PUBLIC HEALTH ASSESSMENT

MARINE CORPS AIR STATION YUMA
YUMA, ARIZONA

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LIST OF ABBREVIATIONS

ACM	asbestos-containing material
ADEQ	Arizona Department of Environmental Quality
AS/SVE	Air sparging/soil vapor extraction
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CALA	Combat Aircraft Loading Apron
CAOC	CERCLA Area of Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CREG	cancer risk evaluation guide
CVs	comparison values
DCA	1,1-dichloroethane
DCE	1,1-dichloroethene
EPA	United States Environmental Protection Agency
FFA	Federal Facilities Agreement
FFAAP	Federal Facilities Agreement Assessment Program
FS	feasibility study
MCAS	Yuma Marine Corps Air Station Yuma
OU	operable unit
PAHs	polynuclear/polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCE	tetrachloroethene
PHA	Public Health Assessment
PHAP	Public Health Action Plan
RI	remedial investigation
RMEG	reference dose media evaluation guide
ROD	record of decision
SVOCs	semivolatile organic compounds
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
UST	underground storage tank
VEMUR	Voluntary Environmental Mitigation Use Restriction program

VOCs volatile organic compounds

SUMMARY

Marine Corps Air Station Yuma (MCAS Yuma) is located on the northern portion of the Yuma Mesa, southeast of the city of Yuma, Arizona. It occupies about 3,000 acres, roughly 4 to 5 miles from, and 60 to 70 feet above, the Colorado River. MCAS Yuma has been used primarily for military purposes from 1941 through the present, and has been operated by the U.S. Department of the Navy since 1959. A variety of hazardous wastes have been handled, stored, and disposed of at MCAS Yuma, resulting in soil and groundwater contamination at a number of locations. The station is fenced at the perimeter and is not open to the public.

Areas of potential concern at MCAS Yuma were used for waste disposal, vehicle maintenance and repair, hazardous materials storage, fire training, pest control, and general industrial purposes. The Agency for Toxic Substances and Disease Registry (ATSDR) conducted site visits in February 1991 and February 1997. Based on information gathered during the site visits, ATSDR identified three potential exposure pathways: exposure to contaminated groundwater; exposure to asbestos-containing material (ACM) at the Radar Hill Disposal Area; and exposure to organic lead in surface soil at the Flight Line, Shops Area, and Fire School Area. This public health assessment (PHA) evaluates the potential public health hazards associated with these three pathways.

Exposure to Contaminated Groundwater

Although the groundwater at MCAS Yuma is contaminated, no one has ever been exposed to the contaminated water. Drinking water is supplied to MCAS Yuma directly from the Colorado River, via a canal system. Berms protect the canals' banks, so contamination from runoff is not a concern. Every year, for about two weeks, the canals are closed for cleaning, and an alternate source of water must be used. Since 1996, the station has relied on water from the city of Yuma during this period, which gets its water from the Colorado River via its own canal system. Until 1996, drinking water at MCAS Yuma was supplied from an on-site well during the canal-cleaning period. The on-site well is located upgradient of the major contaminant plumes underlying the station. All drinking water on the station has always met federal drinking water standards. *For these reasons, ATSDR concludes that exposure to contaminated groundwater at MCAS Yuma does not pose a past, current, or future public health hazard*. However, should new wells be drilled at MCAS Yuma, the potential for exposure to contaminated groundwater should be reevaluated.

Contaminated groundwater from MCAS Yuma will not pose a public health hazard to individuals who use groundwater drawn from locations downgradient of the station for two reasons: 1) the contaminant plumes have not traveled beyond the station perimeter, and 2) contaminated groundwater will be remediated and barriers will be developed to prevent plumes from migrating off station.

Exposure to Asbestos-Containing Material (ACM) at the Radar Hill Disposal Area

The Radar Hill Disposal Area was used in the 1940s and 1950s for general disposal of the station's trash and more recently for the disposal of construction debris, some of which contains asbestos, a known carcinogen. Some warning signs have been posted and some fencing is present. Since the quantity of ACM is limited, and most of the ACM is buried, exposure was and continues to be fairly limited. In the future, the ACM will be removed and the soil cleaned up, eliminating any future public health hazard. The Navy has planned and budgeted removals in 1998 for CERCLA Areas of Concern (CAOCs) 4A and 4B in the Radar Hill Disposal Area, CAOCs 7A and 7B in the Fire School Area and debris piles south of the combat Aircraft Loading Apron, and CAOC 9, the Horse Stable Area. *For these reasons, ATSDR concludes that exposure to ACM at the Radar Hill Disposal Area does not pose a past, current, or future public health hazard.* ATSDR recommends that additional warning signs be installed at Site 4B to help ensure limited potential exposure until cleanup of ACM is complete.

Exposure to Organic Lead in Surface Soil

The predominant source of organic lead in the environment is the use of tetraalkyl lead compounds (primarily tetraethyl lead) as anti-knock additives in gasoline. MCAS Yuma has not purchased leaded gasoline since 1987. Although tetraethyl lead is very toxic, it also generally degrades in soil within a matter of months, so any organic lead currently present at the station is likely in the form of mineralized ionic ethyl lead breakdown products of tetraethyl lead. The toxicity of these compounds is not known.

In 1995, the Navy sampled for organic lead at 11 sites that were suspected of having vehicle-related waste streams. Organic lead was detected in five surface soil samples (one of which was a field duplicate) and one subsurface soil sample from the Flight Line, Shops Area, and Fire School Area. None of these areas has the potential for current or future human exposure, but past exposures at the Shops Area and Fire School Area may have occurred. *Although current and future exposures are not a concern, the high levels of organic lead present in these areas raise concerns about potential past exposures. ATSDR does not have sufficient information at this time to evaluate potential public health impacts, therefore, past exposure to organic lead in surface soil presents an indeterminate public health hazard.*

Exposure to Other Areas of Potential Concern

ATSDR evaluated a number of additional areas of potential concern at MCAS Yuma and off-station. Appendix A contains a list of these areas. ATSDR has determined that these areas, which include every evaluated off-station area, do not present a public health hazard based on one or more of the following reasons: 1) no contaminants were detected, 2) contaminants were detected at concentrations that are too low to pose a health hazard, 3) access to the area was (past scenario), is (current scenario), and will be (future scenario) highly restricted, and/or 4) impacted areas have been or will be remediated.

BACKGROUND

Site Description and Operational History

Site Description

Marine Corps Air Station Yuma (MCAS Yuma) is located on the northern portion of the Yuma Mesa, southeast of the city of Yuma, Arizona. It occupies about 3,000 acres, roughly 4 to 5 miles from, and 60 to 70 feet above, the Colorado River. A variety of hazardous wastes have been handled, stored, and disposed of at MCAS Yuma, resulting in soil and groundwater contamination at a number of locations. The station is fenced at the perimeter and is not open to the public.

Operational History

MCAS Yuma has been used as an airfield since 1928. Between 1941 and 1946, the facility was leased to the U.S. Army Air Corps for pilot and bomber crew training. After a brief period of disuse, the area was used as a civilian airfield from 1948 to 1951, at which time it was reactivated by the U. S. Air Force as a Weapons Proficiency Center for fighter-interceptor units. In 1959, the site was transferred to the U.S. Department of the Navy, and MCAS Yuma was established to provide support for the Marine Aircraft Wing and its subordinate units. The airport is currently operated as a joint military/civilian facility. Aircraft and site maintenance, fire training, and industrial and waste disposal activities generated a variety of toxic wastes, including industrial solvents, airplane fuel and oil, lubricants, paint strippers, and pesticides. Asbestos-containing material (ACM) was also used for construction (JEG, 1996; Stearns, 1985; Uribe, 1996, 1997a).

