Feasibility Study Addendum: Executive Summary

The North Indian Bend Wash (NIBW) Superfund Site (Site) is one of the more extensively studied Superfund sites in the United States. Since 1981, when volatile organic compounds (VOCs) were first found in municipal water wells, parties involved in the cleanup, in conjunction with the U. S. Environmental Protection Agency (EPA) have installed over 150 monitoring wells and collected over 5,000 groundwater samples. Over the last 18 years, dozens of studies have been completed on specific aspects of the Site cleanup. Hydrogeologists for Motorola, Inc., Siemens Corporation, and SmithKline Beecham Corporation (collectively the Participating Companies [PCs]), as well as experts from the EPA, Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), Salt River Project (SRP), City of Scottsdale (COS), and their consultants, have analyzed extensive soil and groundwater data. During 1997 and 1998, a three-dimensional groundwater flow and contaminant transport model was developed for the Site using historical data and the collective interpretation of hydrogeologists working on the project. In short, after years of intensive study and data collection, the Site is well understood.

The PCs, EPA, and other interested parties have devoted substantial resources to investigations and remedial activities over the last 18 years. Most significant, they have constructed two large facilities to treat groundwater extracted from a series of existing and new extraction wells. Voluntary source area groundwater remediation is being conducted at two of the principal areas identified by EPA as potential sources of contamination. All of these facilities are operational, and more than 25 billion gallons of water have been treated and returned to beneficial use, removing more than 25,000 pounds of trichloroethylene (TCE) since 1994. In addition, soil remediation programs have been successfully completed or are near completion at four identified source areas.

This Feasibility Study Addendum (FSA) is a multipurpose document written to fulfill the "Supplemental Study" and "Five-year Review" requirements of the Operable Unit (OU) I Consent Decree (CD), and to provide a basis for EPA's selecting a final remedy for the Site. The purpose of this FSA is to use the extensive scientific data developed for the Site to assist in determining the most effective remedy, consistent with the National Contingency Plan (NCP) and the Remedial Action Objectives (RAOs) defined by the OU I and OU II CDs. The FSA

1. reviews the history of investigations and remediation at the Site,
2. evaluates the effectiveness of the remedy implemented pursuant to EPA's 1988 OU I and 1991 OU II Records of Decision (RODs),
3. assesses additional benefits gained from voluntary remedial enhancements installed to date,
4. analyzes 14 Remedial Actions that might be implemented, and
5. fully evaluates six alternative remedial scenarios, developed from combinations of those Remedial Actions projected to be most effective. One of the Remedial Alternatives is also evaluated using treated water for recharge and reinjection to satisfy the Supplemental Study requirement for evaluating recharge as a possible end-use. The FSA concludes that the original ROD-required remedial activities (the Required Remedy) did not achieve full capture of the VOC contamination. That objective was reached by late 1998 through the additional voluntary remedial steps taken by the PCs (the Enhanced Remedy). Computer modeling work also indicates that the additional remedial activities undertaken by the PCs (including additional extraction, treatment, and source control) are projected to more than double TCE mass removal (compared to the Required Remedy) in the next 30 years. With this aggressive remediation program, concentrations of TCE at many wells within the Site are projected to meet drinking water standards within 30 years. As set

forth throughout this FSA, the Enhanced Remedy and the additional Remedial Alternatives studied in this FSA are all protective of human health and the environment.

Background

The Site is located in the southwest part of the Paradise Valley basin, which is in the east part of the Salt River Valley in Arizona. The VOC contamination underlies parts of Scottsdale, Arizona, a highly developed urban area, which has placed substantial demands on area groundwater resources. There are three primary aquifer units at the Site. The Upper Alluvial Unit (UAU) occurs in the interval between ground surface and a depth of about 90 to 190 feet below ground surface, and consists of unconsolidated sands, gravels, and cobbles. The UAU is thinly saturated to unsaturated, and the groundwater is generally of poor quality due to non-point source inorganic contamination from historical farming and irrigation. The Middle Alluvial Unit (MAU) occurs below the UAU and ranges in thickness between 500 and 600 feet at the center of the basin, but thins at the basin margins. The MAU principally consists of heterogeneous silts, clays, and interbedded fine- to coarse-grained sands. The Lower Alluvial Unit (LAU) occurs below the MAU, with a thickness of more than 700 feet at the center of the basin. The LAU predominantly consists of poorly- to well-cemented sands and gravel. Both the MAU and the LAU are major sources of groundwater in the area.

