REPORT ON

METHYL TERTIARY BUTYL ETHER (MTBE)

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

October 1, 1999

REPORT ON METHYL TERTIARY BUTYL ETHER (MTBE)

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this Report is to provide current information on methyl tertiary butyl ether (MTBE) and a set of recommendations that:

- Foster retention of the air quality benefits provided by Cleaner Burning Gasoline (CBG), which can be produced with or without MTBE;
- Increase the state of knowledge regarding the extent of and risks posed by MTBE contamination of soil and water in Arizona;
- Assure the maximum feasible protection of Arizona's resources from contamination by gasoline and its components, including MTBE; and
- Prevent disruptions in supply, quality and price of gasoline in Arizona.

PROPERTIES OF MTBE

MTBE is a synthetic, flammable, liquid fuel additive made principally from natural gas and other chemical compounds. It is added to gasoline for the purpose of increasing the octane level or reducing vehicular emissions of carbon monoxide (CO) and ozone-forming pollutants. The physical properties of MTBE resemble most of those of hydrocarbon components of gasoline. MTBE has a strong odor similar to a general anesthetic that has been used for surgeries on humans and other mammals. It is detectable by humans at very low concentrations in air and water - 53 parts per billion (ppb) in air and ranges as low as 20 to 40 ppb in water. MTBE is highly soluble in water and more soluble than other gasoline constituents.

Once released, MTBE has properties that tend to cause larger areas of soil and groundwater contamination when compared to those from other gasoline components, such as benzene. MTBE contamination is also more persistent. MTBE migrates rapidly through the soil column and moves faster than benzene. MTBE that reaches water (groundwater or surface water) dissolves readily in water and, based upon studies, moves at roughly the same velocity as water. Furthermore, as the contaminant plume degrades over time, the benzene, toluene, ethyl benzene and xylene (BTEX) constituents will decrease in concentration more significantly than MTBE. Eventually, MTBE may be the only contaminant remaining from the release.

MTBE IN GASOLINE AND AIR QUALITY BENEFITS

MTBE was first used in the United States to increase the octane level of gasoline in place of lead additives, beginning in the late 1970's. During the 1980's, the use of MTBE to boost octane increased throughout the country. Also in the 1980's, it was discovered that MTBE had a number of properties that contributed to reducing emissions from gasoline engines.

Beginning in 1989 in Maricopa County and in 1990 in Pima County, gasoline sold during the wintertime was required to contain oxygenates to reduce vehicular emissions of CO. Although the regulatory requirements do not limit the types of oxygenates that may be used in gasoline, historically MTBE and ethanol have been the main oxygenates used in these counties. During the initial years of the program, 80 percent of the gasoline in Maricopa County contained MTBE and 20 percent contained ethanol. However, by 1993, market conditions had changed and ethanol was the oxygenate of choice, with 73 percent of the gasoline containing ethanol and 27 percent containing MTBE. Today, approximately 100 percent of the gasoline sold in Maricopa County during the wintertime contains ethanol. In Tucson, 74 percent of the gasoline contained ethanol and 26 percent contained MTBE in 1993. By the year 1996, again due to market forces, approximately 98 percent of the wintertime gasoline sold in Tucson contained ethanol.

Beginning in June 1997, Arizona Clean-Burning Gasoline (CBG) was required in Maricopa County during the summertime to reduce ozone-forming pollutants. Arizona CBG is a gasoline with a blend of ingredients, including a summertime oxygen content up to 2.7 percent by weight (11 percent MTBE by volume if MTBE is used). Although the regulations do not prohibit the use of ethanol during the summer months, the addition of ethanol to gasoline increases the gasoline's vapor pressure and makes it difficult for the ethanol-containing gasoline to comply with summertime volatility requirements in Maricopa County. For this reason, MTBE has been used as the summertime oxygenate in Maricopa County.

During the summertime in Maricopa County, when MTBE is used as the oxygenate, the Arizona CBG program offers gasoline suppliers the choice of producing gasoline formulations meeting either the federal reformulated gasoline (RFG) or California Air Resources Board (CARB) RFG standards. Both federal and CARB RFG require minimum oxygen levels; however, refiners that make CARB gasoline may certify their fuel using an emissions-based model that does not have minimum oxygenate requirements. Although this is a legally viable option that does not require the addition of oxygenates, higher production costs are associated with the refining of gasoline that meets emission reduction requirements without the addition of oxygenates.

CBG reduces exhaust emissions of all pollutants associated with on- and off-road mobile sources. In a study conducted for the Governor's Air Quality Strategies Task Force, it was estimated that the use of CBG would reduce emissions of volatile organic compounds by at least 14 tons/day, oxides of nitrogen by at least 2 tons/day, CO by 160 tons/day, particulate matter by 0.4 tons per day and hazardous air pollutants by 1.7 tons/day (benzene equivalent) as compared to conventional gasoline. Contemporary analyses of the relative effectiveness of CBG, as compared to other air pollution control programs, show that CBG has benefits equivalent to those of the Vehicle Emissions Inspection Program. Aside from federal new car standards, these two programs reduce more ozone precursors and carbon monoxide than do all of the air pollution measures combined.

HEALTH EFFECTS OF EXPOSURE TO MTBE

The U.S. Environmental Protection Agency (EPA), the California EPA, national science agencies, and the northeastern states have reviewed numerous health-related studies that have been conducted during recent years on MTBE. The studies have addressed both short- and long-term health effects of MTBE exposure. There is no evidence that exposure to MTBE at ambient air concentrations, which occur during general exposure to gasoline fumes (e.g., vehicle refueling), causes acute health effects. Additionally, the cancer potency of MTBE, as calculated by U.S. EPA, is approximately an order of magnitude lower than that of benzene, a constituent of gasoline that is classified as a known human carcinogen. Evidence from some animal studies suggests that MTBE is a potential human carcinogen; however, EPA has stated that there are no verifiable data relating to the health effects on humans of drinking water contaminated with MTBE and classifies MTBE only as a possible human carcinogen.

Following reviews of toxicological and health-related studies, international and federal science organizations and the Connecticut Academy of Science and Engineering determined either that the evidence was insufficient to classify MTBE as a carcinogen or that MTBE is not a health hazard to humans in concentrations of normal exposure.

When MTBE enters the human body via either inhalation or absorption through the skin, it may metabolize into two compounds (tertiary butyl alcohol and formaldehyde) that are carcinogenic in animals and are classified by the EPA as probable human carcinogens.

A 1998 University of California study concluded that the risk of exposure to MTBE through ingestion of MTBE-contaminated groundwater is currently low in California due to a monitoring program of public drinking water supplies. MTBE-contaminated sources are likely to be detected before most California residents are exposed. Studies have indicated that MTBE has the potential to produce effects associated with central nervous system depression (headaches, dizziness, nausea, and disorientation); however, these effects appear to be reversible on the cessation of exposure.

ENVIRONMENTAL STANDARDS FOR MTBE

In December 1997, EPA issued a Drinking Water Advisory for MTBE (U.S. EPA, 1997). The Advisory recommends that the levels of MTBE contamination in drinking water be limited to 20 to 40 micrograms per liter (µg/L) for most consumers. EPA recommends this limit to protect consumer acceptance of the taste and odor of water resources and to provide a large margin of exposure (safety) from toxic effects.

California has established several health- and aesthetic-based standards for MTBE in drinking water. On March 9, 1999, California's EPA Office of Environmental Health Hazard Assessment adopted a Public Health Goal (PHG) for MTBE of 13 µg/L in drinking water. The PHG is considered by the California Department of Health Services in establishing a drinking water standard for MTBE. A secondary maximum contaminant level (MCL) of 5 µg/L, which addresses aesthetic concerns such as taste and odor, was adopted on January 7, 1999. A primary MCL, which is based on the PHG, has been proposed by California's Department of Health Services and may be adopted late in 1999 to address public health concerns.

U.S. EPA published a draft list of possible contaminants for regulation (Drinking Water Contaminant Candidate List) under the Safe Drinking Water Act (SDWA), on October 6, 1997 (62 FR 52194). MTBE is included on the draft list as both a research and an occurrence priority, but not as a regulatory determination priority. EPA currently concludes that there is a lack of information regarding health and treatment research and occurrence data that precludes the adoption of sound standards for MTBE. Therefore, a drinking water standard for MTBE will probably not be enacted until after February 2005.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA - Superfund) lists MTBE as a hazardous substance. MTBE, however, is not included in the Resource Conservation and Recovery Act (RCRA) list of hazardous constituents or in the list of groundwater monitoring constituents.

Recognizing that the use of treated water was appropriate for certain applications, the Superfund Programs Section of ADEQ requested that the Arizona Department of Health Services (ADHS) develop end-use concentrations for numerous constituents of concern, including MTBE. ADHS developed the concentrations based only upon human exposure to treated water containing MTBE. The proposed end-use levels are solely for the purpose of determining appropriate uses for treated water and are <u>not</u> intended to be used as remediation goals.

Within Arizona, the ADHS has established a health-based guidance level (HBGL) for MTBE (35 µg/L) in groundwater. This HBGL is based on systemic toxicity and is calculated with a relative source (i.e., some from water, air, etc.). The groundwater HBGL for MTBE is not a regulatory or compliance standard, and is therefore not enforceable in Arizona.

On December 4, 1997, when the Final Soil Remediation Standards Rule became effective, ADEQ established a new set of soil compliance standards, known as Soil Remediation Levels (SRLs). The current, final SRLs for MTBE for residential and non-residential property uses are 320 mg/kg and 3,300 mg/kg, respectively.

REMEDIATION TECHNOLOGIES FOR MTBE CONTAMINATION

Not all remediation technologies are effective for treating soil and water that is contaminated with MTBE. The EPA survey of states conducted by the University of Massachusetts found that MTBE is a critical factor in determining whether remediation efforts are effective, particularly when groundwater contamination has occurred. Of the states dealing with MTBE remediation, 26 reported that they have closed MTBE-contaminated LUST sites. Some states indicated that they have reopened closed LUST sites to test for MTBE and remediate contamination.

A search of the literature reveals that technologies for cleaning up gasoline contamination have been utilized, with varying degrees of success, to clean up MTBE in both soils and groundwater. Soil remediation technologies include soil vapor extraction and low-temperature thermal desorption, which have been used successfully. Biodegradation does not appear to be generally effective for soils, but research is ongoing. Soil treatment technologies are more successful if initiated soon after a release. If MTBE migrates through the soil column into groundwater, the difficulty and costs of remediation increase when compared to similar clean ups of gasoline contamination where MTBE is not present. Groundwater remediation technologies include “pump and treat” and air sparging which are viable methods. Air stripping of MTBE is more difficult than it is for benzene. Granular-activated carbon tends not to be a good candidate, but is undergoing additional research. It has proven effective, however, in treating wells at single-family homes. Bioremediation has not been successful in anaerobic environments, but research is underway on this technique. Regardless of the technology utilized, timely implementation of source control is important in mitigating gasoline plumes with MTBE.

According to research by ADEQ, additional site remediation activity related to MTBE has led to increased time and money spent on underground storage tank (UST) remediation projects. In states that have experienced MTBE releases and in which MTBE is regulated, remediation costs have increased an estimated 100 percent at approximately 8 percent of the contaminated sites and by at least 50 percent at 10 percent of the sites where MTBE has been detected in groundwater. Considering that MTBE plumes commonly migrate farther and faster than benzene and that MTBE is generally more difficult to remove from water than benzene, increased costs to remediate MTBE-contaminated sites are not unexpected.

EPA’s Office of Underground Storage Tanks estimates that at approximately

75 percent of MTBE-contaminated sites, the incremental cost increase of remediation will be less than 50 percent above the cost of remediating the BTEX portion alone. At 20 percent of the sites, the incremental increase would be between 50 percent and 100 percent greater. At approximately 5 percent of sites, the additional cost of remediating MTBE would be greater than 100 percent of the cost for remediating the BTEX portion alone.

NATIONAL ENVIRONMENTAL OCCURRENCES OF MTBE

Because gasoline blends containing MTBE have been used for two decades and are now widespread, MTBE has been detected in soil, surface water and groundwater throughout the United States. Potential non-point sources include urban runoff, precipitation, and motorized water craft. Significant point sources of MTBE include releases from underground and above-ground storage tanks and piping and pipelines. Concentrations of MTBE greater than 20 µg/L in groundwater are typically associated with point source releases, while small concentrations of MTBE (0.1 to 3 µg/L) may be either a point or non-point source. MTBE concentrations of greater than 400,000 µg/L have been documented near a point source release of gasoline (not in Arizona).

The U.S. Geological Survey (USGS) groundwater sampling survey of the mid-1990s, as part of the National Water Quality Assessment Program, analyzed for 60 different organic compounds in samples taken from 211 shallow wells in 8 urban areas and 524 shallow wells in 20 agricultural areas (none in Arizona). MTBE was detected in 27 percent of the urban wells and 1.3 percent of the agricultural wells. When detected, concentrations ranged from 0.2 to 23,000 µg/L, with most of the samples measuring less than 1 µg/L. MTBE was detected most frequently in Denver, Colorado, and New England urban areas, with detections in 79 and 37 percent of the samples, respectively. Only three percent of the samples in urban areas had concentrations of MTBE in excess of 20 µg/L.

Of particular note are some incidents in the State of Maine, especially in highly vulnerable areas, where the water table is shallow and aquifers are in highly fractured bedrock. In two such areas, spillage of less than 20 gallons of gasoline from one automobile accident and, presumably, from cars parked in a grass lot, resulted in significant MTBE contamination of drinking water wells. These, and numerous other incidences of MTBE contamination of groundwater prompted Maine to opt-out of the federal RFG program.

In an effort to address public concerns regarding the contamination of water sources by MTBE, EPA convened a “Blue Ribbon Panel on Oxygenates in Gasoline” on November 30, 1998, to gather information and review issues associated with use of MTBE and other oxygenates. This panel, consisting of experts from the public health and scientific communities, automotive fuels industry, water utilities, and local and state governments, reported their findings and recommendations to EPA on July 27, 1999. The Panel determined that between 5 and 10 percent of drinking water supplies in RFG areas across the country had at least detectable amounts of MTBE, but that only about 1 percent of those had levels that exceeded 20 µg/L.

Because California is so large in area, populous, the home of a large number of refineries, and began using reformulated gasolines statewide prior to other parts of the country, its circumstances relative to MTBE contamination of water resources are remarkable and unique.

Lawrence Livermore National Laboratory evaluated groundwater data from 236 leaking underground storage tank (LUST) sites in 24 counties in California; in 1995/1996,78 percent of the sites had MTBE detections ranging from a few µg/L to approximately 100,000 µg/L. Of the 2,297 public water supply wells monitored in their study, 0.35 percent were impacted by MTBE at levels equal to or exceeding 20 µg/L, and 0.42 percent were impacted by benzene at or above 1 µg/L. Hydrocarbons have impacted groundwater at 13,278 of 32,409 recognized LUST sites in California (41 percent), and MTBE contamination might be a problem at as many as 10,000 of those sites.

Probably the most publicized case of MTBE contamination occurred in the Los Angeles area. During the summer of 1996, the City of Santa Monica ceased pumping groundwater from 2 of its well fields because of persistent and increasing levels of MTBE. These two well fields provided roughly 50 percent of the city's total drinking water supply. As a result of the loss of this resource, the City of Santa Monica sued several oil companies believed to be the parties responsible for the contamination.

Surface waters have also been affected, from water craft and spills associated with water craft refueling. However, the greatest problems have occurred from LUSTs, particularly in the South Lake Tahoe area. The South Tahoe Public Utility District (STPUD) has 35 water supply wells in its system, of which 10 have been shut down recently due to MTBE contamination. On November 10, 1998, the STPUD filed a lawsuit in San Francisco Superior Court charging major oil companies and suppliers with the MTBE contamination in the district's water supply.

MTBE IN THE ARIZONA ENVIRONMENT

Gasoline blends containing MTBE have been used in the Phoenix and Tucson metro areas to help curb air pollution. Consequently, MTBE contamination associated with LUSTs and other releases of gasoline in these urban areas could be expected and are documented. It is also expected that MTBE could be found throughout the State for two reasons. First, the distribution facilities located in these urban areas also serve the surrounding rural areas of the State and oxygenated fuels may be distributed outside of the areas where they are required by law because of market or other conditions. Second, gasoline retailers along the Colorado River, on or near the border with California, are likely to acquire California reformulated gasoline from their distributors. This practice would be less frequent in the vicinity of Yuma, because the California to Arizona pipeline runs through Yuma.