Remedial And Regulatory History

Site investigations were initiated in 1985 to evaluate past disposal sites at MCAS Yuma. Preliminary studies indicated the presence of chlorinated solvents in underlying groundwater. Because of these results, in 1990, the U. S. Environmental Protection Agency (EPA) placed MCAS Yuma on the National Priorities List. In 1992, the Navy entered into a Federal Facilities Agreement (FFA) with EPA and the Arizona Department of Environmental Quality (ADEQ) to establish a framework and schedule for implementing environmental investigations and appropriate cleanup actions specified in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). EPA is the lead regulatory agency for the remediation of MCAS Yuma. ADEQ is the supporting state regulatory agency for these activities (Uribe, 1997a).

Major environmental investigations at MCAS Yuma are being conducted under three separate programs:

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Program—Operable Units 1 and 2

The investigations planned under the FFA have largely concentrated on two operable units (OUs). OU1 consists of soil below 10 feet and the groundwater underlying the station. OU2 consists of the first 10 feet of soil below ground surface.

The remedial investigation (RI) for OU1 was completed in 1996. The parties to the FFA have not yet finalized the feasibility study (FS) which evaluates possible remedial alternatives. A record of decision (ROD) will follow the FS and should be finalized in the fall of 1998. The RI identified seven contaminated groundwater plumes (see Figure 4), four of which will be addressed in the FS. The remaining three plumes were referred to the Underground Storage Tank (UST) program (see below) for further action (JEG, 1996; Yuma, 1997a, 1998a).

The FS for OU1 will soon be completed and the Proposed Plan (to be released this summer) will outline a plan for the Navy to remediate the contaminated plumes through a combination of active measures and monitored natural attenuation. Since the plume in Area 1 has reached the station perimeter, the plan calls for the Navy to contain this plume through the use of vertical recirculation wells. The Navy plans to remediate hot spots in the Area 1 plume through mass removal by using air sparging/soil vapor extraction (AS/SVE). After a five-year review, if natural attenuation has not been successful in the center of this plume and in other plume areas, a contingency plan calls for the Navy to remediate contamination using pump-and-treat techniques (Yuma, 1998a; JEG, 1998a).

A ROD was signed for OU2 in late 1997. Of the 18 sites investigated in OU2, three sites containing ACM (sites 4, 7, and 9) will be cleaned up and three sites with other contaminants (sites 1, 8, and 10) will be subject to permanent future use restrictions. Appendix A contains a detailed list of sites in OU1 and OU2 (Uribe, 1997a).

Underground Storage Tank (UST) Program

MCAS Yuma initiated the UST program in 1989 to remove all active and inactive USTs on site. The program was also charged with excavating and removing high-risk USTs, assessing sites, and recommending corrective actions. The major groundwater remedial work of the UST program has been the cleaning up of four contaminated groundwater plumes associated with the Exchange Service Station, Fuel Farm Area, Motor Transportation Pool, and leaking pipe near Building 310. JP-5 jet fuel and fuel constituents (primarily benzene, toluene, ethylbenzene, and total xylenes [BTEX]) make up the primary groundwater contaminants. The Navy has completed groundwater remediation of BTEX, using air sparging and vapor extraction, at the Exchange Service Station and the Motor Transportation Pool plumes. They have recommended continued monitoring, natural attenuation, and biosparging. The Navy is still actively remediating the Building 310 plume, using vapor extraction and pumping, and the Fuel Farm Area plume, using vapor extraction and air sparging (JEG, 1996; OHM, 1998a; Yuma, 1998a,b).

Federal Facilities Agreement Assessment Program

The Federal Facilities Agreement Assessment Program (FFAAP) is a comprehensive review and assessment of current and past waste-generating activities at the station. The FFAAP initially reviewed 559 sites and addressed 36 of these sites in more detail. Of the 36 sites, the FFAAP recommended three sites for future use restrictions under the Arizona's Voluntary Environmental Mitigation Use Restriction (VEMUR) requirements. The program recommended two other sites for further remedial action. Appendix A shows charts of these five actionable sites in more detail. Sites reviewed under the FFAAP and located within the boundaries of the 18 OU2 sites were incorporated into the RI for OU2 (Southwest Division, 1997).

Local Demographics and Land Use

The Agency for Toxic Substances and Disease Registry (ATSDR) used 1990 census data to compile the demographic information in Tables 1 and 2. The population of the city of Yuma in 1990 was 54,923. The city's population more than doubles during the winter months, when the area is a popular haven for senior citizens from colder climates. A majority (58.5%) of households were owner occupied, and 12.7% of households lived in mobile homes.

About 6,300 people work on the station, including about 1,100 are civilians. Roughly 2,700 people live in station-owned housing; of these, about 1,000 are children. MCAS Yuma owns 821 family housing units, of which 128 are located off station. On average, families reside in on-station housing for about 3 years during a typical tour of duty. It is unusual for anyone to serve more than three tours of duty at MCAS Yuma. A large number of Armed Forces personnel come through MCAS Yuma each year for training (Stearns, 1985; Yuma, 1998e,h).

MCAS Yuma is located in the southwestern corner of the state of Arizona, in close proximity to the borders of California and Mexico. Located on the Yuma Mesa, the station is directly to the southeast of the city of Yuma, Arizona. It occupies about 3,000 acres, roughly 4 to 5 miles from, and 60 to 70 feet above, the Colorado River.

MCAS Yuma is located in the Sonoran Desert. The environment in the area of MCAS Yuma is dominated by desert plains, with low stands of creosote bush interspersed with bur sage. There is no natural surface water on the station, and the water canals do not traverse the base. Most of the station property has been developed or disturbed. Little vegetation grows around the buildings and residences, and there are few landscaped areas. Some residents of the station-owned housing units maintain gardens, although few vegetables are grown. Some residents fish in the water canals, although a permit is necessary to do so. While there is no hunting at the station, some residents may be eating rabbits (Stearns, 1985; Yuma, 1998a,e,g).

The station airport is operated as a joint military/civilian facility. The civilian portion is growing and becoming more developed. The Navy also leases 90 acres of the station's property for agricultural use. This property has always been used for agricultural purposes, and has not been impacted by operations at MCAS Yuma.

The majority of the land immediately surrounding the station contains irrigated citrus groves, although commercial and industrial sites predominate to the north, and some residential areas exist to the north and east (Stearns, 1985).

ATSDR Involvement

The ATSDR conducted site visits in February 1991 and February 1997. ATSDR staff met with a number of station personnel, state officials, and representatives from the Navy. Based on information gathered during the site visits, ATSDR identified two potential exposure pathways of concern at MCAS Yuma: exposure to contaminated groundwater and exposure to ACM at the Radar Hill Disposal Area. This Public Health Assessment (PHA) evaluates the potential public health hazards associated with these two pathways as well as a third potential pathway, organic lead in the surface soil, which was later identified. No community health concerns were identified during ATSDR's site visits.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR relied on the information provided in the referenced documents and by contacts. The agency assumes adequate quality assurance and control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this document are determined by the availability and reliability of the referenced information.

PUBLIC HEALTH ASSESSMENT

MARINE CORPS AIR STATION YUMA
YUMA, ARIZONA

EVALUATION OF ENVIRONMENTAL CONTAMINATION AND POTENTIAL EXPOSURE PATHWAYS

Introduction

ATSDR evaluates exposure pathways to determine whether people accessing or living near MCAS Yuma could have been (past scenario), are (current scenario), or will be (future scenario) exposed to site-related contaminants. In evaluating exposure pathways, ATSDR determines whether exposure to contaminated media has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation. When exposure to contaminated media occurs, the exposure pathway is regarded as "complete." To determine whether completed pathways pose a potential public health hazard, ATSDR compares contaminant concentrations to health-based comparison values (CVs). Comparison values are calculated from scientific literature available on exposure and health effects. These values, which are derived for each of the media, reflect the estimated contaminant concentration for a given chemical that is *not* likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (e.g., duration and frequency) and the toxicology of the contaminant. This exposure evaluation process is summarized in Figure 3.