Groundwater movement at the Site is complex, and substantial field investigation has been required to understand the system. The lateral and vertical flow of groundwater has changed historically in response to changes in groundwater pumping. Currently, groundwater flow in the UAU is generally east to west in the south part of the Site and northeast to southwest in the north part of the saturated UAU. In the northern part of the site, the UAU is generally unsaturated. MAU flow generally converges toward pumping centers in the central portion of the Site, although a portion also flows toward the western margin due to underlying pumping stresses in the LAU. LAU flow is south to north toward the wellfield in the vicinity of the Arizona-American Water Company (AAWC) pumping center, the "Paradise Valley wellfield". AAWC was formerly known as the Paradise Valley Water Company. In addition to dominant lateral flow, there is some vertical movement of groundwater from the UAU to the MAU and the LAU and from the MAU to the LAU in response to vertical hydraulic gradients. Downward movement of groundwater to underlying units is most prominent in the southwestern margin area due to the thinness or absence of confining layers in the MAU. In addition, some downward flow occurs locally through deep water supply wells completed across the alluvial units.

Site Remediation

The remedial history of the Site reflects EPA's efforts to address contamination in each alluvial unit. The Site was listed on the National Priorities List in September 1983, and a remedial investigation/feasibility study was prepared during 1984 through 1986 by an EPA contractor. In September 1988, EPA issued its OU I ROD for groundwater cleanup in the MAU and LAU. The remedy consisted of groundwater extraction from four then-existing production wells and treatment at a central Scottsdale facility with air stripping and vapor-phase carbon absorption. The objective of the OU I ROD was containment of all groundwater in the MAU and LAU with VOC levels in excess of federal drinking water standards and provision of water to COS for municipal supply. In September 1991, EPA issued the OU II ROD for remedial action in the vadose zone and UAU. This ROD concluded that VOCs in the UAU would migrate to the

underlying units for extraction and treatment. This ROD also required vadose zone investigation and soil vapor extraction (SVE) in certain areas of the Site to eliminate future threats to groundwater. With EPA's leadership, opportunities for active community participation have been provided throughout the development of both RODs and the implementation of remedial actions at the Site. The CDs for these cleanup efforts were entered in April 1992 (OU I) and August 1993 (OU II). The remedial actions required by these CDs are collectively referred to as the Required Remedy.

Since the original RODs and CDs were prepared, the PCs have worked closely with EPA and ADEQ on remedy issues. Voluntary remedial enhancements, consistent with the Required Remedy specified in the OU I and OU II RODs, have been implemented at the Site by the PCs in cooperation with the regulatory agencies. The required remedial activities and the voluntary remedial enhancements are collectively referred to as the "Enhanced Remedy". The OU I CD included a provision requiring that the PCs prepare a Supplemental Study of the Site that would evaluate the effectiveness of the remedy in maintaining the zone of capture and remediating the groundwater. At EPA’s request, the PCs agreed to expand the Supplemental Study to include results obtained from flow and transport modeling, and to conduct a comparative analysis of further remedial alternatives for the Site. The Required Remedy, the Enhanced Remedy, and the four additional Remedial Alternatives (plus the variant using reinjection of treated water) are the subject of an NCP analysis, as required by the Comprehensive Environmental Response, Compensation, and Liability Act and Superfund Amendment and Reauthorization Act, the Superfund Law, in this FSA.

Groundwater Monitoring

The Groundwater Monitoring Program is an integral component of the Enhanced Remedy. The OU I CD required a monitoring well network to identify the zone of contamination in the MAU and the LAU and to monitor the effectiveness of the groundwater extraction system. The OU II ROD required a program to monitor the presence and fate of VOCs in the UAU. These requirements have been effectively implemented. Over 150 monitoring wells located within and outside the Site are used to track Site conditions and the effectiveness of the current remedy (the "Enhanced Remedy"). Most of the monitoring wells were required by the OU I and OU II CDs, but additional wells were installed by the PCs on a voluntary basis to ensure effective monitoring of containment in the MAU and LAU. The PCs also have undertaken more frequent monitoring than required by the existing CDs and have conducted sampling programs, water level monitoring, and fluid movement investigations that exceed EPA requirements. The depth sampling and fluid movement studies conducted at the Site are state-of-the-art methods to characterize groundwater conditions and contaminant distribution in deep alluvial basins.

The monitoring program generates a wide range of data on a frequent basis. Raw data and interpretive contour maps of water levels and water quality are sent regularly to regulatory agencies and are also available to the public. The program provides for effective identification of the zones of contamination in the three alluvial units and provides sufficient information to identify the zone of hydraulic capture at the Site, as required by the OU I CD.

Groundwater Extraction and Treatment

Central Groundwater Treatment Facility.

