United States
Environmental Protection
Agency

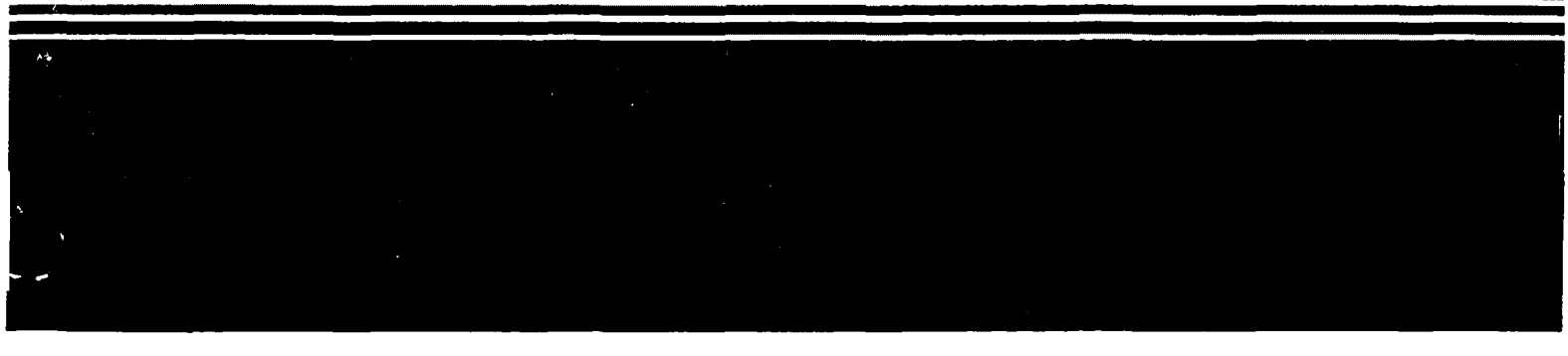
Office of
Emergency and
Remedial Response

EPA/ROD/R09-88/021
August 1988

EPA

Superfund Record of Decision:

Tucson International Airport Aera, AZ



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SUPERFUND RECORD OF DECISION
Tucson International Airport Area, AZ
First Remedial Action

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16. Abstract (Limit: 200 words)

The Tucson International Airport Area (TAA) site encompasses sections of southwest Tucson and adjoining lands south of the city in Pima County, Arizona. The site is located in the Tucson Basin and includes industrial, commercial, residential, and undeveloped areas, as well as the Tucson International Airport, the U.S. Air Force Plant #44 (AFP44), and part of the San Xavier Indian Reservation. The Santa Cruz River borders the site to the west. The ground water system in the Tucson Basin has been designated a Sole-Source Aquifer. Before the discovery of ground water contamination in the TAA, wells within the site boundaries provided water for over 47,000 people. At least 20 facilities have operated in the TAA since 1942. These include aircraft and electronics facilities, which discharged waste liquids directly to surface soil; fire drill training areas, where uncombusted residual wastes from training operations were left in unlined pits; and unlined landfills, which received various wastes from several sources. The first indications of ground water contamination in TAA appeared in the early 1950s when elevated levels of chromium were detected in a municipal supply well adjacent to AFP44 in the southern portion of the site, and residents in another area complained of foul-smelling water from private supply wells. In 1976, a well was closed at AFP44 by the State because of high levels of chromium. By 1981, additional sampling
(See Attached Sheet)

17. Document Analysis a. Descriptors
Record of Decision
Tucson International Airport Area, AZ
First Remedial Action
Contaminated Media: gw
Key Contaminants: VOCs (benzene, TCE, xylens)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

Availability Statement	19. Security Class (This Report) None	21. No. of Pages 36
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EPA/ROD/R09-88/021
Tucson International Airport Area, AZ
First Remedial Action

16. ABSTRACT (continued)

by the Air Force and EPA had indicated the presence of VOCs in the ground water. Consequently, in 1981, the City of Tucson began closing all municipal wells that exceeded the State Action Level for the principle contaminant TCE, and notified private well users of potential risks. The site was divided approximately in half along Los Reales Road, with the Air Force addressing contamination to the south and EPA addressing contamination to the north. In 1987, the Air Force began operating its ground water pump and treatment system using ion exchange and packed column aeration followed by reinjection into the aquifer. This ROD addresses the ground water contamination in the northern portion of the site, which together with the Air Force remedial ground water system constitutes the overall ground water remedy for the site. The northern portion of the site has been divided into two discrete areas, A and B. Area A lies west of the airport and extends approximately 3.5 miles to the northwest in the direction of ground water flow, and is generally less than a mile wide. Area B consists of two smaller separate areas north of the airport. If further investigations indicate that there is soil contamination and that it is a source of continuing ground water contamination, a ROD will be developed to address soil remediation. The primary contaminants of concern affecting ground water are VOCs including TCE, benzene, and xylenes.

The selected remedial action for this site includes: ground water pump and treatment of Areas A and B using packed column aeration, followed by discharge of treated water to the municipal water distribution system and treatment of emissions from the treatment process using granular activated carbon, if necessary. The estimated present worth cost for this remedial action is between $7,328,000 and $7,820,000 with annual O&M between $393,000 and $450,000 for years 1-20.

Tucson International Airport Area

R E C O R D O F D E C I S I O N

for

G R O U N D W A T E R R E M E D I A T I O N

North of Los Reales Road

United States Environmental Protection Agency
Region IX -- San Francisco, California
August 1988

RECORD OF DECISION

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RECORD OF DECISION

DECLARATION

SITE NAME AND LOCATION

Tucson International Airport Area
Tucson, Arizona

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected groundwater remedial action for the portion of the Tucson International Airport Area Site that lies north of Los Reales Road. The remedial action has been developed in accordance with the Comprehensive Environmental Response, Liability, and Compensation Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based upon the administrative record for this site. The attached index identifies the items which comprise the administrative record upon which the selection of the remedial action is based.