ATSDR evaluated a number of sites, both on-station and off-station, to determine whether potential exposure to contaminated media would result in past, current, or future public health hazards. Based on extensive review of available data and compiled information, ATSDR concluded that there were only three potential exposure pathways of concern, all of which were on-station: exposure to contaminated groundwater; exposure to ACM at the Radar Hill Disposal Area; and exposure to organic lead in surface soil at the Flight Line, Shops Area, and Fire School Area. ATSDR determined that the rest of the investigated sites do not represent public health hazards, based on one or more of the following reasons: 1) no contaminants were detected, 2) contaminants were detected at concentrations that are too low to pose a health hazard, 3) access to the area was (past scenario), is (current scenario), and will be (future scenario) highly restricted, and/or 4) impacted areas have been or will be remediated (ADEQ, 1997; Earth Technology, 1991 ; JEG, 1996; Southwest Division, 1997; Stearns, 1985; Uribe, 1996, 1997a,b; Yuma, 1997a,b, 1998a,b,c,e,f,g,h,i,j,k).

Evaluation of Groundwater Exposure Pathway

Contaminants from OU2 Site 7 (Fire School Area), underground storage tanks, and perhaps from other unknown sources, have leached into the groundwater. The primary groundwater contaminants of concern at MCAS Yuma are TCE, tetrachloroethene (PCE), 1,1-dichloroethene (DCE), 1,1-dichloroethane (DCA), JP-5 jet fuel, and fuel constituents (primarily BTEX). There are eight primary contaminated groundwater plumes of concern (see Figure 4 and Appendix A for details) (JEG, 1996; Yuma, 1998a; OHM, 1997, 1998a,b).

Other groundwater contaminants were present above CVs at MCAS Yuma. These contaminants are not of concern, however, because most of them are not associated with any known sources of contamination at MCAS Yuma, and most of the metals are naturally occurring and within background concentrations. Others contaminants, such as chloroform, are likely the result of off-site contamination (e.g., chloroform is a byproduct of water treatment processes using chlorine). The remaining contaminants occur only in isolated spots where exposures are unlikely, or the contaminants are not present at levels that could pose a public health hazard. Moreover, ongoing remedial activities will continue to remove groundwater contaminants (JEG, 1996; OHM, 1998c).

The Navy is actively remediating Area 4 (Fuel Farm Area plume) under the UST program using air sparging and vapor extraction. Also under the UST program, the Navy is remediating Area 8 (plume in vicinity of Building 310) using vapor extraction and pumping. The Navy plans to complete remediation of Area 8 by the end of 1998 (OHM, 1998a).

Remediation and containment has begun for contaminated groundwater plumes not covered by the UST program, and full remedial alternatives are being evaluated for the FS. The proposed plan calls for the Navy to remediate the contaminated plumes by active measures and monitored natural attenuation. In addition, since Area 1 (plume in vicinity of Building 230) has reached the station perimeter, the current plan calls for the Navy to contain this plume through the use of vertical recirculation wells. The Navy also plans to remediate hot spots in Area 1 through mass removal (AS/SVE). After a five-year review, if natural attenuation has not been successful, the current plan calls for the Navy to remediate contamination sources using pump-and-treat techniques (Yuma, 1998a; JEG, 1998a).

Groundwater generally flows under unconfined conditions beneath the station. The direction of flow is principally from the southeast to the northwest. Regularly performed monitoring has revealed that none of the contaminated plumes have migrated beyond the station perimeter (JEG, 1996 ; OHM, 1997, 1998b; Yuma, 1997a, 1998a,c,d).

Although the groundwater at MCAS Yuma is contaminated, no one has ever been exposed to the contaminated water. The groundwater is not used as a water supply source. Drinking water is supplied to the station directly from the Colorado River, via a canal system. Berms protect the canals' banks, so contamination from runoff is not a concern. Every year, for about two weeks, the canals are closed for cleaning, and an alternate source of water must be used. Since 1996, the station has relied on water from the city of Yuma during this period; the city gets its water from the Colorado River via its own canal system. Until 1996, drinking water at MCAS Yuma was supplied from an on-site well during the canal-cleaning period. The on-site well is located in the southeast corner of the station, upgradient of the major contaminant plumes. All drinking water on the station has always met federal drinking water standards (JEG, 1996; Yuma, 1997a, 1998a,c).

There are 14 active off-site wells located within 3 miles to the northwest (downgradient) of MCAS Yuma. None of these wells is located within a half mile of the station. Of the 14 downgradient wells, eight are dewatering wells, three are irrigation wells, one is an industrial well, one is a domestic well, and one is a municipal well. Dewatering wells are generally installed to lower the groundwater table and are not used for drinking water. Within a 1-mile radius of MCAS Yuma, all water used for irrigation purposes is obtained exclusively from the Colorado River via a system of canals. Figure 4 shows the closest downgradient wells. (JEG, 1996, 1998a,b; Stearns, 1985; Yuma, 1998a).

Current Exposure

No public health hazards are associated with current exposure to contaminated groundwater at MCAS Yuma. No on-site wells are used for drinking water, and the contaminated plumes have not moved beyond the station perimeter (OHM, 1998b; Yuma, 1997a, 1998a,c,d).

Future Exposure

No public health hazards are associated with future exposure to contaminated groundwater at MCAS Yuma. The contaminated plumes are being remediated and monitored (see Appendix A and the Public Health Action Plan below for details). The Navy will also implement a containment policy to prevent future contaminant migration beyond the station's perimeter. All off-site wells are sufficiently distant to eliminate any likelihood of future exposure; many of the wells also have dewatering wells between them and the station. The on-site drinking well is upgradient of contaminated groundwater plumes. *Should new wells be drilled at MCAS Yuma, ATSDR will reevaluate the potential for exposure to contaminated groundwater* (JEG, 1996, 1998a,b; OHM, 1997a, 1998a,b; Stearns, 1985; Yuma 1997a, 1998a,c,d).

Past Exposure

No public health hazards are associated with past exposure to contaminated groundwater at MCAS Yuma. The on-site well that was used prior to 1996 for drinking water is located upgradient of the contaminated groundwater plumes. In addition, exposure to water from this well would have been minimal because the well was only used for about 2 weeks each year, and residents of the station typically live on the station for only about 3 years. Drinking water at the station has always met all federal drinking water standards (Yuma, 1998c,e).

Evaluation of Asbestos-Containing Material (ACM) at the Radar Hill Disposal Area

The Radar Hill Disposal Area (see Figure 5) covers approximately 14 acres and is located to the south and west of Radar Hill within the central portion of MCAS Yuma. This area was used in the 1940s and 1950s for burning or burying station trash, and, more recently, for the disposal of construction debris, including broken concrete slabs. The Radar Hill Disposal Area was covered and graded in the early 1950s (JEG, 1996; Stearns, 1985; Uribe, 1997a).

There are two discrete areas within the Radar Hill Disposal Area that contain ACM:

- Site 4A is north of Building 38 and east of Building 40. This area contains small pieces of asbestos-containing transite, cement pipe, and roofing materials, mixed with soil and other construction debris. ACM was found over an area of approximately 56,400 square feet (Uribe, 1996, 1997a).
- Site 4B is west of Radar Hill. It has one debris pile containing approximately 3 cubic yards of ACM fiberboard. The area of contamination was estimated to be approximately 350 square feet (Uribe, 1996, 1997a).

Under the ROD, which was signed by all parties at the end of 1997, surface ACM and ACM-contaminated soil will be remediated. Workers will clean the surface ACM manually and will remove the upper inch of soil beneath the ACM. ACM-contaminated soil will be excavated with conventional construction equipment. The Navy will dispose of all ACM from the sites at a permitted facility (Uribe, 1997a).

Past and Current Exposures

Access to the Radar Hill Disposal Area is restricted by partial fencing and warning signs are posted at Site 4A, but not at Site 4B. The area is fairly isolated. ACM is not present in very large quantities, and most of it is buried underground. ATSDR therefore concludes that *no public health hazards are associated with current and past exposures to ACM at the Radar Hill Disposal Area. Because the Radar Hill Disposal Area has not yet*

been remediated, ATSDR recommends that warning signs be posted at Site 4B as a precautionary measure (Uribe, 1996, 1997a; Yuma, 1997b, 1998a).