The OU I ROD selected a specific groundwater extraction well network and required the design and construction of a groundwater treatment system (the Central Groundwater Treatment Facility [CGTF]) to capture VOC contamination and to reduce such concentrations to drinking water standards. The remedy has a goal of providing the COS with a source of drinking water, as well as achieving the remediation goals for the Site. CGTF construction was completed in October 1993. The plant uses air stripping technology with carbon treatment to reduce air emissions. Throughout its history, the CGTF has produced water that has consistently met drinking water standards, but at first it did not consistently perform to its full design potential. With EPA oversight, the air stripper towers of the CGTF were subjected to extensive technical review, and major changes were made to the tower packing, the influent water distribution system, and the air distribution system. These changes improved the performance and reliability of the CGTF. In the past 6 years, over 5,000 samples have been collected from the CGTF. All of the treated water samples have been below the applicable drinking water and OU I CD standards. As TCE mass is removed and wellhead TCE concentrations decrease, the concentration of TCE in the influent to the CGTF should decrease and the CGTF will continue to produce water with TCE levels well below the applicable drinking water standards.

Well COS75A. In 1994, the PCs determined that groundwater extracted from OU I Well COS75, perforated in both the MAU and LAU, was derived chiefly from the MAU. EPA approved the PCs recommendation to replace Well COS75 with a new extraction well completed solely in the LAU. Well COS75A was constructed and tested in early 1995. Well COS75A has been operated as a lead CGTF extraction well since May 1995 and improves the efficiency of LAU extraction and overall effectiveness of remediation.

Miller Road Treatment Facility. In early 1994, the PCs collected data indicating that low levels of VOC contamination had been detected in groundwater samples from LAU wells north of the Site. This finding led to additional groundwater monitoring and to discussions with the AAWC, the operator of the Paradise Valley wellfield to the north of the Site. In November 1994, the PCs and the AAWC reached agreement on a detailed plan for capturing and containing any contamination that may escape the Site to the north. Under this plan, the PCs performed a detailed hydrogeologic analysis and designed and constructed the Miller Road Treatment Facility (MRTF), which is available to provide groundwater treatment by air stripping for potable water. The facility was operational as of April 1997, before any detectable VOC concentrations reached the wellfield.

Well PCX-1. The PCs subsequently agreed to further enhancements to protect the AAWC wells, principally the installation and use of well PCX-1, an extraction well located upgradient from the Paradise Valley wellfield near the leading edge of the zone of LAU contamination. Well PCX-1 provides a mechanism for enhancing TCE mass removal and ensuring containment of the LAU contamination. The PCs, AAWC, and SRP have cooperated together to provide treatment of PCX-1 water at the MRTF. Treatment of PCX-1 water began at the MRTF in March 1997, and full operations began in April 1997.

Source Control

The OU II CD required SVE to remove VOCs from soils in specified Site areas and an evaluation and characterization of soil contamination in other areas of the Site. This work has been implemented successfully. VOC removal by SVE has eliminated the potential threat of future groundwater contamination from the known source areas. Siemens has operated SVE systems at Areas 7 and 8. The Area 8 system was decommissioned upon successful completion of its objectives. The Area 7 system is expected to have completed its objectives and is currently awaiting results and completion of rebound monitoring. Siemens also completed operation of an SVE system at Area 6 and decommissioned it, with agency approval, in October 2000. Motorola successfully completed Area 12 SVE activities in 1998. EPA provided written concurrence that the work was completed in August 2000. Site decommissioning work is in progress. Over 9,000 pounds of TCE mass have been removed from soils to date.

In addition, the PCs have voluntarily installed MAU groundwater extraction at two source areas (Areas 7 and 12). The development of pump and treat systems at these source areas will enhance mass removal and reduce VOC concentrations more quickly. Siemens has constructed a groundwater extraction and treatment (GWET) system to remove up to 500 gallons per minute (gpm) from one UAU extraction well and three MAU extraction wells at Area 7. The UAU portion of the system has been operational since 1994. Two MAU wells began remediation in 1999, and a third well is planned. Operation of this well is expected in mid-2001. Motorola is operating a GWET system at Area 12 that extracts an annual average of 1,000 gpm from two extraction wells screened in the MAU. This system has been operational since February 1999. The treated groundwater is delivered to the SRP Grand Canal. These voluntary source control initiatives have provided major improvements to the effectiveness of the Required Remedy.