As a result, MTBE-blended fuels can be placed in, dispensed and potentially released from USTs and other containment and distribution systems throughout Arizona. ADEQ does not currently track MTBE occurrences within its UST database (USTrack); however, the State Lead Unit of the UST Corrective Action Program is monitoring MTBE in groundwater at corrective action sites throughout the State.

To better understand the occurrences of MTBE in Arizona, the Governor-appointed UST Policy Commission is in the preliminary stages of a legislatively-approved groundwater study. The purpose of the study is to compile Arizona-specific data regarding releases of regulated substances, including MTBE, from LUSTs, and to provide the data to the Commission in support of LUST site prioritization and a risk-based decision-making process.

ADEQ has commenced a program to identify areas where MTBE may be present in groundwater. This is of particular importance because approximately 65 percent of Arizona's population uses groundwater as a principal drinking water source. In a joint effort with the USGS during 1998, the Water Quality Division (WQD) conducted groundwater quality monitoring in the Upper Santa Cruz Groundwater Basin of southern Arizona, which includes the Tucson area. Of the 60 groundwater samples collected from this basin, mainly from domestic wells, MTBE was not detected in any of the samples. The WQD also collected 58 groundwater samples in the Sacramento Valley Groundwater Basin in northwestern Arizona, which includes the Kingman area, and 28 in the Willcox Groundwater Basin in southeastern Arizona. There have been no detections of MTBE in any of these samples. Other groundwater studies are underway, including in the Prescott area. All groundwater samples collected from these studies will be analyzed for MTBE by the laboratory of ADHS.

The WQD is currently establishing a prioritized schedule for sampling lakes to determine, among other things, if recreational water craft and gasoline spills are resulting in MTBE contamination of surface waters. Bartlett Lake, a reservoir northeast of Phoenix, is scheduled for sampling in the fall 1999. WQD will also test waters along the main stem of the Colorado River for MTBE, and in lakes with heavy boat usage, such as Saguaro Lake.

MAJOR GOVERNMENT ACTIVITIES REGARDING MTBE

California

Detection of MTBE in surface and groundwater, curtailing of public water supplies for Santa Monica, Santa Clara, Sacramento and South Lake Tahoe, and highly publicized opposition to the presence of MTBE in gasoline prompted the California Legislature, in

October 1977, to authorize a University of California-Davis (U.C.-Davis) -led "Health and Environmental Assessment of MTBE." The U.C.-Davis report was released in November 1998. On March 25, 1999, California's Governor Davis ordered the CARB and California Air Resources Board and the California Energy Commission to develop a timetable for removing MTBE from gasoline not later than December 31, 2002. Governor Davis' Executive Order contained a number of directives to address the impacts and use of MTBE.

California is seeking federal legislation to remove, permanently, the Clean Air Act (CAA) minimum oxygen content requirement from reformulated gasoline in states that have alternative programs that achieve air quality benefits equivalent to the federal reformulated gasoline program, and has requested an immediate waiver for California CBG from the federal CAA oxygen content mandate.

U.S. EPA

On November 30, 1998, U.S. EPA convened a "Blue Ribbon Panel on Oxygenates in Gasoline" to gather information and review issues associated with use of MTBE and other oxygenates. The Blue Ribbon Panel reported its findings and recommendations to U.S. EPA on July 27, 1999. Findings of the Blue Ribbon Panel include:

- Gasoline distributions, usage and combustion poses risks to public health and the environment.
- RFG provides considerable air quality improvements and benefits for the public.
- Due to its persistence and mobility in water, MTBE is more likely to contaminate ground and surface water than are other components of gasoline.
- The occurrence of MTBE in drinking water supplies can and should be substantially reduced.
- Because MTBE is an integral component of the gasoline supply, any change in its use must be implemented with sufficient time, certainty, and flexibility to maintain stability of fuel supplies and gasoline prices.

Recommendations of the Blue Ribbon Panel are as follows:

- U.S. EPA and states should enhance federal and state Underground Storage Tanks (UST) programs.
- EPA should work with states and local water suppliers to enhance implementation of the Safe Drinking Water Act Program.

- EPA should work with states and localities to enhance efforts to protect surface waters that serve as drinking water supplies.

- EPA should work with Congress to provide for treatment of MTBE-contaminated drinking water supplies.

- Changes will have to be made to the RFG program to reduce the amount of MTBE used, while ensuring that the air quality benefits of RFG, as well as fuel supply and price stability, are maintained.

In response to the Blue Ribbon Panel's recommendations, U.S. EPA concluded that the use of MTBE in gasoline must be significantly reduced as quickly as possible, while maintaining the gains that have been made in achieving cleaner air. U.S. EPA also committed to improving gasoline leak prevention and remediation programs and to providing states with "maximum flexibility under current law that will make it easier to voluntarily reduce MTBE and use cleaner gasolines with other additives."

Northeast States

Northeast States for Coordinated Air Use Management, a consortium of the New England States, New Jersey and New York, has been tasked by its member states to conduct studies regarding the risks and benefits of RFG. These states are currently exploring options for reducing MTBE in RFG.

CONCLUSIONS AND NEXT STEPS

The use of MTBE as an additive in gasoline has had significant air quality benefits in areas of the United States that do not meet federal health-based standards. During April 1998, the California Environmental Protection Agency concluded from their research that the use of CARB RFG reduces the overall cancer risk from gasoline and exhaust emissions by 60 lifetime cancer cases per million people exposed. They also concluded that the presence of MTBE in fuels may reduce this improvement by 1 to 2 lifetime cancer cases per million people exposed.

Although the air quality benefits are recognized as significant, releases of gasoline containing MTBE from underground and above-ground storage tank systems and pipelines have impacted soil and groundwater locally throughout the country. The extent of MTBE contamination in Arizona is not known at this time. Preliminary information, however, indicates that MTBE and the other constituents of gasoline, notably benzene, have contaminated groundwater at various locations throughout the State.

Recognizing that CBG containing MTBE has been one of the most effective air pollution control strategies in metro Phoenix, it is critical that Arizona maintain the flexibility to retain these air quality benefits, while protecting the quality of water supplies. The report of the Blue Ribbon Panel on Oxygenates in Gasoline contains numerous recommendations that, as they are implemented, will greatly assist Arizona in achieving this goal. To that end, ADEQ will take the following steps in determining the extent of MTBE contamination, preventing future releases and remediating releases that have already occurred:

- Recognizing California's decision to phase out the use of MTBE by December 31, 2002, and the Blue Ribbon Panel's recommendations regarding blending fuel for clean air and water, ADEQ will continue to work closely with gasoline suppliers and other stakeholders to better understand the impact of these actions and recommendations on the Arizona gasoline supply. ADEQ will closely monitor any Congressional action to modify the requirement that CBG contain a minimum oxygen content and any EPA action to ensure that changes in federal requirements do not reduce the benefits of CBG.

- ADEQ will investigate and compile information on the potential existence of MTBE in groundwater and surface water through:

  - Developing correlations between the locations of underground storage tanks and public drinking water systems, and performing surveillance sampling on those public water systems located near underground storage tanks as part of the Drinking Water Source Water Assessment Program.

  - Performing sampling for MTBE along the Colorado River.

  - Sampling for MTBE in public water systems serving over 10,000 people will begin when the U.S. EPA final rule on sampling for unregulated contaminants becomes effective in 2001.

  - Conducting sampling for MTBE as part of groundwater basin studies, including those now underway in the Prescott Active Management Area (AMA), Upper Santa Cruz, Sacramento Valley, and Willcox Basins.

  - Performing sampling on lakes with heavy boat usage.

- ADEQ will investigate and compile information on UST systems and enhance its UST Program by:

  - Ensuring that UST facilities are in compliance with the federally-mandated December 22, 1998, UST upgrade deadline.

- Ensuring compliance with UST system performance requirements for release detection.

- Requesting monitoring and reporting of MTBE at all UST release sites.

- Ensuring that UST system installation and maintenance personnel are certified for pertinent UST system activities by ADEQ.

- Utilizing the concepts of risk-based corrective action to ensure effective prioritization and clean up of sites impacted by releases of regulated substances from USTs.

- Enhancing communication and education programs with the regulated public to maintain a high compliance rate with UST Program requirements for prevention and early detection of releases from UST systems.

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APPENDICES

LIST OF ACRONYMS

ADEQ -	Arizona Department of Environmental Quality
ADHS -	Arizona Department of Health Services
ADWM -	Arizona Department of Weights and Measures
AMA -	Active Management Area
AQD -	Air Quality Division
A.R.S. -	Arizona Revised Statutes
ASTSWMO -	Association of State and Territorial Solid Waste Management Officials
ATSDR -	Agency for Toxic Substances and Disease Registry
AWQS -	Aquifer water quality standard
BTEX -	Benzene, toluene, ethyl benzene, xylene
CAA -	Clean Air Act, as amended
CARB -	California Air Resources Board
CASE -	Connecticut Academy of Science and Engineering
CAWCD -	Central Arizona Water Conservation District
CBG -	Clean-burning gasoline
CEC -	California Energy Commission
CERCLA -	Comprehensive Environmental Response, Compensation and Liability Act
CFR -	Code of Federal Regulations
CIC -	Carcinogen Identification Committee (California)
CO -	Carbon monoxide
DART -	Developmental and Reproductive Toxicants Identification Committee (California)
DIPE -	Diisopropyl ether
EPA -	United States Environmental Protection Agency
ETBE -	Ethyl tertiary butyl ether
GAC -	Granular-activated carbon
GRRC -	Governor's Regulatory Review Council
HEAST -	Health Effects Assessment Summary Tables
HBGL -	Health-based guidance level
IARC -	International Agency for Research on Cancer
IRIS -	Integrated Risk Information System
LLNL -	Lawrence Livermore National Laboratory
LNAPL -	Light non-aqueous phase liquid
LTTD -	Low-temperature thermal desorption
LUST -	Leaking underground storage tank
MCL -	Maximum contaminant level
MTBE -	Methyl tertiary butyl ether; Methyl tertiary-butyl ether; Methyl tert-butyl ether
mg/kg -	Milligrams per kilogram
µg/L -	Micrograms per liter
mg/m^3 -	Milligrams per cubic meter
mg/kg·d -	Milligrams per kilogram · day
mg/L -	Milligrams per liter
NAPL -	Non-aqueous phase liquid

NCEA -	National Center for Environmental Assessment
NESCAUM -	Northeast States for Coordinated Air Use Management
NOx -	Oxides of nitrogen
NTP -	National Toxicology Program
OEHHA -	California EPA Office of Environmental Health Hazard Assessment
OUST -	U.S. EPA Office of Underground Storage Tanks
PHG -	Public health goal
RBCA -	Risk-based corrective action
RCRA -	Resource Conservation and Recovery Act
RfC -	Reference concentration for chronic inhalation exposure
RfD -	Reference dose for chronic oral exposure
RFG -	Reformulated gasoline
STPUD -	South Tahoe Public Utility District
SRL -	Soil remediation level
SRP -	Salt River Project
SVE -	Soil vapor extraction
TAME -	Tertiary amyl methyl ether
TBA -	Tertiary butyl alcohol
USGS -	United States Geological Survey
UST -	Underground storage tank
VOC -	Volatile organic compound
WPD -	Waste Programs Division
WQD -	Water Quality Division

REPORT ON METHYL TERTIARY BUTYL ETHER (MTBE)

INTRODUCTION

Methyl tertiary butyl ether (MTBE) is a gasoline additive that has been used in the U.S. since the late 1970's, initially to enhance octane levels and replace lead. In the 1980's, MTBE and other chemicals containing oxygen (particularly alcohols and ethers) were discovered to reduce carbon monoxide emissions from vehicles. Arizona requires all gasoline sold during the winter months within Maricopa County, beginning in 1989, and in Pima County, beginning in 1990, to contain oxygenates; the favored oxygenate for the first few years of this program was MTBE. The federal Clean Air Act Amendments of 1990 (the Act), following the successful implementation of oxygenated fuels programs in Arizona and Colorado, required states to adopt oxygenated fuel programs in carbon monoxide nonattainment areas. In addition, the Act set a minimum oxygen content standard for reformulated gasoline (RFG), which is designed to reduce ozone-forming pollutants and required in the most polluted ozone nonattainment areas in the U.S. Beginning in July 1997, as an ozone pollution control measure, Maricopa County began receiving reformulated, or Cleaner Burning Gasoline (CBG). Ethanol had entirely replaced MTBE in the wintertime gasoline supply in Maricopa County beginning in about 1994; however, CBG reintroduced MTBE-blended gasoline to the area.

Although MTBE-blended gasoline has been instrumental in reducing air pollution, MTBE is now being detected more frequently in soils and groundwater near release sites throughout the United States. Releases from leaking underground storage tanks (LUST), above-ground storage tanks, and pipelines have resulted in local, fuel-related contamination. Unlike benzene, a constituent of gasoline of significant concern and a known human carcinogen, the documented toxicity and consequent health effects of MTBE occur at levels of exposure that greatly exceed its odor and taste thresholds. As such, MTBE contamination has rendered drinking water supplies in other areas of the U.S. unpalatable. Further, MTBE dissolves in water much more readily than other gasoline components. As a result, when MTBE-blended gasoline contamination occurs, MTBE has a tendency to be more widespread in groundwater than other gasoline components, and is more persistent and difficult to remove from water and soil.

These facts and issues, in addition to contentious public dialog regarding MTBE in other areas of the country, are of great concern to the Arizona Department of Environmental Quality (ADEQ). Beginning in March 1998, ADEQ held meetings involving participants from ADEQ and the Arizona Department of Health Services (ADHS) to discuss current knowledge about the health and environmental effects of MTBE, experiences of other states relative to MTBE contamination of natural resources and their clean up, applicable remediation technologies, and occurrences of MTBE in Arizona. ADEQ prepared a Draft MTBE Report, which was made public on February 26, 1999, and was the subject of public meetings in Phoenix on May 6, 1999, and in Tucson on May 26, 1999; public comments were accepted through June 18, 1999, and are summarized in Appendix 1. The purpose of this Report is to update the information provided in the Draft Report of February 26, 1999, and provide a revised set of recommendations that:

- Foster retention of the air quality benefits provided by CBG (which can be produced with or without MTBE);
- Increase the state of knowledge regarding the extent of and risks posed by MTBE contamination of soil and water in Arizona;
- Assure the maximum feasible protection of Arizona's resources from contamination by gasoline and its components, including MTBE; and
- Prevent disruptions in supply, quality and price of gasoline in Arizona.

As a final note, MTBE is not just an Arizona issue; it is a national issue. Organizations with considerably more resources than the State, like the EPA, the Northeast States for Coordinated Air Use Management ((NESCAUM), which includes all of the New England states, New York and New Jersey) and the State of California, have been tasked by their leaders to evaluate all of the same issues that are covered in this report. Only a portion of those evaluations is completed. This report represents all of the information that is available at the time of release. As the national effort continues, more will become known about the management of MTBE in the environment, what options for the future use of MTBE in gasoline may be available, and, ultimately, how national and regional policy choices may affect Arizona. Appendix 2 of this Report includes a list of selected Internet web-site addresses that were used by ADEQ in its research.

PROPERTIES OF MTBE

MTBE is a synthetic, flammable, liquid fuel additive made by combining methanol and isobutylene. It is added to gasoline for the purpose of increasing the octane level or reducing vehicular emissions of carbon monoxide and ozone-forming pollutants. The physical properties of MTBE resemble most of those of hydrocarbon components of gasoline. Two of its characteristics are of major importance for the purposes of this Report:

- MTBE has a strong odor similar to diethyl ether, which was used as a general anesthetic for surgeries on humans and other mammals. It is detectable by humans at very low concentrations in air and water - 53 parts per billion (ppb) in air and as low as 20 to 40 ppb in water (U.S. EPA Drinking Water Advisory).
- MTBE is highly soluble in water.

Once released, MTBE has properties that cause it to spread farther in soil and groundwater when compared to other gasoline components, such as benzene. Finally, MTBE contamination is more persistent.

<u>MTBE migrates rapidly through the soil column</u>. If MTBE is released into soil above groundwater (vadose zone), it tends to move faster than benzene through the soil pore spaces, whether they are filled with air or water vapor:

- When compared to benzene, MTBE partitions strongly from the gas phase to the water phase (Henry's Law). MTBE tends to stay in the water phase because of its relatively low Henry's constant of 0.022 at 25^{o} C, as opposed to benzene, which moves more readily from the water to the vapor phase because of its higher Henry's constant of 0.22 at 25^{o}C.