Future Exposure

The Navy has planned and budgeted removals in 1998 for CAOCs 4A and 4B in the Radar Hill Disposal Area. In addition, although ATSDR found no potential exposure pathways at these sites, the Navy has also planned and budgeted removals in 1998 for CAOCs 7A and 7B in the Fire School Area and debris piles south of the combat Aircraft Loading Apron and CAOC 9, the Horse Stable Area. These planned remedial activities should eliminate any potential exposures, therefore, *no public health hazards are associated with future exposures to ACM at the Radar Hill Disposal Area.*

Evaluation of Organic Lead in Surface Soil

The predominant source of organic lead in the environment is the use of tetralkyl lead compounds (primarily tetraethyl lead) as anti-knock additives in gasoline. In 1995, the Navy sampled for total organic lead (of which tetraethyl lead is only one possible component) at 11 sites that were suspected of having vehicle-related waste streams (JEG, 1996).

Organic lead was detected in six soil samples at MCAS Yuma:

- Flight Line: Two nearly adjacent surface soil samples had organic lead levels of 0.88 mg/kg and 0.83 mg/kg, respectively. Both sample areas are paved, so there is no access to the contaminated surface soil. Access to the Flight Line has always been restricted (Yuma, 1998b).

- Shops Area: Two samples, the second a field duplicate of the first, had organic lead levels of 12.80 mg/kg and 9.20 mg/kg, respectively. Other nearby samples did not contain organic lead. The sample area is separated and fenced off from the nearby single enlisted personnel barracks and dining facilities (which were built in the early 1980s), and is covered with dirt. The area is currently used by station maintenance contractors, primarily for storage. The area has been used historically for vehicle maintenance and public works (Yuma, 1998b,i,j,k).

- Fire School Area: Two samples, one at the surface and one 2 to 3.5 feet below the surface had organic lead levels of 2.9 mg/kg and 0.53 mg/kg, respectively. The surface sample was taken from former Fire Training Pit 15, which was apparently used during the 1970s for fire and crash training. Former Fire Training Pit 15 is located in an area between two runways that has been covered with sealant since the early 1980s in order to prevent loose debris from being kicked up by planes. Exposure is therefore very limited. The subsurface sample was collected from the middle of an ACM site located within the broader Fire School Area (see Appendix A). Because of the presence of ACM, this area is fenced and warning signs are posted, so exposure is very unlikely (Yuma, 1998j).

Tetraethyl lead is quite toxic, with an adult reference dose media evaluation guide (RMEG) CV of 0.07 mg/kg, which is orders of magnitude below the levels of organic lead at MCAS Yuma. Tetraethyl lead degrades in a matter of months, however, and MCAS Yuma has not purchased leaded gasoline since 1987. The organic lead currently present in the soil is likely in the form of mineralized ionic ethyl lead breakdown products of tetraethyl lead. There are no CVs available for these breakdown products (JEG, 1996).

While the absorption, distribution, metabolism, and toxicity of inorganic lead have been extensively studied, only limited information is available on the toxicity of organic lead components. The limited data available on alkyl lead compounds indicate that the toxicokinetic profiles and toxicological effects of these compounds are qualitatively and quantitatively different from those of inorganic lead. Some of the toxicologic effects of alkyl lead, however, appear to be mediated through metabolism to inorganic lead (ATSDR, 1997; JEG, 1996).

Organic lead compounds are rapidly absorbed through the skin and by inhalation and ingestion. In the body, tetraethyl lead may be converted to triethyl lead, which is a more severe neurotoxin than inorganic lead. One study of subchronic exposure to tetraethyl lead in laboratory animals showed histopathologic effects in the liver and thymus. Very little information is available about the toxicity of the breakdown products of tetraethyl lead (ACGIH, 1993; ATSDR, 1997; CSIRO, 1998; IRIS, 1998).

Exposure to inorganic lead at sufficiently high levels has been shown to cause neurological damage and kidney damage in adults and children. It has also been shown to cause complications during pregnancy and retarded physical and mental development in exposed children. Exposure to inorganic lead at sufficiently high levels may cause increased blood pressure in middle-aged men and can damage the organs responsible for sperm production. No comparison value exists for environmental levels of inorganic lead because no thresholds have been demonstrated for the most sensitive effects in humans. Exposure is generally measured by blood lead levels (ATSDR, 1997). The Centers for Disease Control and Prevention determined that blood lead levels of 10 µg/dL in children were considered to be elevated (CDC, 1991).

Current and Future Exposure

The Flight Line and Fire School Area sample locations are in isolated areas and covered by pavement and a sealant, respectively. These areas do not pose a current or future public health hazard because of the protective barriers and infrequent exposures. Since use of the Shops Area sample location is restricted and primarily only for storage, and the organic lead detected appears isolated, this area also does not pose a current or future public health hazard. *No public health hazards are associated with current or future exposures to organic lead at MCAS Yuma.*

Past Exposure

The very high levels of organic lead found at some locations, while not a current or future concern, do raise questions about potential exposure in the past. The current high levels of tetraethyl lead degradation products suggest the possibility that high levels of tetraethyl lead may have been present in

the past. Past exposure at the Flight Line was quite limited. Although past exposure at the Fire School Area and Shops Area may have also been quite limited, ATSDR does not have sufficient information to evaluate potential past exposures to organic lead at these areas. *ATSDR, therefore, concludes that past exposures to organic lead at the Fire School Area and Shops Area pose an indeterminate public health hazard.*

ATSDR CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive to environmental exposure than adults in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the following factors: 1) children are more likely to be exposed to certain media (e.g., soil or surface water) because they play and eat outdoors; 2) children are shorter than adults, which means that they can breathe dust, soil, and vapors close to the ground; and 3) children are smaller, therefore, childhood exposure results in higher doses of chemical exposure per body weight. Children can sustain permanent damage if these factors lead to toxic exposure during critical growth stages. ATSDR is committed to evaluating their special interests at sites such as MCAS Yuma, as part of the ATSDR Child Health Initiative.

ATSDR evaluated the likelihood that children living on MCAS Yuma may have been or may be exposed to contaminants at levels of health concern. *ATSDR did not identify any situations in which children were likely to be or have been exposed to chemical contaminants at levels which pose a health concern.* Although children playing in the fenced portion of the Southeast Station Landfill (south of North Ordnance Road) may be exposed to low levels of a variety of contaminants (see Appendix A), the contaminant levels do not pose a public health hazard because the area is fairly restricted and exposures would be limited and of short duration. Children may also be exposed to beryllium at the section of family housing built over the First Sewage Lagoon (see Appendix A). These potential exposures do not pose a public health hazard, however, because the beryllium levels are in the range of background concentrations. It is unlikely that children will come in contact with other on-site contaminated media because these sites are not in close proximity to the residential housing on the station and generally have restricted access.

PUBLIC HEALTH ASSESSMENT

MARINE CORPS AIR STATION YUMA
YUMA, ARIZONA

CONCLUSIONS

Based on a thorough evaluation of available environmental information, ATSDR has reached the following conclusions.

1. Exposure to contaminated groundwater does not currently pose, has not posed in the past, and will not pose in the future a public health hazard. No contaminated wells are used for drinking water, and current and planned remediation and containment measures will ensure that there are no future exposures to contaminated groundwater. Should new wells be drilled at MCAS Yuma, the potential for exposure to contaminated groundwater should be reevaluated.

2. Potential exposure to ACM at the Radar Hill Disposal Area is currently, and has been in the past, sufficiently limited as to pose no past or current public health hazard. ATSDR recommends that additional warning signs be installed at Site 4B to help ensure limited potential exposure until cleanup of ACM is complete.

3. Exposure to ACM at the Radar Hill Disposal Area in the future will pose no public health hazard because no ACM will be present at the site once planned remediation activities have been completed.

4. In 1977 or 1978, approximately 300 pounds of dry crystal tear gas components were reportedly buried at OU2 Site 12 (Tear Gas Burial Area) (see Appendix A). Although the reports of tear gas disposal could not be verified, precautionary measures should be taken for future excavations at this site.