Evaluation of Remedial Alternatives

This FSA concludes that the Enhanced Remedy alone would fully achieve the objectives of the RODs and CDs by establishing capture and containment of TCE mass at the Site while protecting human health and the environment. The Enhanced Remedy is projected to remove TCE mass more quickly than the original timetable estimated by EPA. The additional Remedial Alternatives evaluated in this FSA also meet RAOs and are protective of human health and the environment during aquifer restoration. The alternatives also provide reliable water sources for COS, AAWC, and SRP.

The following remedial alternatives are described and evaluated under the NCP criteria in this FSA.

- Alternative 1: the "Required Remedy", as defined in the OU I and OU II RODs and CDs. The Required Remedy comprises the CGTF with four extraction wells pumping at an annual average rate of 6,300 gpm (about 3.3 billion gallons per year), supplying water to the COS that meets drinking water standards. SVE systems are operating at Areas 7, 8, and 12.
- Alternative 2: the "Enhanced Remedy", reflecting voluntary improvements carried out by the PCs to insure capture and containment of the VOC plume in groundwater, and to accelerate Site restoration. The Enhanced Remedy includes the Required Remedy augmented by a new deep extraction well, COS75A, the MRTF, and well PCX-1 to contain and capture the northern part of the LAU plume, SVE at Area 6, UAU groundwater extraction at Area 7, and two new MAU extraction wells each at Areas 7 and 12. This is the remedy that was in place and operational in early 1999.

- Alternative 3: Alternative 2 plus a third Area 7 MAU well (now under construction), and focused pumping from the two most contaminated CGTF wells (COS71 and COS75A) to increase average annual CGTF extraction to 6,600 gpm. This rate is achieved by providing an additional spare pump/motor combination to allow rapid replacement in the event of pump outages. The CGTF air stripping columns have also been upgraded to improve air- and water distribution and increase column height.
- Alternative 4: Alternative 2 plus a third MAU extraction well at Area 7 and a new LAU extraction well in the central part of the zone of contamination connected to the CGTF. The CGTF air stripper column upgrades are also part of this Alternative.
- Alternative 5: Alternative 2 plus a third MAU well at Area 7, and increased focused pumping from the two most contaminated CGTF wells (COS71 and COS75A), using larger capacity pumps and variable frequency drives to increase extraction through the CGTF to an average of 6,600 gpm. The CGTF air stripper column upgrades are also part of this Alternative.
- Alternative 5RR: Alternative 5 above with all treated water reinjected or recharged into the aquifer system.
- Alternative 6: Alternative 2 plus two additional Area 7 MAU wells, approximately double the pumping from the two Area 12 extraction wells, and three new LAU wells. The CGTF air stripper column upgrades are also part of this Alternative.

This FSA concludes with a comparative analysis of all the Remedial Alternatives under the NCP criteria, which suggests the following for Final Remedy selection at the NIBW Site. Alternative 1 does not pass the threshold criteria for protecting human health and the environment and cannot be selected under the NCP analysis. Alternatives 2 through 6 are each protective of human health and the environment and meet the Applicable or Relevant and Appropriate Requirements (ARARs) and RAOs for the Site. Alternatives 2 through 6 are effective in the short term because the Enhanced Remedy is already in place and because they contain the TCE mass in an area where treatment is available as remediation is performed. Alternatives 2 through 6 are effective in the long term and permanent because they reduce TCE concentrations to meet MCLs, thereby preventing any residual risk.

The differences among Alternatives 3, 4, 5, 5RR, and 6 are reflected in their ability to reduce mobility and toxicity, their implementation, and their cost. All of these alternatives remove TCE mass, reduce plume size, and return wells to the drinking water standard more quickly than Alternative 2 (the Enhanced Remedy). Each is projected to remove between 91 percent and 93 percent of the TCE mass after 30 years and more than 95 percent to 96 percent of the TCE mass within 50 years. Alternatives 3 through 6 remove slightly more mass in the first 10 years (70 percent to 75 percent) than Alternative 2 (65 percent), largely because of the addition of a third MAU extraction well near Area 7.

Alternative 2 is the least costly and easiest to implement because it is already in place. Alternative 3 would be the next best alternative in terms of cost and implementation because it involves the least additional infrastructure added to Alternative 2. Alternatives 4 and 5 are more costly and present more difficult implementation challenges. Alternative 5RR and Alternative 6 would be the most costly and the most difficult to implement because they involve the greatest number of additional wells, piping, and associated permitting and technical issues. Alternative 3 extracts more mass than Alternative 2, presents fewer implementation issues, and is lower in cost than Alternatives 5, 5RR, and 6. Table ES.1 summarizes the results of the required NCP analysis, including considerations of performance, reliability, and cost in achieving the RAOs defined for the Site.