The State of Arizona concurs on the selected remedy.

DESCRIPTION OF THE REMEDY

This remedial action is the second to be taken at the site. As of April 1987, the United States Air Force has been extracting and treating groundwater in the southern portion of the site. The remedial action presented herein is the groundwater remedy for the areas ("Area A" and "Area B") of the site not currently addressed by the Air Force's action. This action and the Air Force action together constitute the overall groundwater remedy for the site. Further investigation of potentially contaminated soils on the site and any resulting decision on remedial action(s) for soils is anticipated at a later date.

The selected groundwater remedy for Area A includes control of groundwater contamination through segregation of the upper and lower divided aquifers and through extraction from both the upper divided aquifer and the regional undivided aquifer (all north of Los Reales Road). The treatment method will be packed column aeration. The goal is to treat extracted groundwater to an overall excess cancer risk level (for all contaminants combined) of 10^{-6}, which will require treatment to a TCE concentration of approximately 1.5 parts per billion (ppb). Where airborne emissions of volatile organic compounds (VOCs) from new packed column facilities have the potential to exceed 2.4 pounds per day,

reasonably available control technology (RACT) for the reduction of air emissions will be proposed. (RACT in this case may consist of vapor phase granular activated carbon.) Treated water will be fed directly into the municipal water distribution system. If any groundwater is treated at the nearby United States Air Force facility (AFP44), however, this water may be used for groundwater recharge rather than supplied to the municipal system.

For Area B, groundwater will be extracted from the upper aquifer and treated to an overall excess cancer risk level of 10^{-6}. Packed column aeration will be used unless further information indicates that another treatment strategy is more cost-effective or would be more easily implemented while still offering the same level of protection of human health and the environment and while still complying with all ARARs. The low levels of contamination in Area B indicate that no emission controls should be needed on the packed column(s).

The remedies for Area A and Area B are expected to be in operation for approximately 20 years. Over this period, at least two pore volumes of groundwater will be withdrawn from the aquifer. Groundwater monitoring will also continue.

DECLARATION

The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective. With respect to contamination in groundwater, the remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The statutory preference is not completely satisfied with respect to contamination in the air in that the selected treatment method involves transferral of contamination from water into the air. However, the remedy still reduces the overall risk to human health. As part of the remedy, groundwater monitoring at regular intervals will ensure that the remedy continues to provide adequate protection of human health and the environment.

Daniel W. McGovern
Regional Administrator

8 22 88
Date

RECORD OF DECISION

DECISION SUMMARY

1.0 SITE LOCATION AND DESCRIPTION

The Tucson International Airport Area is located in Pima County, in southeastern Arizona (Figure 1). It encompasses sections of southwest Tucson, as well as adjoining lands south of the city. The site includes industrial, commercial, residential and undeveloped areas. Specifically included are the Tucson International Airport, the United States Air Force Plant #44 (AFP44) and part of the San Xavier Indian Reservation. As shown in Figure 2, the approximate site boundaries are the Santa Cruz River on the west, Ajo Way on the north, Alvernon Way on the east, and the Hughes Access Road south of AFP44 on the south.

The Tucson International Airport Area (TAA)* is located in the Tucson Basin, an alluvial valley bounded by rugged mountain ranges. The basin is bounded on the east and north by the Santa Rita, Empire, Rincon, Tanque Verde, Santa Catalina and Tucson Mountains and on the west by the Sierrita, Black and Tucson Mountains. The mountains on the east and north generally rise to altitudes of 6,000 to 8,000 feet; the mountains to the west reach 3,000 to 6,000 feet. The area is drained to the northwest by the Santa Cruz River and its major tributaries. The Santa Cruz stream system has formed a plain that slopes gently from an elevation of 2,900 feet in the south to approximately 2,000 feet in the northwest. The 50-mile long basin is 15 to 20 miles wide at its southern end and thins to about 4 miles wide at its outlet.

The subsurface beneath the TAA primarily consists of basin-fill deposits (gravels, sandy-gravels, sands, clays, sandy-clays, and clayey-sands). These deposits form two major aquifer zones beneath the TAA: the regional divided aquifer and the regional undivided aquifer. The regional divided aquifer consists of the unconfined "upper aquifer" and the semi-confined "lower aquifer", which are separated by clayey deposits classified as an aquitard. The aquitard pinches out to the northwest beneath the site, resulting in the regional undivided aquifer. The aquifer system is shown in a simplified representation in Figure 3. Groundwater flow beneath the site is generally to the northwest at about 350 to 710 feet per year. (Hydraulic conductivity values in the area range from about 3 to 2,000 gpd/ft^2.) There are also limited areas where groundwater is perched upon clay deposits above the upper aquifer table.

* In the Feasibility Study, "TAA" refers to a study area whose southern boundary is Los Reales Road. In this record of decision, however, "TAA" refers to the entire Superfund site.