5. Past exposure to organic lead in the surface soil at the Flight Line was quite limited and therefore did not likely pose a public health hazard. Past exposure to organic lead in the surface soil may have also been limited at the Fire School Area and Shops Area. ATSDR does not have sufficient information, however, to evaluate past public health hazards associated with exposure to organic lead in surface soil at these two areas. ATSDR, therefore, concludes that past exposures at these areas pose an indeterminate public health hazard. No public health hazards are associated with current or future exposures to organic lead in soil because the contaminated areas have been paved over or have restricted access and use.

PUBLIC HEALTH ACTION PLAN

The public health action plan (PHAP) for MCAS Yuma contains a description of actions taken at the station and those to be taken at the station subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The following public health actions at MCAS Yuma are completed, ongoing, or planned:

Completed Actions

Groundwater

1. Extensive testing was performed to assess potential groundwater contamination.

2. Remediation of BTEX at Areas 5 (Motor Transportation Pool plume) and 7 (Exchange Service Station plume) has been completed under the UST program using air sparging and vapor extraction. The Navy has recommended continued monitoring, natural attenuation, and biosparging (JEG, 1996; Yuma, 1998a).

ACM at Radar Hill Disposal Area

1. Extensive testing was performed to assess potential exposure to ACM. A ROD was signed in late 1997 requiring the cleanup of surface and soil ACM.

Organic Lead in Surface Soil

1. Testing was performed in 1995 at 11 sites that were suspected of having vehicle-related waste streams.

Other Sites

1. Extensive testing was performed to assess potential public health hazards at other sites of possible concern (see Appendix A for details).

Ongoing and Planned Actions

Groundwater

1. The Navy is actively remediating Area 4 (Fuel Farm Area plume) under the UST program using air sparging and vapor extraction. Also under the UST program, the Navy is remediating Area 8 (plume in vicinity of Building 310) using vapor extraction and pumping. The Navy plans to complete remediation of Area 8 by the end of 1998 (OHM, 1998a)

2. Remediation and containment has begun for contaminated groundwater plumes not covered by the UST program, and full remedial alternatives are being evaluated for the FS. The FS for OU1 will soon be completed and the Proposed Plan will outline a plan for the Navy to remediate the contaminated plumes through a combination of active measures and monitored natural attenuation. Since Area 1 (plume in vicinity of Building 230) has reached the station perimeter, the plan calls for the Navy to contain this plume through the use of vertical recirculation wells. The Navy plans to remediate hot spots in Area 1 plume through mass removal (AS/SVE). After a five-year review, if natural attenuation has not been successful in the center of this plume and in other plume areas, a contingency plan calls for the Navy to remediate contamination using pump-and-treat techniques (Yuma,1998a; JEG, 1998a).

ACM at Radar Hill Disposal Area

1. ACM and ACM-contaminated soil will be removed and disposed of at a permitted facility.

Organic Lead in Surface Soil

1. If the restricted access and use changes in the future, ATSDR recommends further site characterization for areas with soil contaminated by organic lead.

Other Sites

1. The Navy will remediate and/or further investigate the following sites: OU2 Site 7 (Fire School Area), OU2 Site 9 (Southeast Sewage Lagoon), FFAAP Unit 855.04 (Battery Shop), and FFAAP Unit 855.19 (Hydraulic Lift). The Navy will place future use restrictions on the following sites: OU1 Site 1 (Flight Line), OU1 Site 8(a) (Southeast Station Landfill), OU1 Site 10 (Ordnance Munitions Disposal Area), FFAAP Unit 327.03 (Drum Storage Area), FFAAP Unit 9005.00 (Transformer Storage Yard), and FFAAP Unit F808.00 (Former Pesticide Control Shop). Appendix A contains further information on all of the sites.

2. The findings of this PHA have been reviewed by the other Divisions of ATSDR to determine if any follow-up activities are recommended for MCAS Yuma. No follow-up activities were recommended.

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PUBLIC HEALTH ASSESSMENT

MARINE CORPS AIR STATION YUMA
YUMA, ARIZONA

TABLES

TABLE 1
POPULATION DATA TABLE

CITY OF YUMA (1990)	
Total persons	54,923
Total area (square miles)	21.86
Persons per square mile	2,512
% Male	49.4
% Female	50.6
% White	73.0
% Black	3.8
% American Indian, Eskimo, or Aleut	1.1
% Asian or Pacific Islander	1.7
% Other races	20.4
% Hispanic origin	35.6
% Under age 10	18.7
% Age 65 and older	12.0

Source: Census, 1991.

TABLE 2
HOUSING DATA TABLE

CITY OF YUMA (1990)

Households[(1)]	19,282
Persons per household	2.80
% Households owner-occupied	58.5
% Households renter-occupied	41.5
% Households mobile homes	12.7
% Persons in group quarters	1.6
Median value, owner-occupied households (dollars)	65,400
Median rent paid, renter-occupied households (dollars)	375

Source: Census, 1991.

FIGURES

Figure 1. Location Map of MCAS Yuma and Surrounding Area

Figure 2. Station Map of MCAS Yuma

Figure 3. ATSDR's Exposure Evaluation Process

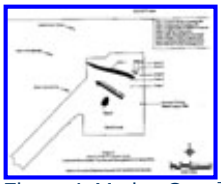


Figure 4. Marine Corps Air Station Yuma Impacted Groundwater Plumes and Downgradient Drinking Wells

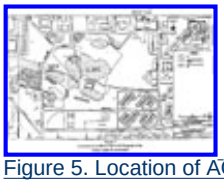


Figure 5. Location of ACM at Radar Hill Disposal Area

Appendix A: Evaluation of Potential Public Health Hazards Associated With Marine Corps Air Station Yuma

The following section was not available in electronic format for conversion to HTML at the time of preparation of this document. To obtain a hard copy of the document, please contact:

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Attn: Chief, Program Evaluation, Records, and Information Services Branch
E-56
1600 Clifton Road NE, Atlanta, Georgia 30333

Appendix B: Comparison Values

The conclusion that a contaminant exceeds the comparison value does not mean that it will cause adverse health effects. Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects.

Cancer Risk Evaluation Guides (CREGs)

Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span. ATSDR's CREGs are calculated from EPA's cancer potency factors.

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) and factors in body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Maximum Contaminant Level (MCL)

The *MCL*is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet. *MCLs*are considered protective of human health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Reference Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses. The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

Appendix C: Glossary

Asbestos-containing material (ACM)
Material, usually involved in construction, which contains asbestos, a known carcinogen. The asbestos fibers in *ACM* are often imbedded in the material and, therefore, exposure to *ACM* is sometimes less of a hazard than direct exposure to asbestos fibers.

Background level
A typical or average level of a chemical in the environment. *Background* often refers to naturally occurring or uncontaminated levels.

Carcinogen
Any substance that may produce cancer.

CERCLA
The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund. This is the legislation that created ATSDR.

Comparison Values (CVs)
Estimated contaminant concentrations in specific media that are not likely to cause adverse health effects, given a standard daily ingestion rate

and standard body weight. The *CVs* are calculated from the scientific literature available on exposure and health effects.

Concentration
The amount of one substance dissolved or contained in a given amount of another. For example, sea water contains a higher concentration of salt than fresh water.

Contaminant
Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

Dermal
Referring to the skin. *Dermal* absorption means absorption through the skin.

Dose
The amount of substance to which a person is exposed. Dose often takes body weight into account.

Exposure
Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). *Exposure* may be short term (acute) or long term (chronic).

Hazard
A source of risk that does not necessarily imply potential for occurrence. A hazard produces risk only if an exposure pathway exists and if exposures create the possibility of adverse consequences.

Indeterminate public health hazard
The designation given to sites for which no conclusions about public health hazards can be made because data are lacking.

Ingestion
Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands where they can be ingested. After *ingestion*, chemicals can be absorbed into the blood and distributed throughout the body.

Inhalation
Breathing. Exposure may occur from inhaling contaminants because they can be deposited in the lungs, taken into the blood, or both.