- When moving from the free product phase to the vapor phase, MTBE is three times more volatile than benzene (U.S. EPA, 1998b).

- MTBE has about one-ninth the capacity of benzene to adsorb to soil or organic carbon particles (U.S. EPA, 1998b).

<u>MTBE remains in water and migrates rapidly in water</u>. MTBE that reaches water (groundwater or surface water) tends to dissolve quite readily into and move at roughly the same velocity as water (Squillace, et al., 1998):

- MTBE is about 30 times more soluble than benzene in water (U.S. EPA, 1998b). An oxygenated gasoline with 10 percent by weight of MTBE has a solubility of MTBE in water of about 5,000 milligrams per liter (mg/L), as opposed to a non-oxygenated gasoline, in which the total hydrocarbon solubility in water is about 120 mg/L (Squillace et al., 1998).

- MTBE is less likely than benzene to partition from groundwater into the vapor phase (Henry's Law).

- Over time, the portion of a plume containing MTBE will tend to become larger relative to the portion containing benzene, toluene, ethyl benzene and xylene (BTEX) as the contaminant plumes migrate (Happel, et al., 1998).

- Organic carbon contained in aquifer material does not retard migration of MTBE as significantly as it retards benzene (U.S. EPA, 1998b).

Based upon these properties, there are some general behaviors that might be expected from MTBE in the field at a gasoline release site. MTBE is likely to have a larger vapor signature within the soil column (vadose zone) and a greater distribution within groundwater (saturated zone) than that of the BTEX constituents of gasoline. Furthermore, as the contaminant plume degrades over time, the BTEX constituents will decrease in concentration more significantly than the MTBE. Eventually, MTBE may be the only contaminant remaining from the release.

Research has been conducted to determine the effects of different concentrations of oxygenates, including MTBE, on the various parts of underground storage tank (UST) systems. A 1989 ADEQ report on the compatibility of oxygenates with UST system components summarized then-current findings that MTBE-blended fuels result in only very minor material degradation at levels up to 20 percent by volume of oxygenate (Thatcher, 1989). More recent research indicates that swelling could occur with some elastomer seals used on UST piping in contact with typical gasoline-MTBE mixture levels (Boggs, 1997). With time, this swelling could cause a failure of these seals and the release of MTBE-bearing fuel into the environment.

USE OF MTBE IN GASOLINE

MTBE was first used in the United States to increase the octane level of gasoline in place of lead additives, beginning in the late 1970's. During the 1980's, the use of MTBE to boost octane increased throughout the country, being primarily used in the mid- and high-grade gasolines at concentrations ranging up to 8 percent by volume. Also in the 1980's, it was discovered that MTBE had a number of properties that contributed to reducing emissions from gasoline engines:

- It provides additional oxygen, which improves combustion efficiency.
- It changes the boiling-point properties of gasoline in a way that increases the efficiency of combustion.
- As a diluent, it reduces the concentration of a number of gasoline constituents that contribute to higher emissions of carbon monoxide, ozone, oxides of nitrogen and hazardous air pollutants: BTEX, olefins and sulfur.
- Because it improves octane performance of gasoline, it can replace BTEX, which is one of the primary sources of octane used by gasoline refiners.
- It has a relatively low vapor pressure when compared with other oxygenates, which helps reduce evaporative emissions of gasoline during refueling and from vehicle fuel systems.

Arizona requires all gasoline sold during the wintertime within Maricopa County, beginning in 1989, and within Pima County, beginning in 1990, to contain oxygenates to reduce vehicular emissions of carbon monoxide (CO). Although the regulatory requirements do not limit the types of oxygenates that may be used in gasoline, historically MTBE and ethanol have been the main oxygenates used in these counties[1]. In Maricopa County, all gasoline is required to have an oxygen content of 2.7 percent by weight if MTBE or other oxygenates are used, and 3.5 percent by weight if ethanol is used. This equates to approximately 15 percent by volume MTBE and 10 percent by volume ethanol. In Pima County, gasoline is required to contain 1.8 to 3.7 percent by weight oxygen.

During the initial years of the program, 80 percent of the gasoline in Maricopa County contained MTBE and 20 percent contained ethanol. However, by 1993, market conditions had changed and ethanol was the oxygenate of choice, with 73 percent of the gasoline containing ethanol and 27 percent containing MTBE. Today, approximately 100 percent of the gasoline sold in Maricopa County during the wintertime contains ethanol. In Tucson, 74 percent of the gasoline contained ethanol and 26 percent contained MTBE in 1993. By 1996, again due to market forces, approximately 98 percent of the wintertime gasoline sold in Tucson contained ethanol.

Beginning in June 1997, Arizona Clean-Burning Gasoline (CBG) was required for use in Maricopa County during the summertime to reduce ozone-forming pollutants. Arizona CBG is a gasoline with a blend of ingredients, including a summertime oxygen content up to 2.7 percent by weight (11 percent MTBE by volume if MTBE is used). Although the regulations do not prohibit the use of ethanol during the summer months, the addition of ethanol to gasoline increases the gasoline's vapor pressure and makes it difficult for the ethanol-containing gasoline to comply with summertime volatility requirements in Maricopa County. For this reason, MTBE has been used as the summertime oxygenate in Maricopa County.

During the summertime in Maricopa County, when MTBE often is used as the oxygenate, the Arizona CBG program offers gasoline suppliers the choice of producing gasoline formulations meeting either the federal RFG or CARB RFG standards. Federal RFG requires minimum oxygen levels of 2.0 weight percent. CARB RFG requires 1.8 to 2.2 weight percent oxygen. Refiners that make CARB gasoline may certify their fuel using an emissions-based model that does not have minimum oxygenate requirements. Although this is a legally viable option that does not require the addition of oxygenates, higher production costs are associated with the refining of gasoline that meets emission reduction requirements without the addition of oxygenates.

In addition to MTBE's lower vapor pressure, which results in decreased evaporation of petroleum constituents at storage facilities and during fuel transfers, MTBE is more compatible with gasoline than is ethanol. Ethanol is typically shipped separately from

[1]Legislation from 1998 (HB 2347) requires the use of 10 percent ethanol by volume in Maricopa County during the period November 1 to March 31, beginning in the year 2000.

gasoline and is blended with the gasoline at the distribution terminal because, if it is stored for an extended period of time, it tends to separate from gasoline during its storage period (U.S. EPA, 1998c). Furthermore, if gasoline blended with ethanol is exposed to water or water vapor (as in a pipeline), the ethanol tends to bring the water into solution and the gasoline may be rendered unusable. Because of this and other properties of ethanol-gasoline blends, Kinder Morgan Energy Partners, which operates the pipelines that deliver nearly 100 percent of all of the gasoline used in central and southern Arizona, does not allow ethanol or ethanol-gasoline blends into their system. Nationwide, MTBE is the most commonly used oxygenate, accounting for use in approximately 80 percent of RFG (U.S. EPA, 1998c). Ethanol is the second most common fuel oxygenate and accounts for an additional 15 percent of the oxygenates used. The remaining 5 percent consists of other oxygenates such as tertiary amyl methyl ether (TAME), ethyl tertiary butyl ether (ETBE), diisopropyl ether (DIPE), and tertiary butyl alcohol (TBA).

MTBE has also been detected in other petroleum products and wastes. In a survey conducted for EPA, five states reported trace amounts of MTBE in other fuels, such as waste oil, diesel and aviation fuel. Because MTBE would not have been added to the diesel or aviation fuel, the states have speculated that the MTBE resulted from cross-contamination at facilities sharing the same pipelines (Underground Storage Tank Guide, August 1998).

AIR QUALITY BENEFITS OF OXYGENATED FUELS IN ARIZONA

The use of oxygenated gasoline (containing either MTBE or ethanol) reduces ozone, carbon monoxide, and hazardous air pollutants. Ozone pollution reaches unhealthful levels during the summertime in Maricopa County and portions of Gila, Pinal and Yavapai Counties. Ground-level ozone is an air pollutant that has been found to be harmful to human health and the environment. Health effects of ozone include damage to the respiratory system, reduced breathing capacity and chest pain, nasal congestion, sore throat and headaches. Individuals with chronic respiratory diseases are especially susceptible to ozone. Additionally, ozone injures certain plants, trees, and materials.

Unlike most air pollutants, ozone is not emitted directly into the air from tailpipes or smokestacks; ozone is formed when sunlight and heat act upon volatile organic compounds (VOCs) and nitrogen oxides (NOx) in a series of complex chemical reactions in the atmosphere. Carbon monoxide (CO) also contributes to ozone formation. Approximately 35 percent of human-caused VOC emissions in Maricopa County are caused by on-road vehicles (cars, trucks) and approximately 23 percent are from off-road mobile sources (lawn mowers, trimmers, construction equipment, etc). The use of CBG containing oxygenates during the summertime reduces the emissions of VOCs, NOx, and CO from on- and off-road gasoline-powered engines.

CO has historically reached unhealthful levels during the wintertime in Maricopa County and, if not controlled, could reach unhealthful levels in Pima County. CO is unhealthy because it bonds much more readily than oxygen with hemoglobin and impairs the ability of blood cells to carry oxygen in the body. Motor vehicles are a significant source of CO. In the year 2000, an estimated 67 percent of CO emissions in Maricopa County will come from on-road vehicles, and 27 percent of CO emissions will come from off-road vehicles and equipment (Draft Technical Support Document for Carbon Monoxide Modeling in Support of the 1998 Serious Area State Implementation Plan, Maricopa Association of Governments, July 1998).

CBG reduces exhaust emissions of all pollutants associated with on- and off-road mobile sources. In a study conducted for the Governor's Air Quality Strategies Task Force, it was estimated that the use of CBG would reduce emissions of VOC compounds by at least 14 tons/day, NOX by at least 2 tons/day, CO by 160 tons/day, particulate matter by 0.4 tons per day and hazardous air pollutants by 1.7 tons/day (benzene equivalent) as compared to conventional gasoline sold in the metro Phoenix area. The necessity of using CBG in order to meet the federal health-based standards for air quality is detailed in the Technical Support Document included with the request for EPA approval of the CBG Program in Arizona (Appendix 3). Contemporary analyses of the relative effectiveness of CBG, as compared to other air pollution control programs in the Phoenix metro area, show that CBG has benefits equivalent to those of the Vehicle Emissions Inspection Program. Aside from federal new car standards, these two programs reduce more ozone precursors and carbon monoxide than do all of the pollution measures combined.

Studies have been conducted that appear to contradict the above findings. A recent study by the University of California (Keller, et al., 1998) concluded that MTBE and other oxygenates have no significant impact on exhaust emissions of CO, NOx, VOC and benzene for advanced technology vehicles. The National Research Council (NRC, June 1999) concluded that ozone reductions are due more to modern vehicle emission control systems than to the oxygen content of RFG. Nevertheless, the NRC also concluded that oxygenates have been significant in reducing some toxic constituents in gasoline, such as benzene, which has resulted in a net reduction of hazardous air pollutants. The most recent and comprehensive study is that of EPA's "Blue Ribbon Panel on Oxygenates in Gasoline," which concluded that the use of oxygenates as part of the RFG program have "provided substantial reductions in the emissions of a number of air pollutants from motor vehicles, most notably volatile organic compounds (precursors of ozone), carbon monoxide, and mobile-source air toxics (benzene, 1,3-butadiene, and others), in most cases resulting in emissions reductions that exceed those required by law."

HEALTH EFFECTS OF MTBE

The U.S. EPA, the California EPA, the National Science and Technology Council Committee on Environment and Natural Resources, the Agency for Toxic Substances and

Disease Registry (ATSDR), NESCAUM, and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) have reviewed numerous health-related studies that have been conducted during recent years on MTBE. The studies have addressed both acute and chronic health effects of MTBE exposure.

- At least 20 studies on animals and humans have been conducted since 1987. Based upon these studies, there is no evidence that exposure to MTBE at ambient air concentrations, which occur during general exposure to gasoline fumes (e.g., vehicle refueling, commuting, or general outdoor exposure), causes acute health effects, and that such exposures are below EPA estimated reference doses and concentrations.[2]

- The cancer potency of MTBE, as calculated by U.S. EPA, is approximately an order of magnitude lower than that of benzene, a constituent of gasoline that is classified as a known human carcinogen, and more than 100 times less than that of 1,3-butadiene, a carcinogenic emission product of incomplete fuel combustion.

- Some experimental animal studies indicate that MTBE exposure at elevated concentrations (several magnitudes above what would be expected under ambient concentrations that occur during general exposure to gasoline fumes or in drinking water) is a carcinogen in rats and mice via inhalation and ingestion (Belpoggi, et al., 1997; Chun, et al., 1992; Burleigh-Flayer, et al., 1992). Evidence from these animal studies suggests that MTBE is a potential human carcinogen (U.S. EPA, 1998a). However, U.S. EPA has stated that there are no verifiable data relating to the health effects on humans of drinking water contaminated with MTBE and classifies MTBE only as a possible human carcinogen.

- Following reviews of toxicological and health-related studies, the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) of

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[2]Based on levels of confidence in the data from toxicological studies, EPA publishes health effects information on contaminants of concern within different reporting systems. Data for contaminants with a relatively high level of confidence are summarized within EPA's Integrated Risk Information System (IRIS). Data with a lower degree of confidence are published in the Health Effects Assessment Summary Tables (HEAST). Data for contaminants with the lowest levels of confidence are through the EPA's National Center for Environmental Assessment (NCEA), and within other reporting systems. EPA has published the following health related exposure thresholds for MTBE, where the reference dose or reference concentration relates to non-carcinogenic, or systemic, toxicity effects:

- Reference concentration for chronic inhalation exposure (RfC): 3.0 mg/m^3 (source: IRIS).

- Reference dose for chronic oral exposure (RfD): 0.005 mg/kg·d (source: NCEA).

- Carcinogenicity assessment of lifetime exposure: U.S. EPA concludes that a lifetime exposure health effects-based recommendation cannot currently be extrapolated from available data.

the National Institute of Environmental Health Sciences, and the Connecticut Academy of Science and Engineering (CASE) determined either that the evidence was insufficient to classify MTBE as a carcinogen or that MTBE is not a health hazard to humans in concentrations of normal exposure.

- When MTBE enters the human body via either inhalation or dermal contact (absorption through the skin), it may metabolize into tertiary butyl alcohol (TBA) and formaldehyde. Both of these compounds are carcinogenic in animals and are classified by the EPA as probable human carcinogens.

- Breathing of MTBE vapors may cause nose and throat irritation and, potentially, headaches, nausea, dizziness, and mental confusion (Agency for Toxic Substances Disease Registry (ATSDR), frequently-asked questions web-site). The ambient concentrations that are thresholds for both the acute and chronic health effects of MTBE range from roughly the same to two magnitudes above the health effects thresholds for other major components of gasoline, particularly toluene and xylene (NESCAUM, 1999).

In addition to the above information, studies evaluating various aspects related to use of MTBE are ongoing. In California, the MTBE Public Health and Environmental Protection Act (Senate Bill 521), which was signed into law in October 1997, mandated the University of California to study the risks and benefits of MTBE. With respect to potential health impacts, this report (Keller, et al., 1998) concluded:

- The risk of exposure to MTBE through ingestion of MTBE-contaminated groundwater is currently low in California due to a monitoring program of public drinking water supplies. MTBE-contaminated sources are likely to be detected before most California residents are exposed.

- Studies have indicated that MTBE has the potential to produce effects associated with central nervous system depression (headaches, dizziness, nausea, and disorientation); however, these effects appear to be reversible upon the cessation of exposure.

- MTBE is an animal carcinogen with the potential to cause cancer in humans.

U.S. EPA, other federal and state agencies, and private entities continue to conduct research on health and environmental issues associated with the use of MTBE and other gasoline oxygenates. Based on the available information regarding the health effects of MTBE, it appears that the taste and odor threshold concentration is lower than the concentration that may adversely impact the public's health. Nevertheless, if a person can smell MTBE, they are probably also inhaling gasoline fumes containing other chemicals of concern. Some of these compounds are known to cause cancer in animals, and benzene is a known human carcinogen.

ENVIRONMENTAL STANDARDS FOR MTBE

In December 1997, EPA issued a Drinking Water Advisory for MTBE (U.S. EPA, 1997). The Advisory recommends that the levels of MTBE contamination in drinking water be limited to 20 to 40 micrograms per liter (µg/L) for most consumers. EPA recommends this limit to protect consumer acceptance of the taste and odor of water resources and to provide a large margin of exposure (safety) from toxic effects. Additionally, the Advisory concludes that MTBE concentrations in this range in drinking water would be unlikely to cause health effects because the concentration is 4 to 5 orders of magnitude lower (i.e., 1-10 thousandth to 1-100 thousandth) than concentrations that cause observable adverse health effects in animals.