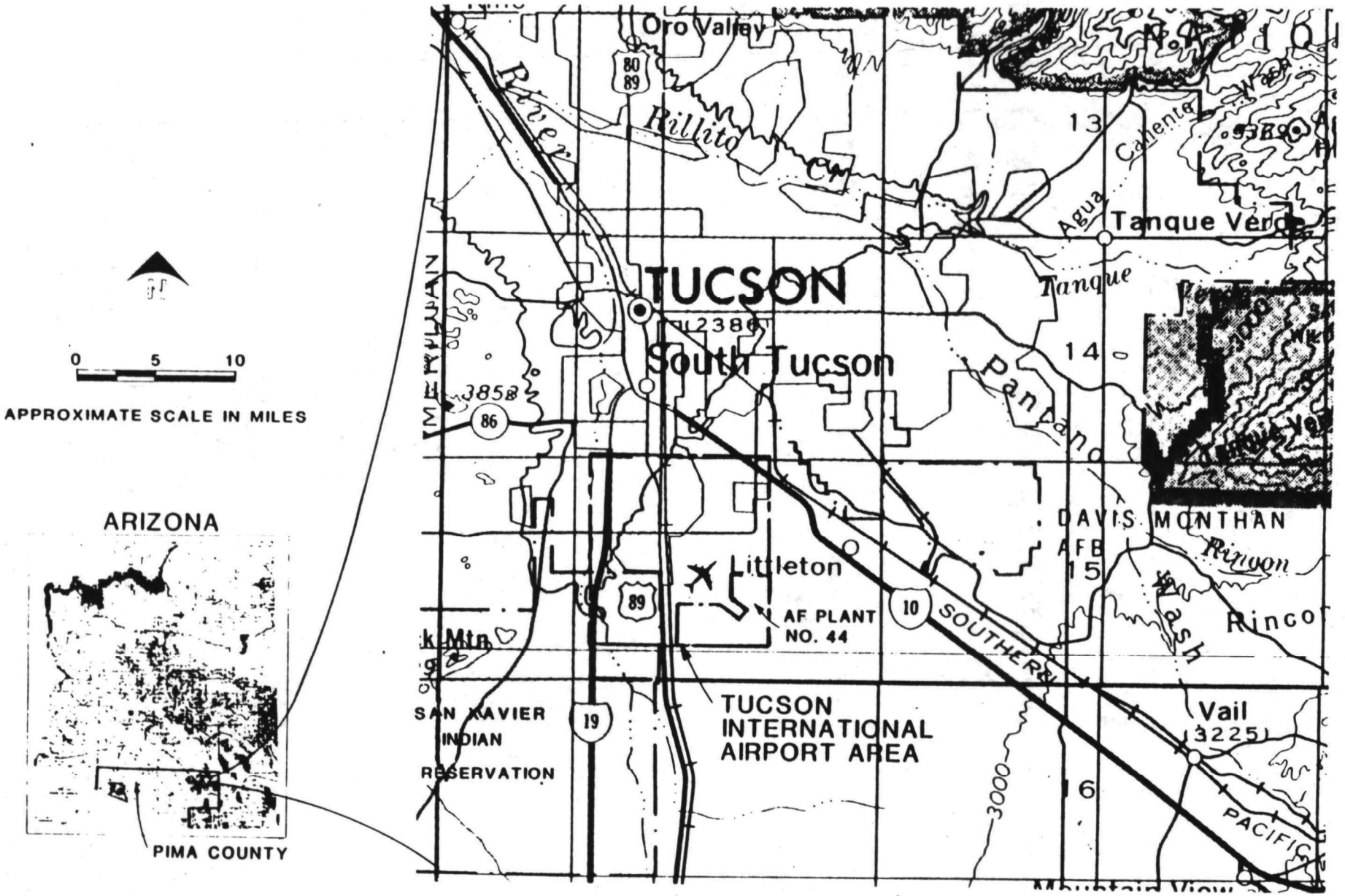
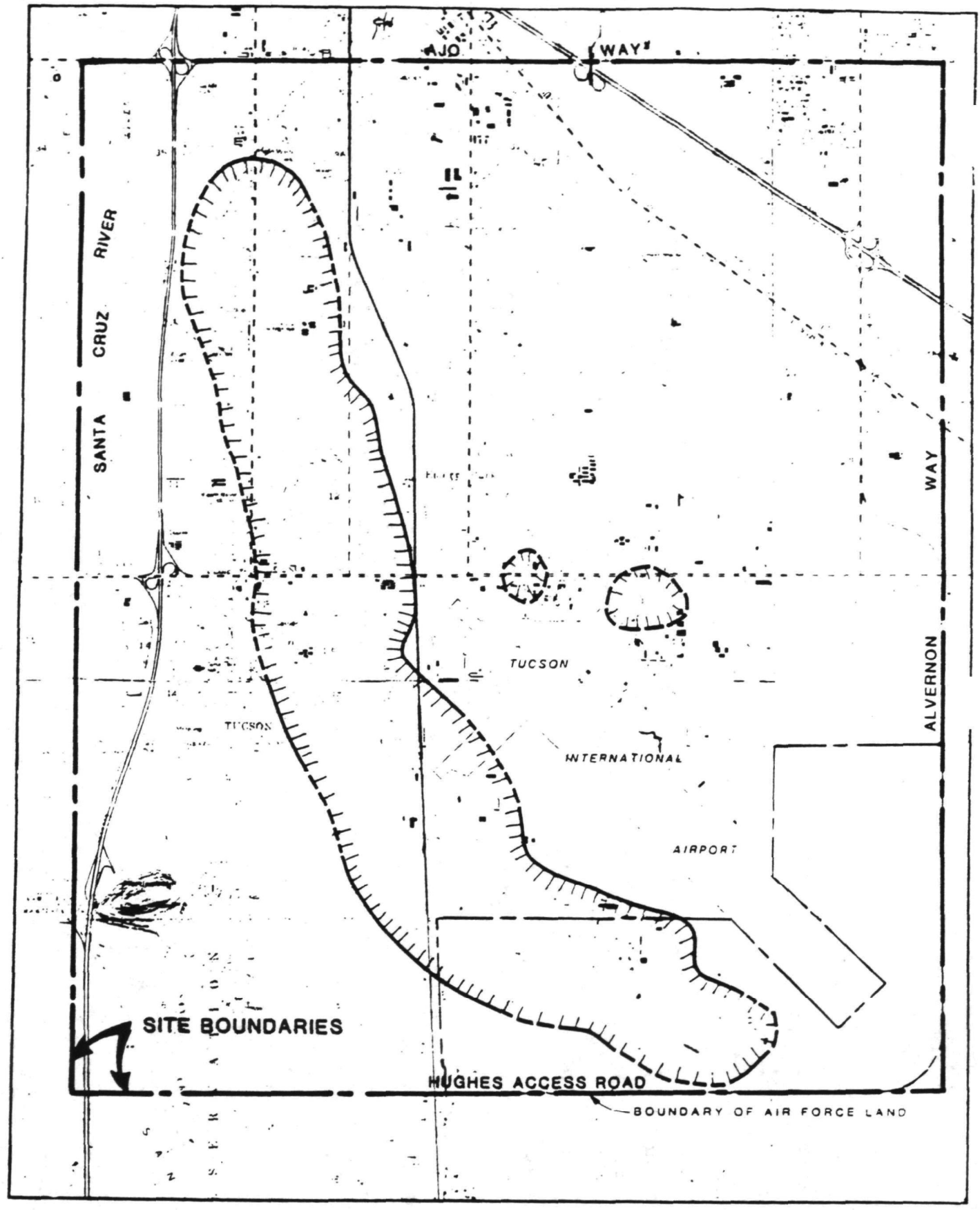