Media
Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Minimal Risk Level (MRL)
An *MRL* is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. *MRLs* are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effects(s) for a specific duration via a given route of exposure. *MRLs* are based on noncancer health effects only. *MRLs* can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

National Priorities List (NPL)
The Environmental Protection Agency (EPA) list of sites that have undergone preliminary assessment and site inspection to determine which locations pose immediate threat to persons living or working near the release. These sites are most in need of cleanup.

No Apparent Public Health Hazard
Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

Plume
An area of chemicals in a particular medium, such as air or groundwater, moving away from its source in a long band or column. A *plume* can be a column of smoke from a chimney or chemicals moving with groundwater.

Public Health Assessment (PHA)
The evaluation of data and information on the release of hazardous substances into the environment in order to assess any current or future impact on public health, develop health advisories or other recommendations, and identify studies or action needed to evaluate and mitigate or prevent human health effects; also the document resulting from that evaluation.

Public Health Hazard
Sites that pose a public health hazard as the result of long-term exposures to hazardous substances.

Risk
In risk assessment, the probability that something will cause injury, combined with the potential severity of that injury.

Volatile organic compounds (VOCs)
Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen; these substances easily become vapors or gases. A significant number of the *VOCs* are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry-cleaning fluids).

Appendix D: Responses to Public Comments

ATSDR distributed copies of the public comment release of the Marine Corps Air Station Yuma Public Health Assessment (PHA). The comment period lasted between June 8, 1998 and July 19, 1998. The following are the comments received by ATSDR and ATSDR's responses.

1. **Comment:** *Page 5 UST Program*

Currently in the State of Arizona, MTBE in the groundwater is not a concern. There are no remedial alternatives being considered to remediate MTBE.

Response: MTBE levels in groundwater at MCAS Yuma do not pose a public health hazard and no one has been, is currently, or likely will be in the future exposed to the MTBE plumes in the groundwater at MCAS Yuma. Therefore, ATSDR has removed references to MTBE contamination in the groundwater at MCAS Yuma.

2. **Comment:** *Page 13 Conclusions*

I do not agree with Conclusion #4.

During the OU2 Remedial Investigation, this area was sampled and did not suggest that there were any tear gas crystals buried in that area. In addition to the sampling, that area is highly disturbed due to the building of the CALA. The comment that tear gas crystals were buried in the area is questionable and if tear gas crystals were to be buried, it would have been done by an individual, who would have used his shovel and dug to a depth of only a few feet below ground surface.

Response: ATSDR has further clarified statements in the PHA on the issue of the reported tear gas disposal. Although the reports of tear gas disposal could not be verified, ATSDR still feels that some precautionary measures should be taken for future excavations at this site.

3. **Comment:** *Page 12 Past Exposure*

The area in which high levels of organic lead were found are currently used as contractor storage yards. These yards mainly contain construction materials and some vehicles. Personnel do not work in these areas 8 hours per day, 5 days per week. Any exposure to organic lead should not be considered as chronic exposure. This area has been used as contractor storage yards for at least the last 10 years. Prior to that, this area was used as shops area. The area in question has not been used as a barracks area. Military personnel who worked in that area would not have been assigned to MCAS Yuma for more than three years. Considering that the areas of contamination are outdoors and the personnel who worked in the area were not assigned to the base for a significant period of time, I would assume that any exposure to tetraethyl lead would have been minimal and would not affect their health.

Page 13 Conclusions

I do not agree with ATSDR with Conclusion #6.

ATSDR identified the presence of organic lead at three sites, CAOCs 1, 2, and 7, as a concern. They go on to say that since these areas are isolated and paved (or covered with sealant), or have restricted access, they do not pose a current or future public health hazard. [The commentor] agrees.

ATSDR goes on to say they do not have sufficient information to evaluate the past exposures to organic lead, so they classify these sites as an indeterminate public health hazard and recommend further investigation regarding the organic lead. [The commentor] does not agree with this assessment.

Based on [the commentor's] review of historical aerial photographs and station records, the portion of CAOC 1 where the organic lead was found has always been associated with flight operations and appears to have been always paved. Thus, past exposure to organic lead in soil at this location is minimal. Any increased exposure to organic lead, or other contaminants, in this area were likely due to the daily maintenance operations that occurred.

At CAOC 7, the organic lead hits were found at former Fire Training Pit (FTP) 15 located to the north of the CALA. This FTP was apparently used during the 1970s for fire and crash training. The FTP is currently covered with a sealant for dust control, and appears to have been covered since the early 1980s. This FTP appears to have been in use for a limited period of time, and has been covered with the sealant since the early 1980s. Thus, exposure to organic lead at this location since use of this FTP was terminated is minimal. During operations, exposure to the burning of flammables during fire training exercises was likely to be more significant than the presence of organic lead in the soil.

At CAOC 2, this site has been used for vehicle maintenance and public works from the 1940s to the early 1980s. The OU2 RI investigated areas of reported spills and ground disposal of chemicals, which reportedly occurred until the early 1980s. Of the areas investigated, only one hit of organic lead was detected. If this hit of organic lead was related to past spills and/or disposal activities, the impacted area appears small so exposure to the contaminated soil was likely minimal. In addition, this area was used for industrial activities, so it is unlikely that any station personnel would be in this area for more than a normal work schedule. Also, the nearby base dormitories and Enlisted Dining Facilities were constructed after the early 1980s so occupants of these buildings would have minimal exposure to past spills or disposals. Since the area where the organic lead hit was found has been used as a vehicle parking area for at least the past 5 years, it is likely that the presence of organic lead came from parked vehicles and does not represent a significant past exposure pathway.

Response: ATSDR has further clarified statements in the PHA on the issue of past exposure to organic lead.

The very high levels of organic lead found at some locations, while not a current or future concern, do raise questions about potential exposures in the past. The current high levels of tetraethyl lead degradation products suggest the possibility that high levels of tetraethyl lead may have been present in the past. Past exposure at the Flight Line CAOC 1 (the Flight Line) was quite limited. Although, as the commentor states, past exposures at the Fire School Area CAOC 7 (the Fire School Area) and CAOC 2 (the Shops Area) may have also been quite limited, ATSDR does not have sufficient information to evaluate potential past exposures to organic lead at these areas.

ATSDR agrees with the commentor that exposure to organic lead in the past at CAOC 1 is not a public health hazard. ATSDR still believes, however, that past exposures at CAOC 7 and CAOC 2 pose an indeterminate public health hazard.

4. **Comment:** Page 15 Organic Lead in Surface Soil

   I do not agree with the ATSDR recommendation that the Navy further investigate the soil contaminated with organic lead.

   As the Public Health Assessment states, it does not present a present or future health risk. Any exposure in the past would have been incidental and would not pose a health risk. The Navy has spent several millions of dollars in investigating soil contamination at MCAS Yuma. The area in question was included in CERCLA Area of Concern #2. This area was recommended for no further action because the threat of exposure to chemicals which would cause cancer was less than one in one million and the non-cancer threat was less than one. The recommendation was agreed upon by the State of Arizona, the Environmental Protection Agency, and the U.S. Navy. It does not seem practical to spend more money to verify what the Public Health Assessment and the OU2 Record of Decision state.

   Response: ATSDR's recommendations have been modified as suggested by the commentor. However, if the restricted access and use of this area changes in the future, ATSDR still recommends further characterization of soil contaminated by organic lead.

1. A household is an occupied housing unit, but does not include group quarters such as military barracks, prisons, and college dormitories.