California has set several health and aesthetic based standards for MTBE in drinking water. In December 1998, California's Carcinogen Identification Committee (CIC) recommended that MTBE not be listed as a carcinogen (Bureau of National Affairs (BNA) Environment Reporter, 1998e).   In 1991, California established an interim action level of 35 µg/L for MTBE in drinking water. On March 9, 1999, the California's EPA Office of Environmental Health Hazard Assessment (OEHHA) adopted a Public Health Goal (PHG) for MTBE of 13 µg/L in drinking water. The PHG is considered by the California Department of Health Services in establishing a drinking water standard for MTBE. California's Local Drinking Water Protection Act of 1997 requires the California Department of Health Services to develop a two-part drinking water standard for MTBE. As the first part, a secondary maximum contaminant level (MCL) of 5 µg/L, which addresses aesthetic concerns such as taste and odor, was adopted on January 7, 1999. The second part, a primary MCL, which is to address public health concerns, has been proposed at 13 µg/L based on the PHG and may be adopted later in 1999.

EPA has published a draft list of possible contaminants for regulation (Drinking Water Contaminant Candidate List) under the Safe Drinking Water Act (SDWA), on October 6, 1997 (62 FR 52194). MTBE is included on the draft list as both a research and an occurrence priority, but not as a regulatory compliance determination priority. EPA currently concludes that there is a lack of information regarding health and treatment research and occurrence data which precludes the adoption of sound standards for MTBE. Therefore, a drinking water standard for MTBE will probably not be enacted until after February 2005 (Happel, et al., 1998).

At the March 1998, EPA-sponsored national UST/LUST Conference in Long Beach, California, attendees from several states urged EPA to complete necessary toxicological testing to determine the carcinogenicity of MTBE. EPA representatives indicated that an additional 2 to 4 years might be needed to complete this testing. Many of these same states consider that they may not be able to address MTBE in drinking water supplies until their state enacts legislation, or until EPA develops an MCL.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) lists MTBE as a hazardous substance. MTBE, however, is not included in the Resource Conservation and Recovery Act (RCRA) list of hazardous constituents (40 CFR 261, Appendix VIII) or in the list of groundwater monitoring constituents (40 CFR 264, Appendix IX).

Many states have established standards for MTBE in soil and water. The University of Massachusetts prepared a summary table of these MTBE soil and groundwater standards, which is contained in Appendix 4 (Underground Storage Tank Guide, 1998a).

The federal government does not currently have an MCL for MTBE; nor does Arizona have an Aquifer Water Quality Standard (AWQS) for MTBE. An AWQS and a MCL are numeric standards that are considered by the respective regulatory agencies to be protective of water quality for use as drinking water. Within Arizona, the ADHS has established a health-based guidance level (HBGL) for MTBE (35 µg/L) in groundwater. This HBGL is based on systemic toxicity and is calculated with a relative source (i.e., some from water, air, food, etc.). The groundwater HBGL for MTBE is not a regulatory or compliance standard, and is therefore not enforceable in Arizona.

Recognizing that the use of treated water was appropriate for certain applications, the Superfund Programs Section of ADEQ requested that the ADHS develop end-use concentrations for numerous constituents of concern, including MTBE. ADHS developed the concentrations based upon human exposure to treated water containing MTBE. The proposed end-use levels are solely for the purpose of determining appropriate uses for treated water and are <u>not</u> intended to be used as remediation goals. The draft end-use levels for MTBE for residential and occupational exposures have not been finalized yet by ADEQ and include the concentrations listed in Table 1.

TABLE 1
DRAFT END-USE LEVELS (µg/L) FOR MTBE-CONTAMINATED WATER[3]

END USE	RESIDENTIAL	OCCUPATIONAL
Non-food crop, agricultural	540	250

[3] In drafting the proposed end-use levels, the most stringent level will apply, under the assumption that it will be protective of all potential exposures. For example, the MTBE concentration for the end use "Non-food crop, agricultural" would be listed as 250 µg/L only.

Landscape, flood	460	250
Landscape, spray	1,000	260
Open water contact	390	250
Ornamental lakes	390	250
Sand and gravel washing	28,000	250
Dust control and soil compaction	490,000	1,200,000

The UST Program at ADEQ considers that MTBE is potentially a significant contaminant of concern at LUST sites. Additionally, the UST Program is continuing efforts to implement a complete risk-based corrective action process (RBCA). RBCA essentially provides for a tiered approach to adequate site characterization and cleanup, progressing from Tier 1 (use of Soil Remediation Levels [SRL] and AWQS, in which results are based on generic site conditions, standard fate and transport models, and standard exposure models and assumptions) through a Tier 3 alternative (site-specific cleanup standards which are based more on site-specific conditions, models, and assumptions).

For soils in Arizona, the ADEQ Interim Soil Remediation Standards Rule became effective April 1, 1996. Under the interim rule, soil standards were established for numerous constituents of concern, including MTBE for both residential (580 mg/kg) and non-residential property uses (2,030 mg/kg). Although these two standards were designated as HBGLs, they are compliance standards for soil in Arizona. On December 4, 1997, ADEQ established a new set of soil compliance standards, known as Soil Remediation Levels (SRLs), when the Final Soil Remediation Standards Rule became effective. Included in the listing of SRLs are soil standards for MTBE for a residential property use (320 mg/kg) and for a non-residential property use (3,300 mg/kg).

REMEDIATION OF MTBE CONTAMINATION

General

The U.S. EPA survey of states conducted by the University of Massachusetts found that MTBE is a critical factor in determining whether remediation efforts are effective, particularly when groundwater contamination has occurred. Of the states dealing with MTBE remediation, 26 reported that they have closed MTBE-contaminated LUST sites. Some states, including Maryland, North Carolina, New Hampshire, New York, Vermont and Wisconsin, indicated that they have reopened closed LUST sites to test for MTBE and remediate contamination (Underground Storage Tank Guide, August 1998).

A search of the literature reveals that technologies for cleaning up gasoline contamination have been utilized, with varying degrees of success, to clean up MTBE in both soils and groundwater. Soil remediation technologies include soil vapor extraction (SVE), low-temperature thermal desorption (LTTD), and biodegradation. Soil treatment technologies are more successful if initiated soon after a release, particularly in areas with consistently moist soils and regular precipitation and/or extremely shallow water tables. If MTBE migrates through the soil column into groundwater, the difficulty and costs of remediation increase when compared to similar clean ups of gasoline contamination where MTBE is not present. Groundwater remediation technologies include “pump and treat,” air sparging, air stripping, granular-activated carbon (GAC), and bioremediation. Regardless of the technology utilized, timely implementation of source control is important in mitigating gasoline plumes containing MTBE.

Soil Vapor Extraction (SVE)

SVE is an in-situ technology that removes volatile contaminants by application of a vacuum to subsurface soils in the unsaturated zone above the groundwater. MTBE can be effectively removed from unsaturated zone soils by SVE (U.S. EPA, 1998b). Fourteen states reported having success using SVE to remediate MTBE in soil (Underground Storage Tank Guide, August 1998).

Low-Temperature Thermal Desorption (LTTD)

LTTD is an ex-situ technology that uses temperatures below ignition levels to separate volatile and semi-volatile contaminants from soil. LTTD is an effective technology for the remediation of MTBE in soil (U.S. EPA, 1998b). Twelve states reported having success with LTTD (Underground Storage Tank Guide, August 1998).

Biodegradation - Soil

Bioremedial methods for soil treatment, including land farming, bioventing and biopiles, are currently not recommended for removing MTBE because it is resistant to biodegradation and moves through the soil column quickly (U.S. EPA, 1998b). Nevertheless, ongoing research indicates that certain strains of bacteria can degrade MTBE under controlled circumstances (Vogel, 1998).

“Pump and Treat”

This technology involves the pumping or extraction of contaminated groundwater and treating it above ground by air stripping or other methods. In general, “pump and treat” is expected to be a viable technology because MTBE does not adsorb significantly to soil or organic particles in the saturated zone. Groundwater extraction may be combined with other technologies, such as SVE, for removal of contaminants from both soils and groundwater at a site.

Ten states have reported success using "pump and treat" to remediate MTBE in groundwater (Underground Storage Tank Guide, August 1998). Chevron evaluated eight sites in Maryland contaminated with MTBE, benzene, and xylene, and determined that combined vapor extraction and groundwater extraction were effective, with average concentration reductions in groundwater of 95 percent for MTBE, 94 percent for benzene, and 92 percent for xylene (Buscheck, et al., 1998). Based upon data compiled by Alpine Environmental, Inc. from 14 sites in California, Florida, Massachusetts, New Jersey, Vermont and Wisconsin, Davidson (1998b) reported preliminarily that many sites may need only 5 to 10 years of "pump and treat" to remove most of the MTBE from groundwater.

Air Sparging

Air sparging is the direct injection of air into groundwater to volatilize the contaminants in situ. Air sparging should be more effective for benzene than MTBE because more air is needed to volatilize MTBE. Nevertheless, air sparging can be effective, as some case studies have shown reductions in MTBE from above 1,000 µg/L to less than 10 µg/L in less than two years (U.S. EPA, 1998b). Additionally, 15 states have reported success using air sparging as a remediation technique (Underground Storage Tank Guide, August 1998).

Air Stripping

This technology may be the most common in use. Contaminated water is cascaded down a tower packed with materials that cause the water to be highly aerated. The more volatile contaminants partition into the air, which may be treated to capture or destroy the released contaminants. Again, because MTBE has a lower volatility and is more soluble than benzene in water, MTBE is more difficult to remove from water than benzene.

Based upon initial field experience, for similar volumes of benzene- and MTBE-contaminated water, 2 to 5 times more air is required to treat the MTBE-contaminated water if the MTBE concentrations are less than 5,000 µg/L (U.S. EPA, 1998b). Based upon evaluation of 12 pilot-scale and full-scale packed tower air strippers, Davidson (1998b) reported that, for systems with air-to-water ratios of greater than 100:1, benzene removal averaged 98 percent, but MTBE removal averaged only 78 percent. Air strippers needed an air-to-water ratio of at least 150:1 to remove more than 95 percent of the MTBE in the water. Miniature air strippers have proven effective in cleaning MTBE-contaminated water at the point of exposure for high-volume potable wells, or in cases where MTBE concentrations exceeded 300 µg/L (U.S. EPA, 1998b).

Granular-Activated Carbon (GAC)

Because it does not adsorb well to activated carbon, GAC tends to not be a good candidate for MTBE removal from contaminated water . Although various sources of carbon may be used for GAC, Davidson (1998b) reported that the adsorption capacity of GAC for BTEX is on the order of 56 milligrams of contaminants per gram of carbon (mg/g); whereas, MTBE adsorption capacity was approximately 3 to 6.5 mg/g. Therefore, the amount of GAC necessary for treatment may be substantially greater where MTBE contamination is present. Creek and Davidson (1998) summarized results at 8 sites where GAC had been used for water treatment. They concluded that GAC does adsorb MTBE to some degree, but tends to readily desorb from GAC and break through more quickly than BTEX. To improve efficiency, serial GAC containers might be required.

GAC is one of the treatment processes being tested on MTBE-contaminated, extracted groundwater in Santa Monica, California. Additionally, based upon the experience of New Jersey, GAC has proven to be effective at the point of exposure in treating low-volume potable water wells (e.g., for single-family homes) with MTBE contamination levels below 300 µg/L (U.S. EPA, 1998b).

Bioremediation - Groundwater

Many studies have indicated that MTBE does not degrade readily in most hydrogeological environments, especially where conditions are more anaerobic. At sites investigated in California, MTBE tended to attenuate more through dispersion in groundwater as opposed to biodegrading (Happel, et al., 1998). Various investigators have reported that MTBE is resistant to degradation by anaerobic microorganisms, as well as under denitrifying conditions, sulfate-reducing conditions, and methanogenic-reducing conditions (Squillace, et al., 1998). Consequently, for releases of gasoline with MTBE, the BTEX part of the plume may ultimately be smaller and biodegraded more quickly than the MTBE part. Nevertheless, some published research has demonstrated that certain bacterial populations have the ability to use MTBE as a sole carbon source (Squillace, et al., 1998). In addition, laboratory experiments on the inoculation of groundwater and aquifer sediments with ether-degrading microbial cultures to enhance aerobic degradation of MTBE suggest that aquifer seeding (bioaugmentation) may be a viable approach for controlling the leading edge of contaminant plumes (Salanitro, et al., 1998). There are several factors that are critical to the effectiveness of aerobic microbes, including culture decay and dilution, persistence, maintenance of metabolic activity, and sustaining adequate levels of dissolved oxygen. In some instances, degradation of MTBE in groundwater may lead to the formation of tertiary butyl alcohol, which has been determined to be a carcinogen in laboratory animals (Squillace, et al., 1998).

In California, in-situ bioremedial research is being conducted jointly by Arizona State University and Equilon Enterprises on an MTBE plume in groundwater at the Port Hueneme Naval Facility. This investigation has focussed on seeding the contaminant plume with a mixed culture of micro-organisms (BC-4) and adding oxygen. Preliminary results of these investigations indicate that biostimulation of indigenous cultures by oxygen addition alone serves to degrade some of the MTBE; MTBE degrades more readily through bioaugmentation, without production of tertiary butyl alcohol; and that BC-4 and oxygen addition can be effective as a "biobarrier" in limiting downgradient movement of MTBE plumes. Following successful laboratory testing, the University of California-Davis is also beginning field research with a single culture micro-organism (PM-1) at the Port Hueneme facility.

Other Groundwater Remediation Technologies

Well-head treatment of drinking water by an ultraviolet/hydrogen peroxide (UV/H_2O_2) advanced oxidation treatment process has proven effective if the levels of BTEX and MTBE are less than 1,000 µg/L (Bolton, et al., 1998). Creek and Davidson (1998) summarized work that has been done on advanced oxidation processes and concluded that oxidation might be a good method for destruction of MTBE, although the formation of certain by-products, such as ozone, may be corrosive to the mechanical parts of the remediation system.

Costs of Remediation

Additional site remediation activity related to MTBE has led to increased time and money spent on UST remediation projects. In states that have experienced MTBE releases and in which MTBE is regulated, remediation costs have increased an estimated 100 percent at approximately 8 percent of the contaminated sites, and by at least 50 percent at 10 percent of the sites where MTBE has been detected in groundwater (Underground Storage Tank Guide, August 1998). Because MTBE plumes commonly migrate farther and faster than benzene, and since MTBE is generally more difficult to remove from water than benzene, increased costs to remediate MTBE-contaminated sites are not unexpected. When estimating costs for remediation of MTBE, in comparison to benzene or BTEX, one must consider several variables (Davidson, 1998b):

- The size of the groundwater plume.
- Site geology.
- Site remediation goals.
- Whether the remediation method is suitable for treating MTBE.
- Whether the presence of MTBE will require an increase in remediation system size.
- Water treatment capacity and effectiveness.
- If the presence of MTBE changes vapor treatment requirements.
- Applicability of natural attenuation.

EPA's Office of Underground Storage Tanks (OUST) estimates that at approximately 75 percent of MTBE-contaminated sites, the incremental cost increase of remediation will be less than 50 percent above the cost of remediating the BTEX portion alone (U.S. EPA, 1998b). At 20 percent of the sites, the incremental increase would be between 50 percent and 100 percent greater. At approximately 5 percent of sites, the additional cost of remediating MTBE would be greater than 100 percent of the cost for remediating the BTEX portion alone. Creek and Davidson (1998) conclude that currently available technologies can be used to remediate MTBE-contaminated environmental media, but that, based upon anecdotal information, costs may increase 10 to 500 percent over the cost of remediating a site contaminated only with BTEX. NESCAUM (1999) estimates that, in areas where RFG has been used, MTBE cleanup adds 30 percent to the cost of remediation; whereas in non-RFG areas the presence of MTBE (which they conclude is added to gasoline to increase octane) is adding 6 percent to the overall costs of remediation. Additionally, the greatest cost increases might occur at sites where monitored natural attenuation may be acceptable for the BTEX contamination, but the mobile MTBE portion of the contamination may require more active methods of remediation.