FIGURE 1
REGIONAL LOCATION MAP
TUCSON INTERNATIONAL AIRPORT AREA
RECORD OF DECISION



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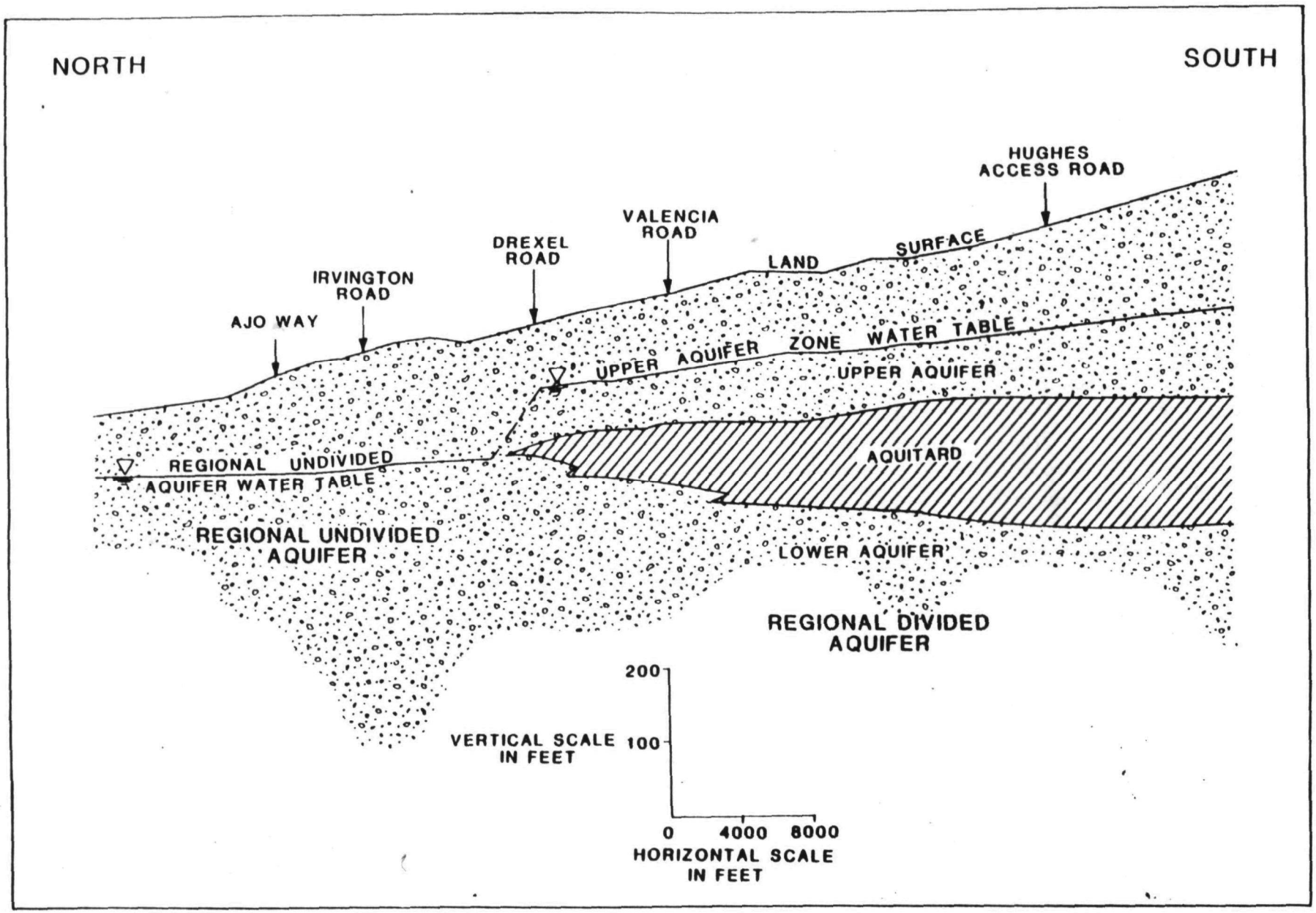
MILES

