# Overview of
# Groundwater Remediation Technologies
# for MTBE and TBA

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## EXECUTIVE SUMMARY

This is the first document in a series to be prepared by the MTBE and Other Fuel Oxygenates Team of the Interstate Technology & Regulatory Council (ITRC) regarding characterization and remediation of methyl *tertiary* butyl ether (MTBE or M*t*BE) and *tertiary* butyl alcohol (TBA or *t*BA) in groundwater. It will be followed by a more detailed and comprehensive technical and regulatory guidance document planned for publication in 2006, along with associated classroom or Internet-based training.

This technology overview document is designed to provide an overview summary of remediation technologies for MTBE and TBA in groundwater; it does not cover remediation of other media such as soil, air, or nonaqueous-phase liquid. It is intended for readers who have a technical background but not necessarily extensive remediation experience.

MTBE has been blended with gasoline in the United States since 1979, initially as an octane booster, and subsequently as an oxygenate. The volume of MTBE produced and blended with gasoline has increased over the years in response to the requirements of the Clean Air Act Amendments for oxygenated fuels. TBA, another oxygenate, has been less extensively blended with gasoline but is also often found in association with MTBE. Releases of MTBE-blended gasoline from leaking underground storage tanks, surface spills, and other sources have resulted in sites with groundwater impacts requiring remedial action. This document is intended to help regulators address these impacts as cost-effectively as possible.

The physical properties of ether and alcohol oxygenates such as MTBE and TBA are substantially different from other gasoline components, and these properties need to be considered during all aspects of site characterization and remedial design. Despite the physical differences, the same technologies are generally used for MTBE and TBA as for other gasoline constituents. However, the application of these technologies needs to be adjusted significantly based on the properties of the target compounds.

Oxygenates are more soluble in water and tend to partition more strongly from the vapor phase into the aqueous phase than do gasoline components such as benzene, toluene, ethylbenzene, and xylenes (BTEX). Oxygenates tend to be more mobile in groundwater systems than other gasoline components and are not significantly slowed by sorptive processes. Consequently, an emphasis on early detection and response to oxygenated fuel leaks and spills is essential. Oxygenates tend to migrate at the same velocity as flowing groundwater; therefore, an oxygenate plume is likely to be longer than a corresponding BTEX plume. If groundwater is moving gradually downward, the chemicals dissolved in it will also gradually move downward (“plunge” or “dive”). Because MTBE may migrate over greater distances, the magnitude of dive may be greater. Because of this behavior, it is critical to characterize oxygenate plumes both vertically as well as horizontally. Compared with more readily biodegradable plumes such as BTEX, sites contaminated with MTBE and TBA are likely to require corrective action for longer periods of time and may require more extensive monitoring over both time and space.

A critical component in the site evaluation and cleanup process is the development of a conceptual site model. This is a written and/or graphical representation of the current understanding of how the release occurred; geological, hydrogeological, and other physical site

characteristics; and the (likely) distribution of chemicals at the site. It should describe the potential migration of all chemicals of concern to potential receptors through transport processes in air, soil, and water.

Groundwater remediation technologies shown to be effective for the treatment and removal of MTBE and TBA include both ex situ technologies (pump and treat) and in situ technologies (air sparging, bioremediation, chemical oxidation, phytoremediation, and monitored natural attenuation). Pump-and-treat processes, which have been shown to have a lower effectiveness for petroleum contaminants, are effective in treating MTBE and TBA due to the low affinity these compounds have for organics in the soil and the ability to "flush" these contaminants from the soil. MTBE and TBA can be biologically degraded under both aerobic and anaerobic conditions and both in situ and ex situ (for example, as part of a pump-and-treat process). However, degradation of MTBE can be incomplete, resulting in the formation of TBA. Generally, aerobic conditions have been shown to be far more effective in the complete biological treatment and removal of these compounds.

Under favorable conditions and when properly applied, these technologies can treat both MTBE and TBA to concentrations currently acceptable in all states. However, the technologies chosen must be specific to the contaminant of concern and cannot be applied equally to all contaminants. In some instances, processes effective for the removal of MTBE may have little or no effect on TBA.