NATIONAL ENVIRONMENTAL OCCURRENCES OF MTBE

Because MTBE-containing gasoline blends have been used for 2 decades and are now widespread, MTBE has been detected in soil, surface water and groundwater throughout the United States. Potential non-point sources include urban runoff, precipitation, and motorized water craft. NESCAUM (1999) estimates that, for the Northeastern states, MTBE dissolved in rainwater contributes very little to contamination of water resources, whereas urban storm water runoff has much greater potential for introducing MTBE into surface water and groundwater. Significant point sources of MTBE include releases from underground and above-ground storage tanks and piping and pipelines. Concentrations of MTBE greater than 20 µg/L in groundwater are typically associated with point source releases, while small concentrations of MTBE (0.1 to 3 µg/L) may be either a point- or non-point source (Squillace, et al., 1998). MTBE concentrations of greater than 400,000 µg/L have been documented near a point source release of gasoline.

Surveys on MTBE occurrences across the nation have been conducted through water sampling by the United State Geologic Survey, and more recently by a University of Massachusetts survey of states for the U.S. EPA (Underground Storage Tank Guide, 1998a).

The USGS groundwater sampling survey, as part of the National Water Quality Assessment Program, analyzed for 60 different organic compounds in samples taken from 211 shallow wells in 8 urban areas and 524 shallow wells in 20 agricultural areas (none in Arizona). MTBE was detected in 27 percent of the urban wells and 1.3 percent of the agricultural wells. When detected, concentrations ranged from 0.2 to 23,000 µg/L, with most of the samples measuring less than 1 µg/L. MTBE was detected most frequently in Denver, Colorado and New England urban areas, with detections in 79 and 37 percent of the samples, respectively. Only 3 percent of the samples in urban areas had concentrations of MTBE in excess of 20 µg/L (Squillace et al., 1995).

Of particular note are some incidents in the State of Maine, especially in highly vulnerable areas, where the water table is shallow and aquifers are in highly fractured bedrock. In two such areas, spillage of less than 20 gallons of gasoline from one automobile accident and, presumably, from cars parked in a grass lot, resulted in significant MTBE contamination of drinking water wells (NESCAUM, 1999). These, and numerous other incidences of MTBE contamination of groundwater, prompted Maine to opt-out of the federal RFG program.

In an effort to address public concerns regarding the MTBE contamination of water sources, EPA convened a “Blue Ribbon Panel on Oxygenates in Gasoline” on November 30, 1998, to gather information and review issues associated with use of MTBE and other oxygenates. This panel, consisting of experts from the public health and scientific communities, automotive fuels industry, water utilities, and local and state governments, reported their findings and recommendations to EPA on July 27, 1999. The Panel determined that between 5 and 10 percent of drinking water supplies in RFG areas across the country had at least detectable amounts of MTBE, but that only about 1 percent of those had levels that exceeded 20 µg/L. To determine whether MTBE in drinking water may require future regulation, EPA will be including MTBE on the list of unregulated contaminants that may have to be monitored and reported by public water systems with greater than 10,000 users (BNA Environment Reporter, 1999f). The upcoming rule may also provide for monitoring by representative samples of systems that serve fewer than 10,000 users.

The University of Massachusetts survey indicates that MTBE has been detected in 20 states at sites without any apparent UST leaks. The states conclude that the occurrence of MTBE at these sites is probably due to surface dumping of fuel, leaking of overfill catch basins, overfilling of tanks, or other historic releases.

The University of Massachusetts survey further concluded that states are most concerned about MTBE contamination in groundwater. Fourteen states in the survey reported that more than 40 private drinking water wells in each state were contaminated with MTBE. Only New Jersey, however, reported that more than 40 public drinking water wells had detectable MTBE. Eighteen of the surveyed states indicated that MTBE had been detected in one or more public drinking water wells.

States that have been evaluating LUST sites and sampling surface and groundwater for MTBE include California, Delaware, Kansas, Maine, Maryland, Montana, New Hampshire, New Jersey, New Mexico and Texas. In addition, many oil companies have conducted studies to detect MTBE contamination associated with LUSTs at their facilities, finding a large percentage of sites with high concentrations of MTBE in association with other gasoline components. More detailed information regarding MTBE contamination in those states can be found in Appendix 5.

California

Because California is so large in area, populous, the home of a large number of refineries, and began using reformulated gasolines statewide prior to other parts of the country, its circumstances relative to MTBE contamination of water resources are unique.

Lawrence Livermore National Laboratory (Happel, et al., 1998) evaluated groundwater data from 236 LUST sites in 24 counties in California; in 1995/1996,78 percent of the sites had MTBE detections ranging from a few µg/L to approximately 100,000 µg/L. Of the 2,297 public water supply wells monitored in the study, 0.35 percent were impacted by MTBE at levels equal to or exceeding 20 µg/L, and 0.42 percent were impacted by benzene at or above 1 µg/L. Hydrocarbons have impacted groundwater at 13,278 of 32,409 recognized LUST sites in California (41 percent), and MTBE contamination might be a problem at as many as 10,000 of those sites (Happel, et al., 1998).

Probably the most publicized case of MTBE contamination occurred in the Los Angeles area. During the summer of 1996, the City of Santa Monica ceased pumping groundwater from its Charnock and Arcadia well fields because of persistent and increasing levels of MTBE (Brown, et al., 1998). These 2 well fields provided roughly 50 percent of the city's total drinking water supply. As a result of the loss of this resource, the City of Santa Monica sued several oil companies believed to be the parties responsible for the contamination.

Surface waters have also been affected, from water craft and spills associated with water craft refueling. However, the greatest problems have occurred from LUSTs, particularly in the South Lake Tahoe area. The South Tahoe Public Utility District (STPUD) has 35 water supply wells in its system, of which 10 have been shut down recently due to MTBE contamination (Association of State and Territorial Solid Waste Management Officials (ASTSWMO), 1998c). On November 10, 1998, the STPUD filed a lawsuit in San Francisco Superior Court charging major oil companies and suppliers with the MTBE contamination in the District's water supply. Defendants include ARCO, Shell, Chevron, Exxon, and several other refiners, distributors, and retailers of gasoline. The suit alleges that these companies intentionally induced the public and others to rely on false and misleading representations about MTBE, and that the companies were negligent because they knew or should have known that certain gasoline storage systems were leaking (BNA Environment Reporter, 1998c).

On January 19, 1999, Communities for a Better Environment filed a lawsuit in the same court against 14 oil companies, charging that the companies had violated California's Safe Drinking Water and Toxic Enforcement Act (Proposition 65), which prohibits contamination of the state’s drinking water supplies. The suit seeks relief in certain areas, including the clean up of 3,500 LUST sites and refinery leaks, which have allowed groundwater and drinking water supplies to become tainted by MTBE, benzene, and other constituents of gasoline (BNA Environment Reporter, 1999c).

During October 1997, Tosco requested CARB to “move away” from MTBE as a fuel oxygenate because of the extensive contamination that could occur and the resulting liability that the company, state and other entities could face in restoring drinking water supplies. Chevron has also called for a halt to the use of MTBE as a fuel oxygenate.

MTBE IN THE ARIZONA ENVIRONMENT

Gasoline blends containing MTBE have been used in the Phoenix and Tucson metro areas to help curb air pollution. Consequently, MTBE contamination associated with LUSTs and other releases of gasoline in these urban areas could be expected, and is documented. It is also expected that MTBE could be found throughout the State for two reasons:

- The distribution facilities located in these urban areas also serve the surrounding rural areas of the State. Oil companies typically trade and distribute oxygenated fuels outside of the areas where they are required by law because of market conditions, gasoline availability and, on occasion, inadequate storage tank capacity for segregating the rural from the urban gasoline supply.

- For similar reasons, gasoline retailers along the Colorado River on or near the border with California are likely to acquire California reformulated gasoline from their distributors. This practice would be less frequent in the vicinity of Yuma, because the California-to-Arizona pipeline runs through Yuma.

As a result, MTBE-blended fuels can be placed in, dispensed and potentially released from USTs and other containment and distribution systems throughout Arizona. ADEQ does not currently track MTBE occurrences within its UST database (USTrack); however, the State Lead Unit of the UST Program is monitoring MTBE in groundwater at their corrective action sites throughout the State, as indicated in Appendix 6.

To better understand the occurrences of MTBE in Arizona, the Governor-appointed UST Policy Commission is in the preliminary stages of a legislatively-approved groundwater study. The purpose of the study is to compile Arizona-specific data regarding releases of regulated substances, including MTBE, from LUSTs, and to provide the data to the Commission in support of LUST site prioritization and a risk-based decision-making process. Further, as more USTs are brought into compliance with federal and state requirements for corrosion protection and overfill and spill prevention, the number of releases from USTs should decrease.

ADEQ has commenced a program to identify areas where MTBE may be present in groundwater. This is of particular importance because approximately 65 percent of Arizona's population uses groundwater as a principal drinking water source. In a joint effort with the USGS during 1998, the Water Quality Division (WQD) conducted groundwater quality monitoring in the Upper Santa Cruz Groundwater Basin of southern Arizona, which includes the Tucson area. Of the 60 groundwater samples from this basin, mainly from domestic wells, MTBE was not detected in any of the samples. The WQD also collected 58 groundwater samples in the Sacramento Valley Groundwater Basin in northwestern Arizona, which includes the Kingman area, and 28 in the Willcox Groundwater Basin in southeastern Arizona. There have been no detections of MTBE in any of these samples. Other groundwater studies are underway, including in the Prescott area. All groundwater samples collected from these studies will be analyzed for MTBE by the laboratory of ADHS.

The WQD is currently establishing a prioritized schedule for sampling lakes to determine, among other things, if recreational water craft and gasoline spills are resulting in MTBE contamination in surface waters. Bartlett Lake, a reservoir northeast of Phoenix, is scheduled for sampling later in the fall of 1999. WQD will also test waters along the main stem of the Colorado River for MTBE, and lakes with heavy boat usage, like Saguaro Lake.

Other public and private entities have indicated that they either are or will be testing for MTBE in groundwater. The Salt River Project (SRP) has looked for MTBE in groundwater but has not reported their findings yet. The City of Phoenix and other large utilities have responded only partially to inquiries from ADEQ about MTBE sampling. As part of a new EPA rule, however, public water systems serving over 10,000 people may be required to sample for and report on MTBE, beginning in 2001. In Arizona, both surface water and groundwater supply these systems. Phoenix, which monitors for MTBE, has closed four, shallow production wells due to current or impending MTBE contamination. The contamination resulted from a LUST at a former gas station immediately east of Phoenix. No other Phoenix production wells have apparently been impacted by MTBE. The major oil companies operating in Arizona are presumed to be evaluating MTBE in groundwater at their LUST sites, but they are not required to report these data. The Central Arizona Water Conservation District (CAWCD), which manages the Central Arizona Project canal and distribution system, has not collected samples to date for MTBE analysis but has offered to work with ADEQ on a preliminary cooperative sampling project, if schedules permit.

MAJOR GOVERNMENT ACTIVITIES REGARDING MTBE

The presence of MTBE in gasoline, and the discovery of contamination of surface and ground waters with MTBE, are a matter of controversy in several areas of the United States. The U.S. EPA and a few state governments have responded to public concerns through initiatives designed to better understand the risks posed by MTBE in gasoline and the environment, determine whether the benefits of the use of MTBE in gasoline outweighed the risks, and evaluate options relative to reducing or eliminating MTBE from gasoline.

California

Detection of MTBE in surface water and groundwater, curtailing public water supplies for Santa Monica, Santa Clara, Sacramento, and South Lake Tahoe prompted the Legislature, in October 1997, to adopt the MTBE Public Health and Environmental Protection Act (Senate Bill 521). This legislation authorized two major research efforts on MTBE, and required the Governor to make a determination on the safety of MTBE.

The California Energy Commission (CEC) was tasked with conducting a study of the feasibility and costs of removing MTBE from gasoline while retaining the air quality benefits afforded by California RFG.[4] The CEC determined that immediate removal of MTBE from gasoline was infeasible; however, over a 3 or 6 year phase-out period, refiners would have the ability to reconfigure their refineries to blend RFG without MTBE and with relatively modest increases in the cost of production (California Energy Commission, October 23, 1998).

The University of California Davis was tasked with the preparation of a report, "Health and Environmental Assessment of MTBE," the results of which are discussed earlier in the discussion of health effects of MTBE.

On March 25, 1999, Governor Gray Davis found that "on balance, there is significant risk to the environment from using MTBE in gasoline in California" (Executive Order D-5-99). He ordered the CEC, in consultation with the CARB, to, by July 1, 1999, develop a timetable for removing "MTBE from gasoline at the earliest possible date, but not later than December 31, 2002." The Order commands a number of other actions designed to further protect the state's water resources, assess alternatives to MTBE, and seek a waiver from requirement in the Clean Air Act for RFG to contain a minimum oxygen content.

U.S. EPA

In the presence of mounting evidence that MTBE may pose an unacceptable risk to water resources, EPA Administrator Carol Browner convened a "Blue Ribbon Panel on

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[4] Unlike the federal program, which requires two percent oxygen (by weight), it is possible to produce RFG under the California program that meets the emissions reductions requirements and contains reduced amounts of or no oxygenate. Because the greater Los Angeles area, San Diego and Sacramento are also subject to the requirement for implementing the federal RFG program, EPA required the retention of the federal minimum oxygen content in those areas.

Oxygenates in Gasoline" to gather information and review issues associated with the use of MTBE and other oxygenates. The Panel was charged with:

- Examining the role of oxygenates in meeting the nation's goal of clean air;
- Evaluating each product's efficiency in providing clean air benefits and the existence of alternatives;
- Assessing the behavior of oxygenates in the environment;
- Reviewing any known health effects; and
- Comparing the cost of production and use, and each product's availability-- both at present and in the future.

The Panel was also tasked with studying the causes of groundwater and drinking water contamination from motor vehicle fuels, and to explore prevention and cleanup technologies for water and soil.

The Panel's findings and recommendations were released on July 27, 1999:

- Findings of the Blue Ribbon Panel:
  - Gasoline distributions, usage and combustion poses risks to public health and the environment.
  - RFG provides considerable air quality improvements and benefits for the public.
  - Due to its persistence and mobility in water. MTBE is more likely to contaminate ground and surface water than other components of gasoline.
  - The occurrence of MTBE in drinking water supplies can and should be substantially reduced.
  - Because MTBE is an integral component of the gasoline supply, any change in its use must be implemented with sufficient time, certainty, and flexibility to maintain stability of fuel supplies and gasoline prices.

- Recommendations of the Blue Ribbon Panel:
  - EPA and states should enhance federal and state Underground Storage Tanks (UST) programs.
  - EPA should work with states and local water suppliers to enhance implementation of Safe Drinking Water Act Program.
  - EPA should work with states and localities to enhance efforts to protect surface waters that serve as drinking water supplies.
  - EPA should work with Congress to provide for treatment of MTBE-contaminated drinking water supplies.

- Changes will have to be made to the RFG program to reduce the amount of MTBE used, while ensuring that the air quality benefits of RFG, as well as fuel supply and price stability, are maintained.

In response to the Blue Ribbon Panel's recommendations, EPA concluded that the use of MTBE in gasoline must be significancy reduced as quickly as possible while maintaining the gains that have been made in achieving cleaner air. EPA also committed to improving gasoline leak prevention and remediation programs and to providing states with "maximum flexibility under current law that will make it easier to voluntarily reduce MTBE and use cleaner gasolines with other additives." The full text of these recommendations may be found in Appendix 7. The Blue Ribbon Panel's Final Report was released on September 15, 1999, and is available on EPA's web page at http:\www.epa.gov/orcdizux/consumer/fuels/oxypanel/blueribb.htm.

Northeastern States

In response to concerns of its member states, NESCAUM engaged in the evaluation of the air quality benefits of RFG (Marin, et al., August 1998), a full scale assessment of MTBE and the feasibility and costs of reducing its use in RFG (NESCAUM, 1999), and evaluation of options available to the NESCAUM states for reducing MTBE in RFG. All of these documents are available on the web site at http://www.nescaum.org.

STAKEHOLDER INVOLVEMENT IN ARIZONA

When Arizona opted into the federal RFG program in 1997, a public education and assistance program was implemented to provide the public with timely, factual information on "Clean-Burning Gasoline" and to deal with complaints associated with its introduction and use in Maricopa County.

A small number of stakeholders have expressed concerns regarding health effects related to gasoline containing MTBE and other problems associated with CBG. ADEQ has responded to letters and has been working with those citizens to resolve problems.