EXPLANATION:

APPROXIMATE LIMITS OF TCE CONTAMINATION DURING 1984 (DASHED WHERE UNKNOWN OR INFERRED)

FIGURE 2
TUCSON INTERNATIONAL AIRPORT AREA SITE
TUCSON INTERNATIONAL AIRPORT AREA RECORD OF DECISION



NOTE: GENERALIZED FROM ARIZONA DEPARTMENT OF WATER RESOURCES (1985)

FIGURE 3
SUBSURFACE HYDROGEOLOGY
TUCSON INTERNATIONAL A ORT AREA
RECORD OF DECISION

Flowing surface water occurs only intermittently in the TAA. Most of the year, in the absence of major rainstorms, the Santa Cruz River and its major tributaries run dry. Therefore, the city of Tucson relies solely upon the aquifers of the Tucson Basin for its drinking water, resulting in the designation of the basin's groundwater system as a Sole Source Aquifer under the federal Safe Drinking Water Act. Before the discovery of contaminated groundwater in the TAA, wells within the site boundaries provided water for about 47,000 people.

2.0 SITE HISTORY

Waste-related activities in the TAA are believed to have begun sometime after the start of airplane refitting operations in 1942 at the location of what is now the Tucson Aviation Center. Since then, at least 20 facilities potentially capable of releasing hazardous materials have operated in the TAA:

- -- Aircraft manufacturing, maintenance and reworking facilities,
- -- Electronics components manufacturing and assembly facilities,
- -- Fire drill training areas, and
- -- Landfills.

Waste disposal at several of the aircraft and electronics facilities consisted of surface discharge of waste liquids to soils on-site. Liquid waste run-off ponded in drainage areas, providing the driving force for contaminants to infiltrate into the underlying groundwater. At fire drill training areas, flammable wastes, including solvents and fuels, were ignited in unlined fuel pits and doused with large quantities of water. Water and uncombusted wastes were then able to migrate to the underlying saturated zone. The on-site unlined landfills received various wastes from several sources, including facility operators and tenants. Figure 4 indicates the source areas that have been identified within the TAA.

First indications of groundwater contamination in the TAA date back to at least the early 1950's. In 1952, samples from a municipal supply well adjacent to AFP44 indicated elevated levels of chromium. At about the same time, residents near what is now the Tucson Aviation Center complained of foul smelling water from private supply wells. The residents brought suit against the city of Tucson and the Grand Central Aircraft Company, the operator of an aircraft refitting facility at that time. The suit was dismissed when the city offered the residents access to the city water system.