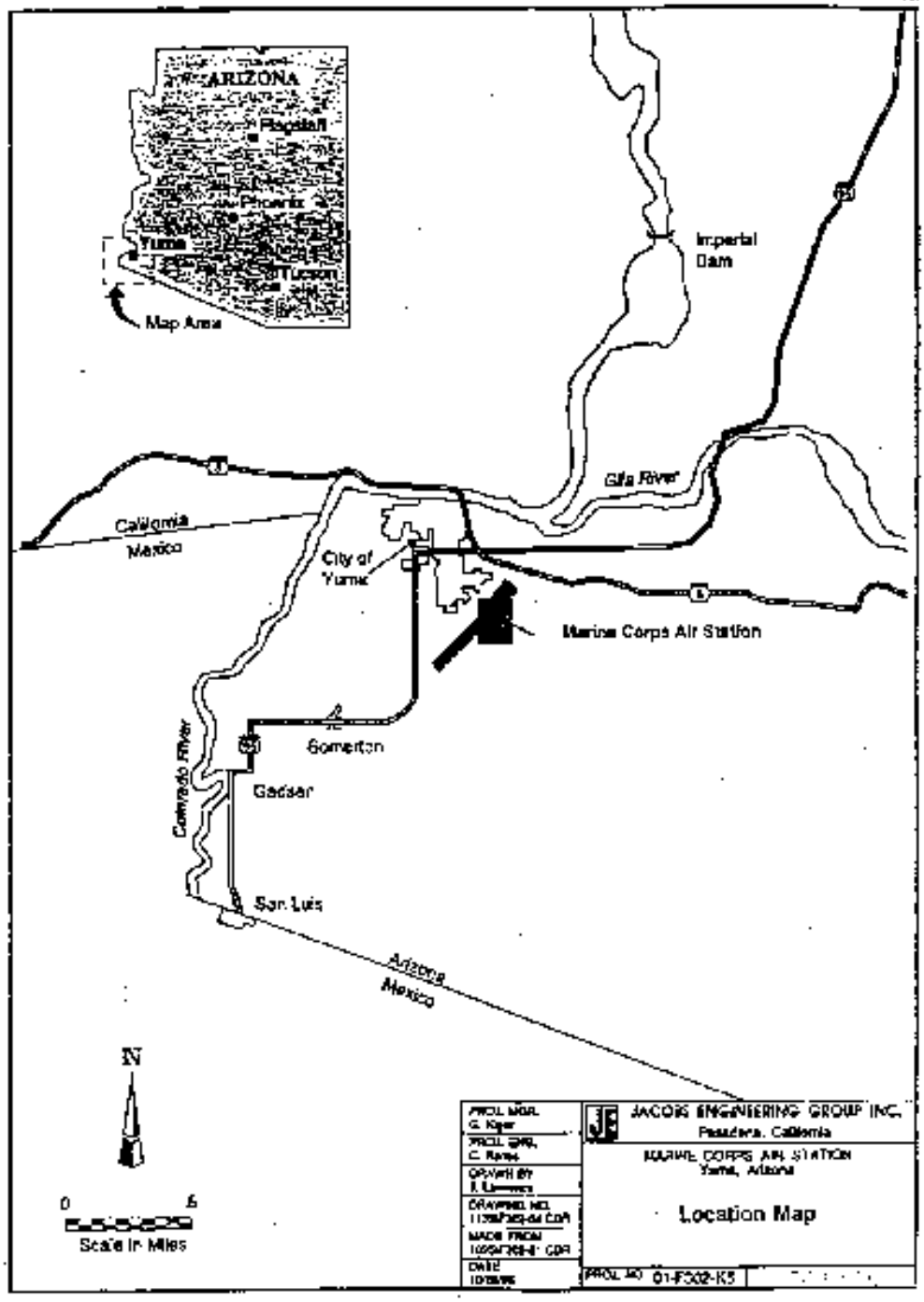


Figure 1
Location Map of MCAS Yuma and Surrounding Area
From: Jacobs Engineering Group

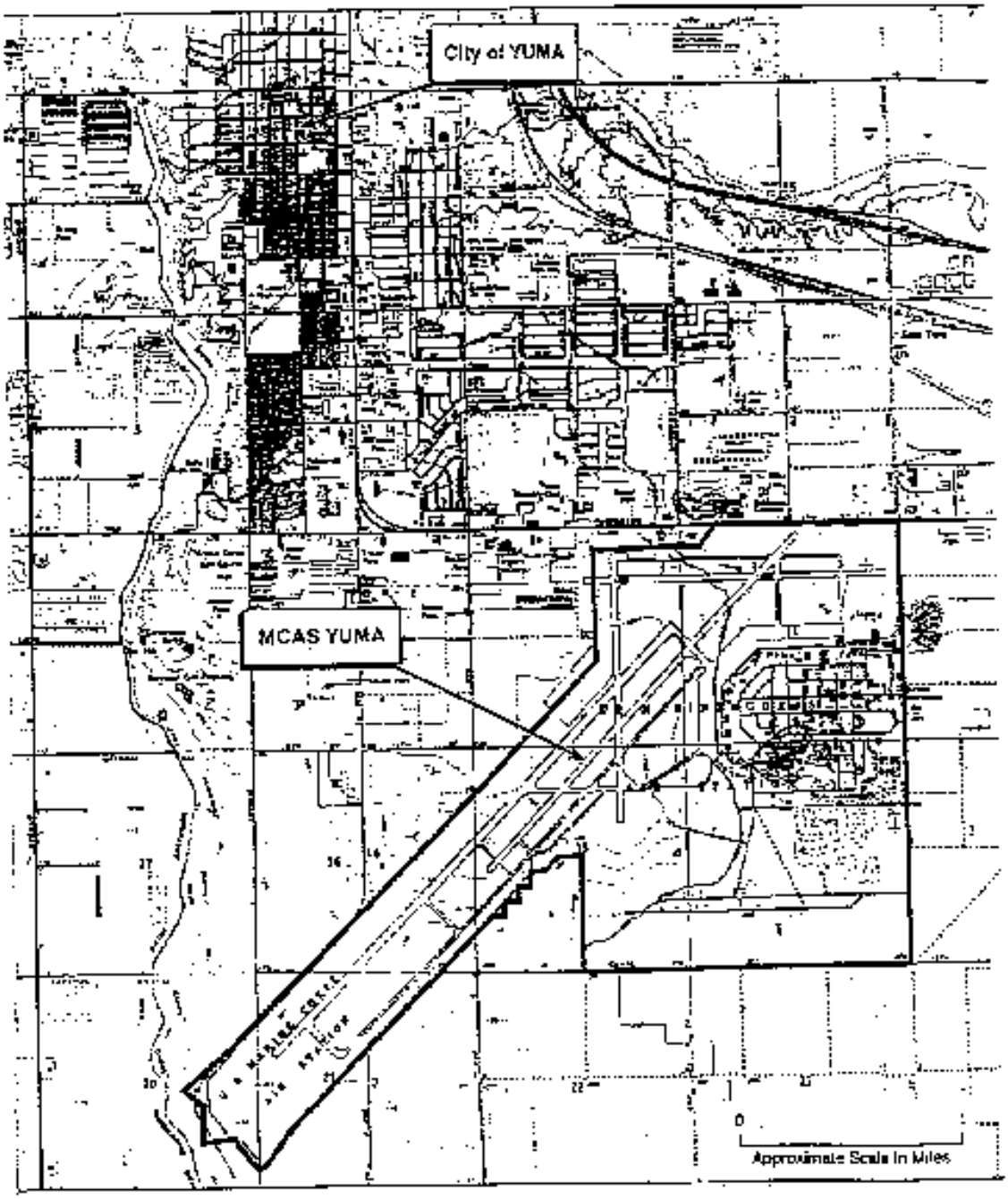


Figure 2
Station Map of MCAS Yuma
Adapted from: Uribe & Associates

FIGURE 3

ATSDR's Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

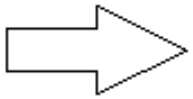
- People must come into contact with areas that have potential contamination
- Contaminants must exist in the environment
- The amount of contamination must be sufficient to affect people's health

Are People Exposed To Areas With Potentially Contaminated Media?

For exposure to occur, contaminants must be in locations where people can contact them.

People may contact contaminants by any of the following three exposure routes:

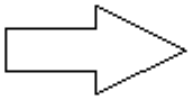
Inhalation
Ingestion
Dermal absorption



Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources



For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?

ATSDR will evaluate existing data on contaminant concentration and exposure duration and frequency.