Both ADEQ and the Arizona Department of Weights and Measures (ADWM) recognize that current events in California and activities associated with EPA's Blue Ribbon Panel on Oxygenates in Gasoline will affect Arizona policy and have the potential to affect gasoline quality, supply and price. ADEQ and ADWM have maintained an open dialog with stakeholders involved in gasoline supply and marketing on regulatory issues since the inception of the CBG program. They will continue to consult with these stakeholders regarding new developments within and outside of Arizona, including issues of gasoline supply, air quality and protection of natural resources and public health associated with gasoline releases to the environment. In addition, ADEQ is working with the UST Policy Commission on issues associated with gasoline release prevention and remediation of soil and water contamination where MTBE has been detected.

CONCLUSIONS AND NEXT STEPS

The use of MTBE as an additive in gasoline has had significant air quality benefits in areas of the U.S. that do not meet federal health-based standards. During April 1998, the CARB concluded that the use of CARB RFG reduces the overall cancer risk from gasoline and exhaust emissions by 60 lifetime cancer cases per million people exposed. They also concluded that the presence of MTBE in fuels may reduce this improvement by 1 to 2 lifetime cancer cases per million people exposed.

Although the air quality benefits are recognized as significant, releases of gasoline containing MTBE from underground and above-ground storage tank systems, and pipelines have affected soil and groundwater locally throughout the country. The extent of MTBE contamination in Arizona is not known at this time. Preliminary information, however, indicates that MTBE and the other constituents of gasoline, notably benzene, have contaminated groundwater at many locations throughout the State.

Recognizing that CBG containing MTBE has been one of the most effective air pollution control strategies in metro Phoenix, it is critical that Arizona maintain the flexibility to retain these air quality benefits, while protecting the quality of water supplies. The report of the Blue Ribbon Panel on Oxygenates in Gasoline contains numerous recommendations that, as they are implemented, will greatly assist Arizona in achieving this goal. To that end, ADEQ will take the following steps in determining the extent of MTBE contamination, preventing future releases and remediating releases that have already occurred:

- Recognizing California's decision to phase out the use of MTBE by December 31, 2002, and the Blue Ribbon Panel's recommendations regarding blending fuel for clean air and water, ADEQ will continue to work closely with gasoline suppliers and other stakeholders to better understand the impact of these actions and recommendations on the Arizona gasoline supply. ADEQ will closely monitor any Congressional action to modify the requirement that RFG contain a minimum oxygen content and any EPA action to ensure that changes in federal requirements do not reduce the benefits of CBG.

- ADEQ will investigate and compile information on the potential existence of MTBE in groundwater and surface water through:

    - Developing correlations between the locations of underground storage tanks and public drinking water systems, and performing surveillance sampling on those public water systems located near underground storage tanks as part of the Drinking Water Source Water Assessment Program.

- Performing sampling for MTBE along the Colorado River.
- Sampling for MTBE in public water systems serving over 10,000 people will begin when the U.S. EPA final rule on sampling for unregulated contaminants becomes effective in 2001.
- Conducting sampling for MTBE as part of groundwater basin studies, including those now underway in the Prescott Active Management Area (AMA), Upper Santa Cruz, Sacramento Valley, and Willcox Basins.
- Performing sampling on lakes with heavy boat usage.

• ADEQ will seek out and compile information on UST systems and enhance its UST Program by:

  - Ensuring that UST facilities are in compliance with the federally-mandated December 22, 1998, UST upgrade deadline.
  - Ensuring compliance with UST system performance requirements for release detection.
  - Requesting monitoring for and reporting of MTBE at all UST release sites.
  - Ensuring that UST system installation and maintenance personnel are certified for pertinent UST system activities by ADEQ.
  - Utilizing the concepts of risk-based corrective action to ensure effective prioritization and clean up of sites impacted by releases of regulated substances from USTs.
  - Enhancing communication and education programs with the regulated public to maintain a high compliance rate with UST Program requirements for prevention and early detection of releases from UST systems.

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APPENDIX 1

SUMMARY OF PUBLIC COMMENTS

After ADEQ made public the draft MTBE Report on February 26, 1999, the agency solicited and accepted public comments on the draft report through June 18, 1999. Verbal and written comments were received during this period via personal discussion, telephone, fax, letter, and electronically, as well as during two MTBE stakeholder meetings, one in Phoenix on May 6, 1999, and one in Tucson on May 26, 1999. The comments have been compiled and summarized below in a question format. ADEQ is evaluating these comments and the issues, acquiring the necessary data and information, and will be addressing these issues following evaluation of the facts.

1. Will ADEQ propose a ban or phase out of MTBE use in reformulated gasoline?

2. Will ADEQ seek federal legislation to waive the Clean Air Act "requirement" for oxygenates in reformulated gasoline in Maricopa and Pima Counties?

3. Will ADEQ seek to bring petroleum product above-ground storage tanks and/or pipelines under its direct jurisdiction (prevention and corrective action programs)?

4. Will ADEQ seek changes to UST statutes enabling the agency to prevent distribution of fuels to or pumping of fuels from USTs which are not in compliance with the federal 1998 UST upgrade requirements?

5. Will ADEQ, in coordination with ADHS, develop numeric aquifer water quality standards and surface water quality standards?

6. Will ADEQ re-open a "closed" corrective action site if MTBE exceeds ADEQ standards in groundwater or surface water at the site?

7. Will the UST Program require development of site-specific or narrative water quality standards for remediation of MTBE within a risk-based corrective action (RBCA) approach? Will other programs at ADEQ develop site-specific or narrative water quality standards for MTBE?

APPENDIX 2

SELECTED WEB-SITES

- **Agency for Toxic Substances and Disease Registry (ATSDR)**:
  http://atsdr1.atsdr.cdc.gov:8080/toxfaq.html
  http://atsdr1.atsdr.cdc.gov:8080/hazdat.html

- **API Research on MTBE**:
  http://www.api.org/ehs/mtbelink.htm

- **ASTSWMO**:
  http://www.astswmo.org/publications/summaries.htm

- **California Energy Commission**:
  http://www.energy.ca.gov/mtbe

- **California EPA**:
  http://www.calepa.ca.gov/epadocs/mtbe.txt

- **California Governor's Executive Order D-5-99**:
  http://www.state.ca.us/s/governor/d599.html

- **Dupont-Dow Research on Oxygenates**:
  http://www.dupont-dow.com/products/viton/lkprev.html

- **EPA - Blue Ribbon Panel on MTBE**:
  http://www.epa.gov/orcdizux/consumer/fuels/oxypanel/blueribb.htm

- **EPA Drinking Water Advisory for MTBE**:
  http://www.epa.gov/OST/drinking/mtbe.html

- **EPA IRIS Substance File**:
  http://www.epa.gov/ngispgm3/iris/subst/0545.htm

- **EPA Office of Water - Standards and Advisories**:
  http://www.epa.gov/docs/ostwater/tools/dwstds.html

- **EPA - OUST Site on MTBE**:
  http://www.epa.gov/OUST/mtbe

- **EPA Research Strategy for Oxygenates in Water**:
  http://www.epa.gov/ncea/oxyneeds.htm

- **International Agency for Research on Cancer (IARC)**:
  http:\\www.iarc.fr

- **National Academy of Sciences**:
  http://www.nas.edu

- **National Toxicology Program - Nat. Institute of Env. Health Sciences**:
  http://ntp-server.niehs.nih.gov

- **Northeast States for Coordinated Air Use Management (NESCAUM)**
  http://www.nescaum.org

- **Oxygenated Fuels Association**:
  http://www.cleanfuels.net

- **Renewable Fuels Association**:
  http://www.ethanolrfa.org

- **UC Davis Toxic Substances Research and Teaching Program**:
  http://tsrtp.ucdavis.edu

- **USGS Bibliography of MTBE Resources**:
  http://wwwsd.cr.usgs.gov/nawqa/vocns/MTBE/bib/

APPENDIX 3

TECHNICAL SUPPORT DOCUMENT

CLEAN AIR ACT § 211(c)(4)(C) WAIVER REQUEST FOR

ARIZONA CLEANER BURNING GASOLINE

MARICOPA COUNTY OZONE AND PM_{10} NONATTAINMENT AREA

AIR QUALITY DIVISION
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
SEPTEMBER 1997

TECHNICAL SUPPORT DOCUMENT:
CLEAN AIR ACT § 211(c)(4)(C) WAIVER REQUESTS FOR ARIZONA CLEANER BURNING GASOLINE IN THE MARICOPA COUNTY OZONE AND PM10 NONATTAINMENT AREAS

Introduction

Clean Air Act Section 211(c)(4)(A) preempts states from regulating certain characteristics or components of gasoline over which EPA has authority. However, §211(c)(4)(C) of the Act allows EPA to approve state regulation of gasoline in a State Implementation Plan (SIP) revision if EPA determines such controls are necessary to achieve the National Ambient Air Quality Standards (NAAQS). The subject of this request for a waiver from §211(c)(4)(A) requirements is the Arizona Cleaner Burning Gasoline (CBG) Program.

<u>Background</u>

Under the Clean Air Act Amendments of 1990, metro Phoenix was classified as a "moderate" nonattainment area for ozone. In accordance with its obligations under the Clean Air Act, the State prepared plans in 1993 and 1994 that demonstrated:

- Implementation of control strategies would, by 1996, reduce volatile organic compound (VOC) emissions (a precursor of ozone pollution) 15% from the level of emissions documented for 1990; and

- The 15% reduction in VOC was sufficient to bring about compliance with the federal ozone standard by November 15, 1996.

Despite the best efforts of the implementing agencies, several of the control strategies included in the plan were not achieving the planned emissions reductions.[5] Further, the summer of 1995 brought more ozone violations than had occurred since the mid-1980's. The potential impacts of failure to attain the ozone standard would result in reclassification of metro Phoenix to a "serious" nonattainment area, which carries mandatory emissions control program requirements under the Clean Air Act that would stifle the expansion of manufacturing and impose new costs for businesses and industries. Further, it would be necessary for the State to both demonstrate and achieve attainment by November 15, 1999, in order to prevent the reclassification of Maricopa County to severe nonattainment for ozone. Consequently, the urgent need existed (and still does) to reduce ozone precursor emissions as much as possible before 1999 in order to prevent reclassification of the ozone nonattainment area.

These events prompted Governor Symington in May 1996 to declare an Air Pollution Emergency under ARS §49-465 establish the Ozone Strategies Task Force by Executive Order. The purpose of

[5] For example, problems with the EPA designed enhanced vehicular inspection and maintenance program, the strategy with the highest planned emissions reduction, resulted in a loss of about half of emissions reductions modeled in the plan.

the Task Force was to recommend ozone pollution reduction strategies that could be implemented immediately so as to prevent violations of the ozone standard during the summer of 1996.

The Governor adopted the strategies recommended by the Task Force in a July 1996 revision to the earlier Air Pollution Emergency and reauthorizing and expanding the charge of what became the Air Quality Strategies Task Force. A Fuels Subcommittee to the Task Force was established under the revised Executive Order and charged, in part, with steering the development of a consultant report on the costs and effectiveness of fuel formulation for reducing ozone pollution. This report, Assessment of Fuel Formulation Options for Maricopa County (MathPro, November 7, 1996; included as Appendix A), documented emissions reduction potential of various fuel formulations for volatile organic compounds (VOC), oxides of nitrogen (NOx), carbon monoxide (CO), particulates, and hazardous air pollutants. After intense debate during the development of the Fuels Subcommittee report and among the Task Force itself, the recommendation to opt-in to the FRFG program and adopt a more stringent State RFG program was adopted. The Task Force acknowledged that Phase II of the federal RFG program would not be available until the year 2000, and that greater and earlier emissions reductions from gasoline reformulation were feasible; this was their justification for adoption of the more stringent State RFG program. This recommendation became the basis for two subsequent events:

- A January 17, 1997, letter from Governor Symington EPA Administrator Carol Browner requesting that metro Phoenix be covered under the FRFG program (Appendix B); and

- Enactment of HB 2307, which authorized the establishment of a more stringent State reformulated gasoline program. (Appendix C)

EPA approved Governor Symington's request to opt-into the FRFG program on June 3, 1997. ADEQ and the Arizona Department of Weights and Measures (ADWM) implemented a facilitated informal rule making process to develop the program authorized under HB 2307, resulting in the publication of proposed rules on July 15, 1997, and conduct of a public hearing on these rules on August 15, 1997. ADEQ adopted these rules on September 12, 1997.

In addition, to operate the Arizona CBG program as a substitute for the federal RFG program, the State is requesting to opt-out of the federal RFG program, effective June 1, 1998, and contingent upon EPA approval of the Arizona CBG SIP revision and these waiver requests.

This document accompanies the SIP revision containing the Arizona CBG rules as a demonstration of the necessity for the State to regulate gasoline properties, which would otherwise be under the exclusive jurisdiction of EPA, to attain the NAAQS for ozone and particulates.

Summary of the Gasoline Standards

The CBG Program establishes three sets of gasoline standards based on "types" of CBG (see Appendix D). Emissions performance and property-based standards are associated with all types of gasoline. Types 1 and 3 gasoline standards, which are modeled after the federal reformulated gasoline (RFG) standards for phases II and I, respectively, and, as such, include emissions performance standards for volatile organic compounds (VOC) and oxides of nitrogen (NOx) based on the Federal Complex Model (which is adopted by reference in the Arizona CBG rules), with broad limits on gasoline properties; Type 2 gasoline standards are modeled after the California Air Resources Board (CARB) Phase 2 standards, and include relatively stringent property standards and compliance with VOC and NOx performance standards based on the CARB Predictive Model (also adopted by reference in the CBG rules). Type 2 and 3 gasoline standards apply in from June 1 through September 30, 1998, and Type 1 and 2 standards from and after May 1, 1999. Refiners may choose to meet either applicable standard. This choice is provides regulatory flexibility to refiners while maintaining air quality benefits that exceed those required under the federal RFG program. Estimates of regional emissions reductions for ozone precursors (including carbon monoxide) and particulates are contained in Table 1.

Table 1
Regional Emissions Reductions Estimates in Metric Tons
Maricopa County, 1999 Summer Day

Formulation	VOC	NOx	CO	Particulates*
Type 1	12.5	2.0	143.3	0.40
Type 2	14.1	8.2	198.9	0.76
Type 3	8.7	0.2	118.6	0.27

Source: Assessment of Fuel Formulation Options for Maricopa County (MathPro, November 7, 1996)
*Primary emission reductions only.

General Issues and Findings

Clean Air Act Section 211(c)(4)(C) requires states demonstrate the following in order to qualify for waivers of federal preemption:

1. The state has evaluated all control options to reduce emissions of pollutants and their precursors in their respective nonattainment areas and is currently implementing or is committed to implementing all reasonable control strategies to attain applicable NAAQS;

2. Even if the state were to implement all reasonable emissions controls other than the preempted gasoline standards, compliance with the NAAQS would not be achieved and additional controls would be needed; and

3. Implementation of the preempted gasoline standards provides additional reductions in emissions of nonattainment pollutants and their precursors over and above the applicable federal gasoline standards.

Applicable NAAQS and NAAQS Pollutant Precursor Emissions

This document will show that the implementation of the Arizona CBG standards is necessary for attainment of the ozone and particulate matter standards. For the purposes of ozone, standards affecting VOC and CO emissions reduction will be considered. For the purposes of the PM_{10} NAAQS, primary emissions of particulates, and particulate precursor emissions of VOC and NOx will be considered.

Federal Baseline Gasoline Standards

Applicable federal gasoline standards constitute the baseline standards in effect that preempt the State's ability to impose its own. This is not necessarily straight forward for Maricopa County. The Phoenix Ozone Nonattainment Area is currently covered under the federal RFG program as an opt-in area, and the State has received approval for a waiver of federal preemption to enforce a 7.0 psi Reid Vapor Pressure (RVP) standard. However, Arizona is requesting to opt-out of the federal RFG program effective June 1, 1998, pending approval of the Arizona CBG program. EPA has determined that, if the opt-out request is approved, the applicable fuel requirements for Maricopa County under the preemption requirements of §211(c)(4)(A) would be conventional gasoline with the approved 7.0 psi RVP standard currently enforced by the State.[6] (See Appendix E, Debbie Jordan, EPA, letter to Nancy Wrona, ADEQ, dated August 15, 1997).

Nonseverability of Property Standards

Each of the compliance options under the Arizona CBG program are driven by emission reduction performance standards for VOC and NOx. EPA has opined that justifications for implementing these performance standards by themselves will make unnecessary any similar showing for each property-based standard that underlies the performance standards. (See Appendix E)

Despite EPA's conviction, EPA may be in the position of defending one or more of the property standards if they propose to approve these waivers of preemption. ADEQ received a comment on the proposed interim CBG rules challenging the need for the oxygen content standards for CBG. Because of the potential for other challenges of the necessity of specific property standards contained in the

[6] Arizona also received a waiver to permit the enforcement of its wintertime oxygen content standards, which exceed the requirements of the federal RFG regulations and are in place as part of the existing State CO control plan.