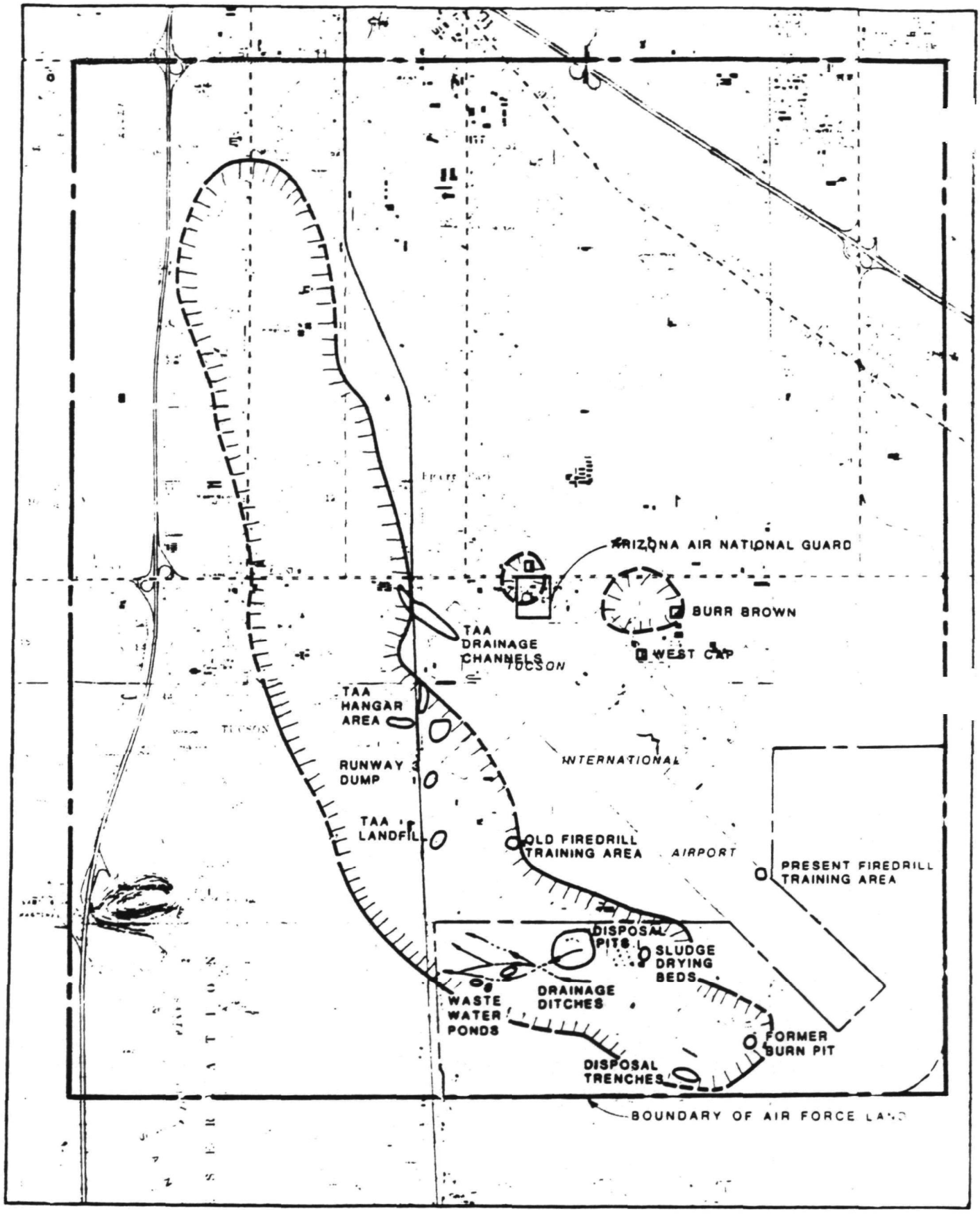


FIGURE 4
POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION
TUCSON INTERNATIONAL AIRPORT AREA
RECORD OF DECISION

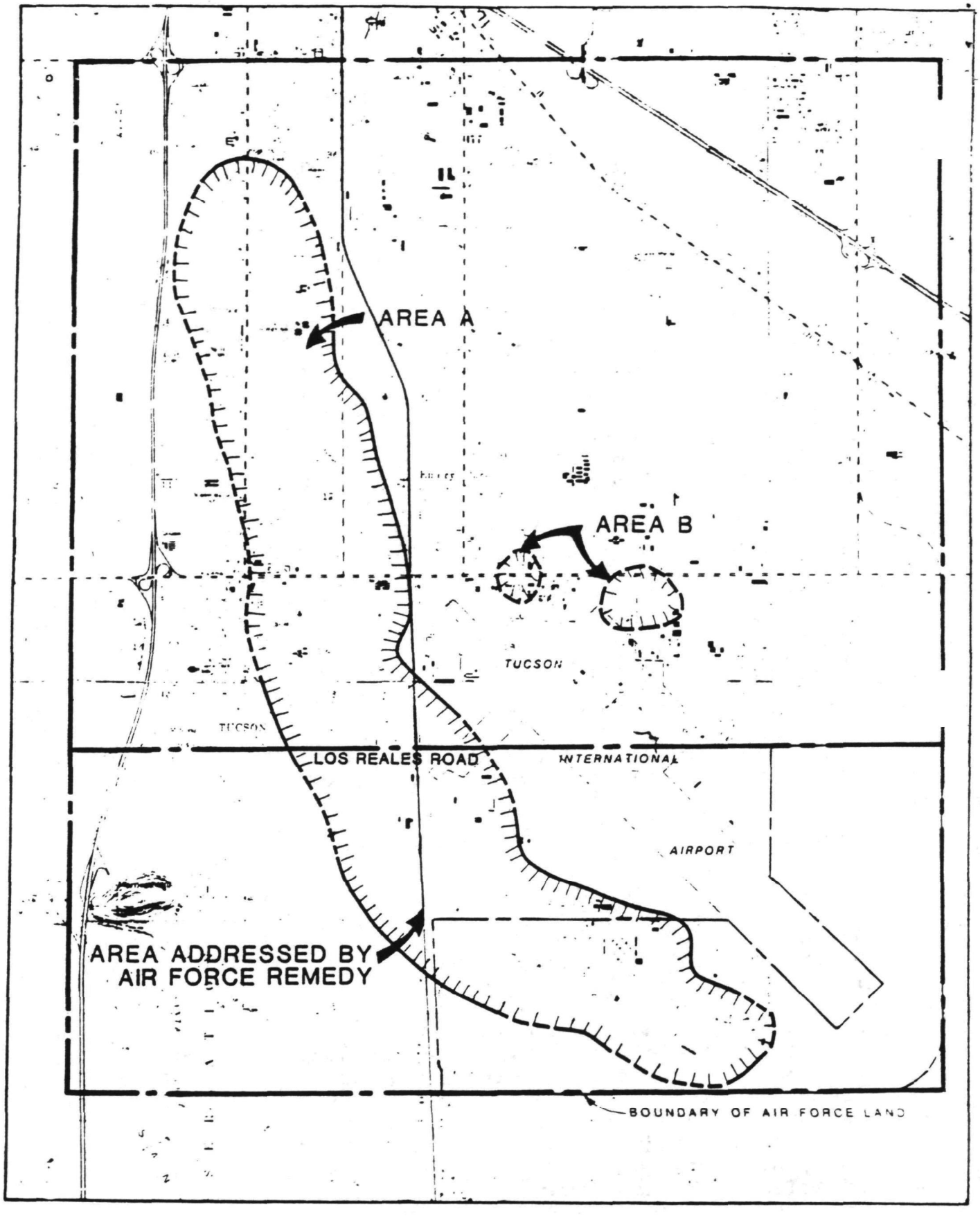
The next indication of groundwater contamination occurred around 1976, when a well at AFP44 was closed by the state because of high levels of chromium. By 1981, further sampling by the Air Force and its contractor, Hughes Aircraft Company, verified high levels of contamination beneath the facility. The sampling at AFP44 and other sampling north of the facility conducted under the direction of the United States Environmental Protection Agency (EPA) indicated the presence of volatile organic contaminants including 1,1,1-trichloroethylene (TCE), 1-1-dichloroethylene (1,1-DCE), 1,1,1-trichloroethane (TCA), chloroform, benzene and xylene. The presence of chromium, mostly in hexavalent form, was also confirmed.

