling, and the availability of newer devices, has increased the number of requests for regulatory review, approval, and acceptance on project sites. Few, if any, specific regulations addressing the use of passive samplers have been written into promulgated documents. The use and/or approval process varies widely by agency and even by individuals within an agency due, in part, to a general lack of reliable, vetted information on the use and efficacy of passive sampling technologies.

The intent of this team is to replace the current ITRC Passive Diffusion documents (2001, 2004, 2006, and 2007) with a single new guidance document that will include 12 additional technologies, for a total of 24 passive sampling technologies. Devices that sample groundwater, surface water, pore water, sediment, soil gas, indoor air, outdoor air, soil, and nonaqueous phase liquid (NAPL) are included and each technology's use, operation, viability for specific contaminants, development or commercial status, project applicability, advantages and limitations are described. Case studies for each technology are included to demonstrate the use and effectiveness in real-world conditions. This guidance will help appropriately transition sites to passive sampling, build confidence in passive sampling, and enable more sustainable management of monitoring sites.

The inclusion of the following passive sampling technologies in this document does not constitute endorsement or approval from your state. The sampling technologies are provided for informational purposes only and are not all-inclusive or exhaustive. Additional technologies and information may be available or in development but not discussed in this document.

1.2 What is Passive Sampling?

ITRC defines passive sampling as using a device that acquires a sample from a discrete location without inducing active media transport. The passive technologies considered in this document rely on exposure of the sampling device to media in ambient equilibrium during the deployment period and are classified into three types of technology based on the sampler mechanism and nature of the collected sample. The technology classifications to be discussed include grab, equilibrium, and accumulation samplers, which are summarized below and further discussed in more detail in **Section 5**.

- **Grab Samplers (Section 5.1):** Devices that recover a sample of the selected medium that represents the conditions at the sampling point, including any chemicals and suspended material present in the sample interval, at the moment of sample collection or a period surrounding sample collection (for example, as presented in this document, HydraSleeve and Snap Sampler).
- **Equilibrium Samplers (Section 5.2):** Devices that rely on diffusion and equilibrium of the chemicals/parameters into the collecting medium for the sampler to reach equilibrium between the sample and the sample medium (for example, as presented in this document, Passive Diffusion Bag Sampler (PDB) and Dual Membrane Passive Diffusion Bag Sampler). Samples are time-weighted toward conditions at the sampling point during the latter portion of the deployment period. The degree of weighting depends on chemical- and device-specific diffusion rates
- **Accumulation Samplers (Section 5.3):** Devices that generally rely on diffusion and sorption, absorption, or precipitation to accumulate chemicals/parameters in the sampler (for example, as presented in this document, AGI Universal Sampler and Polar Organic Chemical Interval Sampler). Accumulation devices concentrate the target chemical on a selective collecting medium such as an adsorbent or absorbent solid, a solvent, or chemical reagent (ITRC 2023 [55DMC29X] ITRC. 2023. "PFAS Technical and Regulatory Guidance Document and Fact Sheets." Interstate Technology & Regulatory Council, PFAS Team. https://pfas-1.itrcweb.org/.). Target molecules continue to accumulate on the collecting medium during the exposure period and do not come to concentration equilibration with the surrounding medium (ITRC 2023 [55DMC29X] ITRC. 2023. "PFAS Technical and Regulatory Guidance Document and Fact Sheets." Interstate Technology & Regulatory Council, PFAS Team. https://pfas-1.itrcweb.org/.). Samples are a time-integrated representation of conditions at the sampling point over the entire deployment period. The accumulated mass and duration of deployment are used to calculate

chemical concentrations in the sampled medium over the exposure period. Accumulation samplers are also sometimes referred to as integrative or kinetic samplers.

In addition to the passive sampling technologies, this document discusses the following three nonpassive sampling technologies, which are further discussed in Section 6 . These nonpassive samplers do not collect true passive samples because they induce active media transport.

- **Syringe Samplers (Section 6.1):** Devices designed to capture a groundwater sample by grabbing a sample of the water and everything in the water at the sample interval and isolating the sample to preserve the conditions at the selected depth. The sample is collected without contact with air by precluding sample aeration and pressure changes at the selected depth of sampling.
- **Deep Discrete Interval Samplers (Section 6.2):** Devices designed to obtain representative discrete groundwater samples from a specific sampling zone where the sampler is activated, with limited drawdown and negligible agitation of the water column**.**
- **Horizontal Surface Water Interval Samplers (Section 6.3):** Devices designed to collect surface water samples at a prescribed depth.

1.3 Passive Sampling vs. Active Sampling

In contrast to the passive sampling methodologies described in this document, active sampling methods rely on the movement of a medium by the sampling equipment to draw the medium and chemicals into the sampling device, causing deviations from the natural flow or ambient conditions. Active sampling methods are sometime thought of as traditional methods because they have been in use prior to the use of passive sampling methods. Traditional active sampling methods generally require a power source, such as gasoline generator or battery, for the operation, and a submersible or peristaltic pump for water sample acquisition. Active methods, by nature of changing the conditions in the sampling environment, affect sampling results; using a pump, vacuum, or physical removal method introduces variables (that is, pumping rate and duration, criteria for stabilization prior to sample collection, and variability in sampling equipment components between events) into the sample collection sequence that may not be reproducible between sampling events and will influence the results obtained. Passive sampling eliminates many of the active sampling variables by limiting the extent of the sampling method’s interaction with media and, thus, the potential to influence sample results. The use of both types of samplers throughout the remedial phases of a project may yield insightful results to understand in greater detail the fate and transport of compounds through the medium under different conditions at a site. Passive sampling may then be used to provide consistent sampling methodology during long-term monitoring programs from an established sampling interval.

Passive sampling programs can result in several benefits, including elimination of a power source, reduction in investigation-derived waste (IDW), less equipment, and fewer personnel needed on site. These may also lead to the additional benefits of increased site accessibility and help achieve green and sustainable metrics. Despite these benefits, passive sampling may not be appropriate for all circumstances. For example, active methods are most efficient for groundwater monitoring programs requiring large sample volumes (such as for extensive radionuclide analysis or a particularly large analyte list) beyond the capacity of currently available passive sampling devices. Technology and device-specific benefits and limitations are described in detail in **Section 5**.

Similar to active sampling methods, passive sampling is a reproducible methodology that can reassure samplers and regulators alike that the data obtained are a result of the environmental conditions present. In addition, appropriate quality assurance/quality control (QA/QC) procedures should be followed for all sampling methods.