Arizona CBG rules, it would be prudent to make a more specific showing that the property standards may not be severable from the Arizona CBG program.

Table 2 assesses the relative emissions reductions impact of each property for which standards have been set under the Arizona CBG program. This analysis is based on how the EPA complex model assesses the impact of each regulated gasoline property on VOC and NOx emissions (See Appendix F), research on the impact of gasoline reformulation on CO emissions (See Appendix G, Development of an Exhaust Carbon Monoxide Emissions Model, V. Rao, SAE Technical Paper #961214, 1996),[7] current knowledge regarding primary particulate emissions (See Appendix 1, pp 58-74) and the impact of VOC and NOx emissions on secondary particulate formation. This assessment demonstrates the interrelationships between the various property standards and pollutant emissions. It is a relatively simple task to use the EPA Complex Model to calculate emissions changes expected with the removal of one or more of the property standards contained in the Arizona CBG rules. However, it would be difficult, at best to determine the impact of removal of one or more property standards on attainment of NAAQS. Furthermore, it may make application of the CARB Predictive Model for the Type 2 gasoline standards suspect because gasoline properties that would be preempted, and, thus, permissible under the Arizona CBG rules could exceed the valid ranges for use in that regulatory model. Finally, it is unknown how refiners would reformulate their fuels to meet performance standards in the absence of one or more of the property standards. It is likely that the cost effectiveness and practicality of the program would be negatively affected, and result in loss of program effectiveness and credibility.

Table 2
Relative Emissions Reduction Impact* of Arizona CBG Property Standards
by Property and Pollutant

	VOC	NOx	CO	Particulates (not ranked)
RVP	6	2	0	Reduces secondary (VOC)
Oxygen	1	2	3.5	Reduces secondary (VOC)
Sulfur	4	6	3.5	Reduces primary & secondary (SO_2, VOC & NOx)
Olefins	0	4	0	Reduces secondary (NOx)
Aromatics	5	5	3.5	Reduces secondary (VOC & NOx)
E200/T50	3	-1	1	Reduces secondary (VOC)
E300/T90	2	2	3.5	Reduces primary & secondary (VOC & NOx)

[7] EPA has incorporated the results of this research, as a nonregulatory component, into the Complex Model. This was the basis for estimating the CO emissions reductions expected from various fuel reformulations by MathPro in their report Assessment Fuel Reformulation Options for Maricopa County, with the agreement of all of the stakeholders that were involved in the development of the report.

*Higher numbers represent greater emissions reductions; zero indicates none or nearly no impact; negative numbers indicate increases in emissions.

Evaluation of Reasonable Control Options and Demonstration of Necessity of Further Controls

Ozone

Arizona has already completed a comprehensive evaluation of reasonable ozone control measures for their contribution to attainment of the ozone NAAQS and a demonstration of the need for additional ozone controls as part of the 7.0 psi RVP Gasoline SIP Revision and Clean Air Act § 211(c)(4)(C) Waiver Request, submitted to EPA, Region IX, April 29, 1997, and subsequently approved on June 3, 1997 (62 FR 30260). Appendix H excerpts the portion of the earlier preemption waiver request that lists the measures evaluated and the resulting modeled shortfall (presuming the implementation of the listed measures) in achieving the ozone NAAQS.

It should be noted that in the earlier waiver analysis the use of either Federal Phase I or II RFG or CARB Phase 2 RFG still failed to achieve the ozone NAAQS.

PM_{10}

Arizona submitted the Maricopa Association of Governments 1991 Particulate Plan for PM_{10} for the Maricopa County Area and 1993 Revisions to EPA, Region IX, August 11, 1993, and the Revised Chapter Nine and Maricopa County Rules- Fugitive Dust, March 3, 1994. Both SIP Revisions constitute the Maricopa County Moderate Area PM_{10} Plan (the Plan). The Plan documents the exhaustive evaluation of Reasonably Available Control Measures (RACM) to address PM_{10} emissions and contains a reasoned justification for rejecting measures as not reasonable. The Plan documents that even with full implementation of all RACM, the Maricopa County PM_{10} Nonattainment Area (the PM_{10} area) would still not achieve the PM_{10} NAAQS.

On April 10, 1995, EPA published it the final approval of the Plan, including the RACM demonstration (60 FR 18010). Subsequently, the Arizona Center for Law in the Public Interest appealed EPA's approval of the Plan. In a May 14, 1996, decision, the 9th Circuit Court of Appeals ordered EPA to disapprove the Plan, but let stand EPA's approval of the regional RACM demonstration (*Ober vs. EPA*, 84 F3d 304 at 311 (9th Cir.1996)). Meanwhile, EPA reclassified the PM_{10} Area from "moderate" to "serious", effective June 10, 1996 (61 FR 21372), due to continuing violations of the

PM_{10} NAAQS. The serious area PM_{10} plan is under development, and preliminary results show the necessity of reducing PM_{10} emissions by at least 35% over and above reductions accounted for in the moderate area plan discussed above.

New PM_{10} emissions controls have been adopted and/or implemented since the Plan was submitted, yet violations of the PM_{10} NAAQS continue. The new PM_{10} controls are as follows:

1) Prohibition of the sale of diesel fuel oil grades 1, 2, or 4 that contains sulfur in excess of five hundred parts per million within Maricopa County, which effects non-road use of high sulfur diesel (ARS §41-2083(J), See S.B. 1002, Appendix I);

2) More stringent diesel vehicle emissions testing requirements (ARS §49-542(F)(1)(d), See S.B. 1002, Appendix I);

3) By January 1, 2004, all heavy duty diesel vehicles must conform to specific emissions standards (ARS §49-542(F)(7), See S.B. 1002, Appendix I);

4) Requirements for the installation of oxidation catalysts or other emissions control devices on certain heavy duty diesel vehicles (ARS §§ 9-500.04(D), 15-349(B), 41-803, 49-474.01(D), 49-573(B), and 49-555, See H.B. 2237, Appendix J)

5) Adoption of California emissions standards for off-road engines (ARS §49-542.04, See H.B. 2237, Appendix J)

The impact of these control measures on reducing PM_{10} concentrations will be evaluated in the serious area plan.

Estimated Additional Reductions in Ozone and PM_{10} Through Implementation of the Arizona Cleaner Burning Gasoline Program

The CBG Program was established to provide at least the same emissions reductions as the Federal RFG program with implementation of Phase II in 1999. Types 1 and 3 gasoline essentially mimic the fuel characteristics of Federal RFG Phase II and I respectively. Type 2 gasoline mimics CARB fuel. ADEQ contracted with MathPro, Incorporated to evaluate the emissions reductions of these three fuels when compared to a baseline of 7.0 psi RVP conventional gasoline (MathPro's report is contained in Appendix A). The results of their analyses can be found in Table 1 (See page 3).

<u>Ozone</u>

The Arizona CBG program is estimated to provide a minimum reduction of 12.5 tons per day of VOC and 143.3 tons per day of CO (See earlier discussion, and Table 1).

As was mentioned earlier, one commenter on the proposed Arizona CBG rules challenged the need for a summertime oxygen content standard. Although EPA has not addressed whether the State oxygen content standard (or VOC performance standard or property standards for T50, T90) are preempted (See Appendix E), ADEQ developed an analysis of the potential impact of preemption of a State oxygen content standard on ozone attainment. Because oxygenation of gasoline reduces CO emissions and CO is an ozone precursor, it was determined that preemption of the oxygen content standard would reduce the potential ozone reduction benefits of the Arizona CBG program. This analysis is contained in Appendices K and L.

Because Arizona is proposing a NOx performance standard in gasoline when there currently is a NOx requirement for conventional gasoline, a preemption waiver is required. EPA has expressed concerns regarding the necessity of making a demonstration of the need for a NOx performance standard, especially in light of the NOx RACT exemption granted for the Phoenix Ozone Nonattainment Area (See 60 FR 19510, April 19, 1995). While justification for the NOx performance standards is being based primarily on attainment of the particulate matter NAAQS, another consideration must be taken into account with respect to this issue. It should be noted that EPA has already required Arizona to implement NOx reductions in motor vehicle exhaust as part of the federally-approved Enhanced Inspection/Maintenance Program for Arizona. Such a current federal NOx requirement for the Enhanced Inspection/Maintenance program would tend to support the need for a State NOx performance standard under the Arizona CBG program.

PM_{10}

The Arizona CBG program is estimated to provide a minimum reduction of 0.4 tons per day of primary PM_{10} emissions (See Table 1). However, additional emissions reductions will accrue from the control of VOC and NOx emissions, which contribute to the formation of secondary particles in the Maricopa County PM_{10} nonattainment area.

While the link of VOCs and NOx to ozone formation may be well-known, the contribution of NOx emissions to ambient PM_{10}, especially NOx emissions from fuel combustion, also needs to be highlighted for this waiver request to justify State NOx performance standards. The contribution of NOx generated by gasoline powered engines to ambient secondary nitrate particulates is estimated to be 0.9 $\mu g/m^3$ toward annual average concentrations of PM_{10}, based on relatively crude modeling estimates (See Appendix M). Further, control of sulfur content of CBG would be the primary means of meeting the NOx performance standard. When both the impacts of primary and secondary PM_{10} emissions arising from gasoline sulfur content and the contribution of gasoline powered engines to secondary nitrate formation are considered, the contribution of gasoline powered engines to ambient PM_{10} concentrations relative to a CBG NOx performance standard would certainly be 1 $\mu g/m^3$ or more. As classes of sources that contribute 1 $\mu g/m^3$ of PM_{10} toward the annual average PM_{10}

concentration are considered significant, and, thus, subject to Best Available Control Measures (BACM),[8] Arizona considers the NOx performance standard in the Arizona CBG program as being a BACM that can be applied toward attainment of the PM_{10} NAAQS.

In addition to the reduction in NOx that will reduce the formation of secondary particles, CBG has been demonstrated to provide other benefits for reductions in PM_{10}, both in the form of primary emissions of elemental and organic carbon particulates, and secondary organic particle formation. A specific evaluation of the contribution of CBG to reductions in ambient PM_{10} concentrations will not be evaluated until the serious area PM_{10} plan is completed. A draft of this plan is expected to be available by the middle of October.

Waiver Request

Arizona requests a waiver from preemption provisions under §211(c)(4)(C) of the Clean Air Act to permit enforcement of the Arizona CBG program by the State, based on the following findings:

1) Arizona has implemented all reasonable controls to attain the ozone and PM_{10} NAAQS;

2) Additional controls are needed to the attain the ozone and PM_{10} NAAQS; and

3) The Arizona CBG Program will, through performance standards for VOCs and NOx, and property standards for oxygen, sulfur, aromatic hydrocarbons and olefins content, RVP, E200/T50 and E300/T90:

    a) Reduce primary PM_{10} emissions;

    b) Reduce NOx and VOC emissions, which will in turn reduce formation of secondary particles that contribute to ambient PM_{10} violations; and

    c) Provide additional reductions in carbon monoxide and VOC emissions, both of which contribute to ozone violations.

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[8] See 59 FR 41998 (August 16, 1994).

List of Appendices

APPENDIX 4

STATE MTBE STANDARDS (1999)
(Preliminary Data Adapted from University of Massachusetts Survey of States)

State	Soil Action	Soil Cleanup	Soil Drinking Water	Groundwater Action	Groundwater Cleanup	Groundwater Drinking Water
AL		Risk-based	No		20 µg/L	No
AZ	none established	320 mg/kg-residential, 3,300 mg/kg non-resident.		none established	none established	none established
CA					5 µg/L (aesthetic)	
CT	>2 mg/kg			>100 µg/L	100 µg/L	100 µg/L
FL	cleanup, monitoring or institutional controls required when cleanup levels are exceeded	350 mg/kg-direct exposure; 0.2 mg/kg-leachability		cleanup, monitoring or institutional controls required when cleanup levels are exceeded	50 µg/L	
ID	Depends on pathway	Depends on Pathway		Depends on Pathway	Depends on Pathway	52, 261,511 µg/L depends on use
KS					20 µg/L	
LA					18 µg/L	
MA	RCS-1 0.3 mg/kg; RCS-2 200 mg/kg	Depending on method, 0.3-200 mg/kg		RCGW-1: 0.07 mg/L; RCGW-2: 50 mg/L	GW-1: 70 µg/L GW-2: 50,000 µg/L GW-3: 50,000 µg/L	
MD					Site-Specific	50 µg/L
ME	variable depending on proximity of receptors. TPH-5 mg/kg - 10,000 mg/kg	variable depending on proximity of receptors. TPH- 5 mg/kg - 10,000 mg/kg	50 µg/L	25 µg/L	25 µg/L	50 µg/L
MI		4.8 mg/kg	4800 µg/L	20 µg/L	40 µg/L (aesthetic)	240 µg/L
MO	60 mg/kg if soil is to be used as clean fill	60-280 mg/kg depending on matrix score		none	40 µg/L for potable 400 µg/L for nonpotable	none
MT					30 µg/L	
NC	920 µg/kg	920 µg/kg		200 µg/L	200 µg/L	200 µg/L
NH				100 µg/L	70 µg/L	
NJ				70 µg/L	70 µg/L	70 µg/L
NM					100 µg/L	
NY	50 µg/kg	50 µg/kg	50 µg/L	50 µg/L	50 µg/L	50 µg/L
OH				40 µg/L		
OK				20 µg/L		
OR	0.92-520 mg/kg	0.92-520 mg/kg	0.92-2.6 mg/kg	0.18-3000 mg/L	20-40µg/L	20-40µg/L
PA	NA	0.28 mg/kg	0.28 mg/kg	NA	20 µg/L	20 µg/L
RI				20 µg/L	40 µg/L	40 µg/L
SC				40 µg/L	40 µg/L	
SD	NA	NA	NA	Non-detect		NA
UT	>0.3 mg/kg	0.3 mg/kg		>0.2 mg/L	0.2 mg/L	0.07 mg/L
VT	no	no	NA	no	40 µg/L	40 µg/L
WI				12 µg/L	12 µg/L	60 µg/L
WY	>cleanup level	313 mg/kg	NA	>0.2 mg/L	0.2 mg/L	0.2 mg/L

APPENDIX 5

Detailed Information on MTBE Contamination in Other States

California

In their 1998 report, Lawrence Livermore National Laboratory (Happel, et al., 1998) evaluated groundwater data from 236 LUST sites in 24 counties in California; in 1995/1996,78 percent of the sites had MTBE detections ranging from a few µg/L to approximately 100,000 µg/L. Of the 2,297 public water supply wells monitored in their study, 0.35 percent were impacted by MTBE at levels equal to or exceeding 20 µg/L, and 0.42 percent were impacted by benzene at or above 1 µg/L. Hydrocarbons have impacted groundwater at 13,278 of 32,409 recognized LUST sites in California (41 percent), and MTBE contamination might be a problem at as many as 10,000 of those sites (Happel, et al., 1998).

As a major oil company, Chevron has monitored MTBE in groundwater at several randomly selected operating stations in California (Buscheck, et al., 1998). MTBE was detected at levels of greater than 1,000 µg/L in 47 percent of 251 selected sites; MTBE was detected in groundwater at 83 percent of the sites.

Within the whole Santa Clara Valley Water District, the district is currently monitoring 400 of 500 sites at which the groundwater has been contaminated by gasoline (ASTSWMO, 1998b). Of the 400 sites, 75 percent have detectable MTBE at concentrations ranging up to 430,000 µg/L.

In the Lake Tahoe area, the South Tahoe Public Utility District (STPUD) has 35 water supply wells in its system, of which ten have been shut down recently due to MTBE contamination (ASTSWMO, 1998c). On November 10, 1998, the STPUD filed a lawsuit in San Francisco Superior Court charging major oil companies and suppliers with the MTBE contamination in the district's water supply. Defendants include ARCO, Shell, Chevron, Exxon, and several other refiners, distributors, and retailers of gasoline. The suit alleges that these companies intentionally induced the public and others to rely on false and misleading representations about MTBE, and that the companies were negligent because they knew or should have known that certain gasoline storage systems were leaking (BNA Environment Reporter, 1998c). Subsequently, on January 19, 1999, Communities for a Better Environment filed another lawsuit in the same court against fourteen oil companies, charging that the companies had violated California's Safe Drinking Water and Toxic Enforcement Act (Proposition 65), which prohibits contamination of the state's drinking water supplies. The suit seeks relief in certain areas, including the clean up of 3,500 LUST sites and refinery leaks, which have allowed groundwater and drinking water supplies to become tainted by MTBE, benzene, and other constituents of gasoline (BNA Environment Reporter, 1999c). During October 1997, Tosco requested the California Air Resources Board (CARB) to “move away” from MTBE as a fuel oxygenate because of the extensive contamination that could occur and the resulting liability that the company, state and other entities could face in restoring drinking water supplies. Chevron has also called for a halt to the use of MTBE as a fuel oxygenate.