The Tucson International Airport Area was listed on the "Expanded Eligibility List", a preliminary National Priorities List (NPL), on July 23, 1982. It was proposed for inclusion on the original NPL on December 30, 1982, attaining final NPL status on September 8, 1983.

The Air Force continued its investigation of the contamination at AFP44 under the Department of Defense Installation Restoration Program (IRP). Investigations north of AFP44 were carried out by EPA, with the cooperation of the state of Arizona, the city of Tucson and Pima County. As the two investigations continued, there were attempts among the parties to negotiate a Memorandum of Agreement that would formalize roles and responsibilities. These efforts, however, never resulted in a signed agreement. Therefore, the parties decided that the site would be divided -- for purposes of study -- at Los Reales Road, with the Air Force addressing contamination south of the road and EPA studying the area north of the road (Figure 5).

The Air Force Remedial Action Plan (RAP) for the area south of Los Reales Road was released in April 1986. During 1987, the Air Force began operation of its groundwater reclamation system, which extracts groundwater, treats it for removal of hexavalent chromium (ion exchange) and volatile chemicals (packed column aeration with partial control of emissions using vapor phase granular activated carbon), and injects the treated water back into the aquifer.

In 1985, under a Cooperative Agreement with EPA, the Arizona Department of Health Services (ADHS) completed the Remedial Investigation (RI) for the area north of Los Reales Road. Under a second Cooperative Agreement, the Arizona Department of Water Resources (ADWR) conducted the Feasibility Study (FS). Management and technical committees with representatives from EPA, ADWR, ADHS and Tucson Water, the municipal water purveyor, were established to coordinate, review and monitor project activities. On March 3, 1988, the draft "Feasibility Study for Ground Water Remediation in the Tucson Airport Area" was released for public review and comment.



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MILES

EXPLANATION:

APPROXIMATE LIMITS OF TCE CONTAMINATION DURING 1984 (DASHED WHERE UNKNOWN OR INFERRED)

FIGURE 5
AREAS OF GROUNDWATER REMEDIATION WITHIN THE TUCSON INTERNATIONAL AIRPORT AREA
TUCSON INTERNATIONAL AIRPORT AREA
RECORD OF DECISION

Hughes Aircraft has applied for a final RCRA operating permit for its operations at AFP44 pursuant to the Resource Conservation and Recovery Act (RCRA). Hughes has a long RCRA history, with several inspections by EPA and the state of Arizona that have identified instances of noncompliance with regulations. Alleged violations of environmental statutes at the facility are the subject of continuing investigations.

3.0 ENFORCEMENT

During August and September, 1987, EPA sent General Notice Letters to the nine potentially responsible parties (PRPs) listed below, officially notifying them of their potential liability for the groundwater remedy north of Los Reales Road.

-- Hughes Aircraft Company
-- U.S. Air Force
-- City of Tucson
-- Tucson Airport Authority
-- McDonnell Douglas Corporation
-- General Dynamics Corporation
-- Arizona Air National Guard
-- Burr-Brown Research Corporation
-- West-Cap Arizona

EPA held an informational meeting for the PRPs in December 1987. EPA and the state of Arizona also presented a briefing on the Feasibility Study for technical representatives of the noticed parties. The PRPs have been meeting among themselves for the past several months, although initially not all parties were attending meetings regularly. Attempts by some of the parties to develop a PRP "steering committee" have not been successful.

Special Notice Letters were mailed to the General Notice Letter recipients on July 6, 1988. The 60-day negotiations moratorium that is triggered by Special Notice Letters officially began on July 11th.

4.0 COMMUNITY RELATIONS

The public comment period for the FS and the proposed plan opened March 3rd and continued through April 1st. The public meeting was held March 15th at an on-site neighborhood school.

Advanced notice of the availability of the FS for public comment was mailed on February 16, 1988. Two other notices about the FS, the proposed plan fact sheet and the public meeting were mailed by March 15th. For such mailings, EPA has a list of over 600 addresses of community members.

EPA and ADWR sent a press release to local newspapers on March 1st. A newspaper advertisement was published in two local newspapers on March 3rd with information regarding the availability of the FS and the proposed plan and giving the time and place of the public meeting.

The proposed plan fact sheet was sent to the people on the site mailing list on February 25th. In addition, nearly 2000 fact sheets were mailed to community groups for distribution to their own mailing lists. One thousand fact sheets printed in Spanish were also made available at a neighborhood center near the site.

The RI, FS, proposed plan fact sheet and other relevant site information have been available at seven information repositories set up at local libraries and at the Tucson ADWR office. The administrative record, a compilation of the information upon which EPA is basing its selection of remedy, has been available since late February at ADWR's offices in Phoenix and Tucson as well as at EPA's regional office in San Francsico. The administrative record index is provided as an attachment to this Record of Decision.

ADWR and EPA completed the attached responsiveness summary. The responsiveness summary includes responses to comments submitted in writing by residents, elected officials, and the PRPs. It also addresses comments made by attendees at the March 15th public meeting.

In addition to the release activities described above, the agencies met regularly with a group of approximately 10 community members while preparing the FS. This group, called the Community Advisory Group, had representatives from several concerned community organizations. Some members were appointed by elected officials. The Community Advisory Group reviewed and commented upon several drafts of the FS. The group also heard presentations by health and environmental agency officials and were given the opportunity to discuss their concerns with these officials.

5.0 DECISION SCOPE

As discussed in the Site History (page 2), the Air Force has begun operation of its remedial groundwater system for the southern area of the site. The response action that is the subject of this decision document is the groundwater remedy for the northern portion of the site. Together, these two remedies constitute the overall remedial strategy for groundwater. This strategy is necessary to restore the Sole Source Aquifer of the Tucson Basin to drinking water quality.

