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API Guide on Petroleum Natural Source Zone Depletion Evaluation

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Background/Objectives. There is growing recognition that natural source zone depletion (NSZD) often contributes significant loss of light non-aqueous phase liquid (LNAPL) mass, and has become an important consideration for petroleum remediation. NSZD is a term used to describe the collective, naturally occurring processes of dissolution, volatilization, and biodegradation that results in mass losses of LNAPL constituents from the subsurface.

Approach/Activities. In order to provide interested parties (i.e., site owners, regulators, and practitioners) with a basic understanding of NSZD processes and methods to quantify mass loss rates related to NSZD, the American Petroleum Institute (API) led an initiative to develop a practical guidance for Quantification of Vapor Phase-related NSZD Processes (API NSZD guide). The primary objective of the document is to improve NSZD data quality by providing a consensus-driven, consistent methodology that represents the current state of knowledge and practice.

This presentation will describe the API NSZD guide, including theory, application, measurement methods, and data interpretation. Three methods are described in detail: i) the gradient method, ii) passive flux traps, and iii) the dynamic closed chamber (DCC). The gradient method has been described in the 2009 ITRC NSZD technology overview document. It estimates fluxes of biodegradation gases (e.g., oxygen and carbon dioxide) within a region of the vadose zone based on effective vapor diffusion coefficients and changes in concentration with distance (the soil gas concentration gradient). Two new methods have emerged in recent years: passive flux traps and the DCC method. Both of these methods focus on directly measuring the fluxes of biodegradation by-product gases from the ground surface (i.e., soil gas efflux). The DCC method measures efflux real-time using an automated chamber and gas analyzer system. It generates single time (snap shot) soil gas flux measurements. The passive carbon dioxide traps measure long-term integrated (average) fluxes over multiple days using a temporary receiver pipe and sorbent apparatus.

In addition to a detailed description of specific NSZD quantification methodologies, the API NSZD guide provides key elements of a monitoring program design, implementation procedures, data evaluation considerations, a case study, and a statement of method limitations. It also identifies areas of emerging research related to petroleum biodegradation, such as emerging methods to quantify NSZD (for example methodologies based on soil temperature measurements and soil thermal flux).

Results/Lessons Learned. This presentation will represent a concise compilation of the current literature, describe site applicability, provide practical how-to guidance, and state important caveats, all potentially useful information for those responsible for interpreting and applying the results of NSZD evaluations.