Delaware

According to ASTSWMO (1998a, 1999b), Delaware only recently required testing for MTBE at LUST sites, and the longest known plume is approximately 2,000 feet. MTBE is scheduled to become a required analyte when a formal Risk-based Corrective Action (RBCA) program is implemented. Recently (ASTSWMO, 1999b), a new MTBE LUST site was identified in Camden. Water samples collected from a private well contained up to 24,000 µg/L MTBE. The investigation into the release indicates that the plume is at least 1,100 feet long.

Kansas

Kansas has been collecting data on MTBE in groundwater since 1991 (ASTSWMO, 1999a). Even though they do not have requirements for RFG, MTBE has been used in Kansas as an octane enhancer for many years. During the period of monitoring, analytical data from 818 sites indicates that MTBE contamination is present in groundwater at 88 percent of the sites.

Several public wells have been impacted. In a small western Kansas community, MTBE from a gasoline plume has migrated in the aquifer approximately 4,700 feet from the LUST sources, passed beneath downgradient monitoring wells which indicated no detections, and contaminated public water supply wells at concentrations up to 1,050 µg/L.

Maine

After learning of MTBE contamination in groundwater monitoring wells located near drinking water supplies in two municipalities, the Governor of Maine initiated a program of testing for MTBE and BTEX in 800 public water supply wells and 1,000 private domestic wells (ASTSWMO, 1999a). The preliminary findings, reported October 13, 1998, indicated MTBE occurred in 16 percent of the tested public water supply wells and 15.8 percent of the sampled private wells. Contamination in wells at two of the thirteen homes, at which MTBE concentrations exceeded 25 µg/L, was determined to be related to releases from an UST or an above-ground storage tank. The origin of MTBE in wells at the other eleven homes was linked to minor gasoline spills or was indeterminate.

Maryland

As part of their in-house survey, Chevron detected MTBE in groundwater at 98 percent of randomly selected operating stations (Buscheck, et al., 1998). MTBE levels of greater than 1,000 µg/L were detected in groundwater at 82 percent of 41 total sites.

Recently, Maryland officials detected MTBE in a private water supply in a small western Maryland town (ASTSWMO, 1999a). MTBE, at concentrations of 2,890 µg/L, were found in unfiltered water. Source of the contamination is considered to be a nearby LUST.

Montana

According to ASTSWMO (1998a), Montana has only recently implemented wide-scale testing for MTBE at LUST sites but is detecting MTBE in groundwater throughout the state. Near Ronan, Montana, for example, an MTBE plume from a large gasoline release has migrated over 1,000 feet from the source and is posing a threat to nearby surface water.

New Hampshire

Through October 1998, MTBE has been reported in 59 public water supply wells at concentrations from 0.5 µg/L to 700 µg/L. The majority of detections have been in the range of 0.5 µg/L to 3.0 µg/L (ASTSWMO, 1999a).

New Jersey

The state has 2,400 known LUST sites; 80 percent of these have MTBE concentrations which exceed 70 µg/L in groundwater. Groundwater is the primary source of potable water for 60 percent of New Jersey's population. To date, the New Jersey Department of Environmental Protection has detected MTBE in 400 private and 65 public water supply wells (ASTSWMO, 1999b).

New Mexico

Following a preliminary review of LUST data, the New Mexico Environment Department indicates that groundwater at two-thirds of their sites may be impacted by MTBE. The longest groundwater plume is about 700 feet (ASTSWMO, 1999a).

Texas

Chevron detected MTBE in groundwater at 96 percent of their randomly selected service stations (Buscheck, et al., 1998). MTBE levels of greater than 1,000 µg/L were detected in groundwater at 63 percent of 153 total sites.

APPENDIX 6

BENZENE AND MTBE CONCENTRATIONS IN GROUNDWATER IN ARIZONA[3]

CITY	LOCATION	WELL DESIGNATION	SAMPLE DATE	BENZENE (µg/L)	MTBE (µg/L)	NOTES
Lake Havasu City	Trailside General Store 283 S. Lake Havasu Blvd.	MW-TS-5 “ MW-TS-10 “	5/98 1/99 5/98 1/99	16,000 650 61 <1	14,000 1,100 6,600 13	MW-TS-5 is located 200 feet hydraulically downgradient from release site MW-TS-10 is located 400 feet hydraulically downgradient from release site
Prescott	Convenience Plus Store #81 333 Grove Avenue	MW-1	6/99	10,000	28,000	Depth to groundwater = 9 feet; well is 150 feet downgradient from release area
McGuireville	private well of David Womack 4620 N. Culpepper Road	private well	2/98	3.6	51.6	
Willcox	area of Haskell Avenue	KW-3	4/98	0.81	0.93	State Lead corrective action site with commingled contaminant plumes
Parker	Lil Mike's Service Center Highway 95	MW-3	12/96	<0.5	89.8	Depth to groundwater = 9 feet
Fort Huachuca	former AAFES PX Service Station	PX-MW-1 “	8/98 2/99	<0.5 <0.5	790 27,000	Depth to groundwater = 65 feet
Phoenix	former Weiss Guys Car Wash 15 W. Camelback Road	MW-2	3/98	25,000	94,000	Monitoring well at release site; corrective action is ongoing; gasoline plume is commingled with solvent plume (tetrachloroethene) from another source
Phoenix	Chevron Service Station #9-3808 5845 North 7th Avenue	MW-02	6/97 7/98	5,600 1,400	700 160	Depth to groundwater = 72 feet
Springerville	site near Murphy True Value Hardware Store	SP-432-MW	11/94 2/95	400 83	335 148	
Scottsdale	Hallum Self Serve site 6930 E. Thomas Road	MW-TDI-1	3/98 11/98	92 <1	600 16	
Mesa	City of Mesa 6th Street Service Center 310 E. 6th Street	MW-8 “ “ “	6/98 “ “ “	470 440 17 20	13,000 9,400 1,400 1,500	Sampled at depth = 142 feet Sampled at depth = 167 feet Sampled at depth = 179 feet Sampled at depth = 197 feet
Fountain Hills	former E-Z Serve 15225 Fountain Hills Blvd.	MW-23 MW-25	1/99 6/99	- -	76 6.3	MW-23 is located 1,400 feet hydraulically downgradient from release site MW-25 is located 2,900 feet hydraulically downgradient from release site
Black Canyon City	former Canyon Service Center Route 69	BC-MW-2	1/99	<10	260	

3 The Aquifer Water Quality Standard (AWQS) for benzene is 5 µg/L, and the health-based guidance level (HBGL) for MTBE is 35 µg/L.

APPENDIX 7

SUMMARY OF EPA'S BLUE RIBBON PANEL FINDING AND RECOMMENDATIONS (July 27, 1999)

FINDINGS

- Distribution, use, and combustion of gasoline poses risks to our environment and public health.
- RFG provides considerable air quality improvements and benefits for millions of U.S. citizens.
- Although the Panel was not constituted to perform an independent, comprehensive health assessment of MTBE, what seems clear to the Panel is that MTBE, due to its persistence and mobility in water, is more likely to contaminate ground and surface water than other components of gasoline.
- Although MTBE has been detected in drinking water supplies at levels well above EPA and state guidelines, these occurrences are rare. The Panel believes that the occurrence of MTBE in drinking water supplies can and should be substantially reduced.
- Because MTBE is an integral component of the U.S. gasoline supply, any change in its use must be implemented with sufficient time, certainty, and flexibility to maintain the stability of both the complex U.S. fuel supply system and gasoline prices.

RECOMMENDATIONS (Intended to be implemented as a *single package* of actions to simultaneously maintain air quality benefits, enhance water quality protection, and assure a stable fuel supply at reasonable cost)

I. Recommendations to Enhance Water Protection

1. Prevention
   - EPA and states should enhance federal and state UST programs by:
     - accelerating enforcement of replacement of existing UST systems which are not in compliance with the federally-mandated December 22, 1998 upgrade deadline, including having all states prohibit fuel deliveries to non-upgraded tanks and adding enforcement and compliance resources to ensure prompt enforcement action, particularly in RFG and Wintertime Oxyfuel areas
     - evaluating the field performance of UST system design requirements and technology to improve system requirements to minimize leaks/releases
     - strengthening UST release detection requirements to enhance early detection
     - requiring monitoring and reporting of MTBE (and other ethers) in groundwater at all UST release sites
     - encouraging states to require that proximity to drinking water supplies, and the potential to impact those supplies, be considered in land-use

planning and permitting decisions for siting of new UST facilities and petroleum pipelines
  - implement and expand programs to train and license UST system installers and maintenance personnel
  - working with Congress to evaluate and, if needed, expand the universe of regulated tank systems to include underground and above-ground fuel storage systems which are not currently regulated but which pose substantial risk to drinking water supplies

- EPA should work with its state and local water supply partners to enhance implementation of the federal and state Safe Drinking Water Act programs to:
  - accelerate, particularly in RFG or Oxygenated Fuel areas, the assessments of drinking water source protection areas required in Section 1453 of the 1996 Safe Drinking Water Act Amendments
  - coordinate the Source Water Assessment program in each state with federal and state UST programs using geographical information and other advanced data systems to determine the location of drinking water sources and to identify UST sites within source protection zones
  - accelerate currently-planned implementation of testing for and reporting of MTBE in drinking water supplies to occur before 2001
  - increase ongoing federal, state and local efforts in Wellhead Protection Areas including enhanced requirements for USTs and pipelines in these areas, strengthened efforts to ensure non-operating USTs are permanently closed, enhanced UST release prevention and detection, and improved fuel inventory management

- EPA should work with states and localities to enhance their efforts to protect lakes and reservoirs that serve as drinking water supplies by restricting use of recreational water craft, particularly those with older motors.

- EPA should work with other federal agencies, states, and private sector partners to implement expanded programs to protect private well users, including:
  - a nationwide assessment of the incidence of contamination of private wells by components of gasoline as well as by other common contaminants in shallow groundwater
  - broad-based outreach and public education programs for owners and users of private wells on preventing, detecting and treating contamination
  - programs to encourage and facilitate regular water quality testing of private wells

- Implement, through public-private partnerships, expanded Public Education programs at the federal, state and local levels on the proper handling and disposal of gasoline.

- Develop and implement an integrated field research program into the groundwater behavior of gasoline and oxygenates, including:

- identifying and initiating research at a population of UST release sites and nearby drinking water supplies, including sites with MTBE, sites with ethanol, and sites with no oxygenate
- conducting broader, comparative studies of levels of MTBE, ethanol, benzene, and other gasoline compounds in drinking water supplies in areas using primarily MTBE, areas using primarily ethanol, and areas using no or lower levels of oxygenate

2. <u>Treatment and Remediation</u>

- EPA should work with Congress to expand resources for the up-front funding of treatment of drinking water supplies contaminated with MTBE and other gasoline components to ensure that affected supplies can be rapidly treated and returned to service, or that an alternative water supply can be provided. This could take a number of forms, including:
  - enhancing the existing federal Leaking Underground Storage Tank Trust Fund by fully appropriating the annual available amount in the Fund, ensuring that treatment of contaminated drinking water supplies can be funded, and streamlining the procedures for obtaining funding
  - establishing another form of funding mechanism which ties the funding more directly to the source of contamination
  - encouraging states to consider targeting State Revolving Funds to help accelerate treatment and remediation in high priority areas

- Given the different behavior of MTBE in groundwater when compared to other components, states in RFG and Oxyfuel areas should reexamine and enhance state and federal “triage” procedures for prioritizing remediation efforts at UST sites based on their proximity to drinking water supplies.

- Accelerate laboratory and field research, and pilot projects, for the development and implementation of cost-effective water supply treatment and remediation technology, and harmonize these efforts with other public/private efforts underway.

II. <u>Recommendations for Blending Fuel for Clean Air and Water</u>

(Even with implementing the above recommendations, the Panel agreed broadly that enhanced protection programs will not give adequate assurance that water supplies will be protected and that changes will have to be made to the RFG program to reduce the amount of MTBE used, while ensuring that the benefits of RFG, as well as fuel supply and price stability, are maintained)

1. <u>The Oxygen Requirement</u>

- The Clean Air Act mandate to require 2% oxygen, by weight, in RFG must be removed to provide flexibility for blending of adequate fuel supplies in a cost-effective manner while quickly reducing usage of MTBE and maintaining air quality benefits.

2. <u>Maintaining Air Benefits</u>

- Toxic emission performance of RFG can be attributed, in part, to a combination of three primary factors: 1) mass emission performance requirements, 2) use of oxygenates, and 3) a necessary compliance margin with a per gallon standard. Lifting the oxygen requirement as recommended above may lead to fuel reformulations that achieve the minimum performance standards required under the 1990 Clean Air Act, rather than the larger air quality benefits currently observed. The Panel urges EPA to explore and implement mechanisms to achieve equivalent or improved health results that focus on reducing those compounds which pose the greatest risk.

3. <u>Reducing the Use of MTBE</u>

- The Panel agreed broadly that, to minimize current and future threats to drinking water, the use of MTBE should be reduced substantially. The Panel recommends that Congress act quickly to clarify federal and state authority to regulate and/or eliminate the use of gasoline additives that pose a threat to drinking water supplies. Accomplishing any such major change in the gasoline supply without disruptions to fuel supply and price will require adequate lead time - up to 4 years if the use of MTBE is eliminated, sooner in the case of a substantial reduction. The Panel further recommends that any reduction should be designed to not result in an increase in MTBE use in Conventional Gasoline areas.
- Other ethers (e.g. TAME, ETBE, and DIPE) have been less widely used and less widely studied than MTBE. The Panel recommends accelerated study of the health effects and groundwater characteristics of these compounds before they are allowed to be placed in widespread use. EPA should also accelerate research into the inhalation and ingestion health effects, air emission transformation byproducts, and environmental behavior of <u>all</u> oxygenates likely to increase in the absence of MTBE, including ethanol, alkylates, aromatics, and gasoline compositions containing those components.
- To ensure that any reduction in MTBE is adequate to protect water supplies, the Panel recommends that EPA, in conjunction with the USGS, the Departments of Agriculture and Energy, industry, and water suppliers should move quickly to:
  - conduct short-term modeling analyses and other research based on existing data to estimate current and likely future threats of contamination
  - establish routine systems to collect and publish, at least annually, all available monitoring data on use of MTBE, other ethers, and ethanol; levels of MTBE, ethanol, and petroleum hydrocarbons in ground, surface and drinking water; and trends in detections and levels of MTBE, ethanol, and petroleum hydrocarbons in ground and drinking water
  - identify and begin to collect the data necessary to adequately assist in determining the current and potential future state of contamination

4. <u>The Wintertime Oxyfuel Program</u> (This program continues to provide means for some areas of the country to come into or maintain compliance with the Carbon Monoxide standard. Most areas use ethanol to meet the wintertime needs for oxygen)

- The Panel recommends that the Wintertime Oxyphil program be continued as long as it provides a useful compliance and/or maintenance fool for the affected areas, assuming states are states are provided with the wherewithal to regulate and/or eliminate the use of gasoline additives that threaten drinking water supplies.

III. Recommendations for Evaluating and Learning from Experience

(Although the introduction of RFG has resulted in substantial air quality benefits, the unanticipated effects of RFG on groundwater highlight the importance of exploring the potential for adverse effects in all environmental media, and on human and ecosystem health, before widespread introduction of any new, broadly-used product)

- In order to prevent future such incidents, and to evaluate the effectiveness and impacts of the RFG program, EPA should:
  - conduct a full, multi-media assessment (for effects on environmental media) of any major new additive to gasoline prior to its introduction
  - Establish routine and statistically valid methods for assessing the actual composition of RFG and its air quality benefits
  - establish a routine process for reporting on the air quality results from the RFG program
  - build on existing public health surveillance systems to measure the broader impacts of changes in gasoline formulations on public health and the environment

(*Web-site*: http://www.epa.gov/orcdizux/consumer/fuels/oxypanel/blueribb.htm)