ATSDR will also consider individual characteristics (such as age, gender, and lifestyle) of the exposed population that may influence the public health effects of contamination.

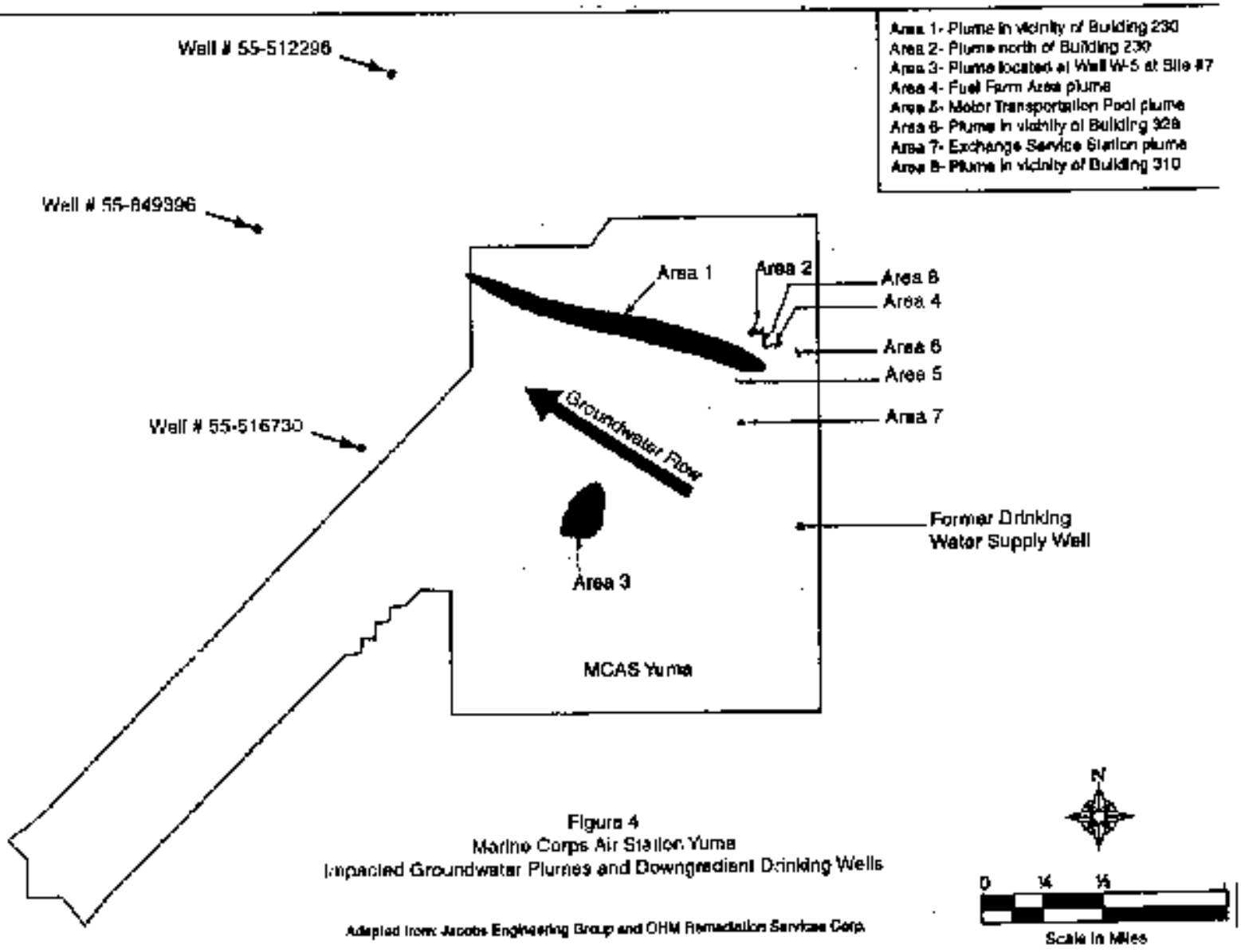


Figure 4
Marine Corps Air Station Yuma
Impacted Groundwater Plumes and Downgradient Drinking Wells

Adapted from: Jacobs Engineering Group and OHM Remediation Services Corp.

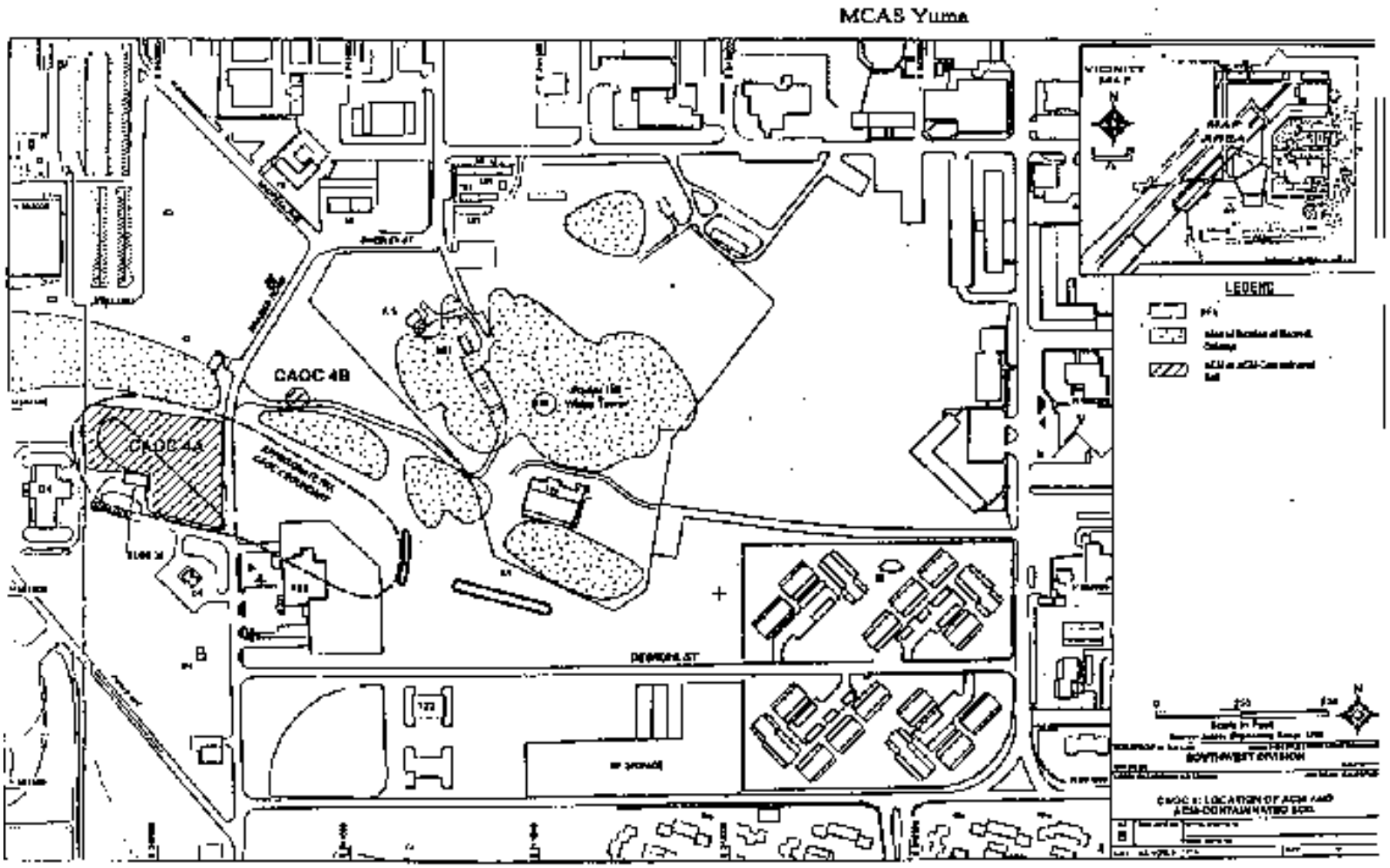


Figure 5
Location of ACM at Radar Hill Disposal Area
From: Uribe & Associates