Waste disposal practices in the TAA, at AFP44 as well as elsewhere within the site boundaries, may have resulted in residual soil contamination. Some soils may continue to contribute contamination to the underlying groundwater. Investigations of potential soil contamination throughout the Superfund site are currently planned under both CERCLA and RCRA. Any response actions for soils taken pursuant to CERCLA will be the subject of a future Record of Decision. Actions to be taken pursuant to RCRA, particularly potential actions at AFP44, will likely be incorporated in permit conditions or in administrative orders.

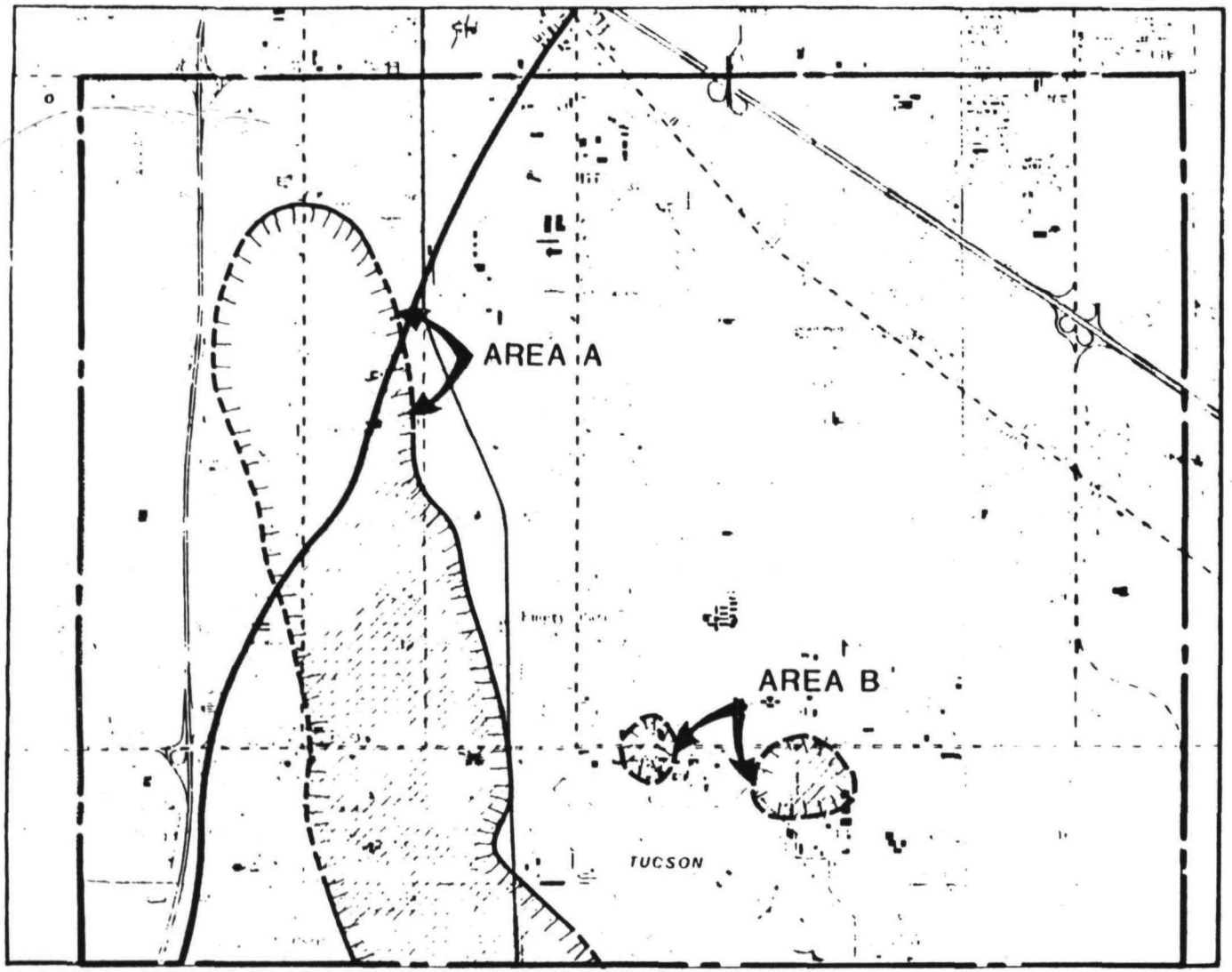
6.0 NATURE AND EXTENT OF CONTAMINATION

The RI found several areas of groundwater north of Los Reales Road to be contaminated with the solvent TCE, as shown on Figure 6. The main area, referred to as "Area A" starts to the west of the Tucson International Airport and continues to the northwest. Two smaller areas -- believed to be separate from the main area and referred to together as "Area B" -- lie north of the airport.

Area A extends north from Los Reales Road more than three and one-half miles to beyond Irvington Road. The area is generally about three-quarters of a mile wide. Most of the contamination in Area A is in the upper aquifer of the regional divided aquifer. However, as the main contaminant plume has migrated to the northwest, its leading edge has also spread into the regional undivided aquifer. The lower aquifer of the regional divided aquifer is not believed to be contaminated except in the immediate vicinity of wells that form vertical conduits from the upper to the lower aquifer.

The two parts of Area B are more limited in extent, probably because of lower hydraulic conductivities north of the airport. Contamination is believed to be limited to the upper aquifer in these areas.

The RI identified many groundwater contaminants in addition to TCE within the study area. The volatile contaminants of most concern include 1,1-DCE, trans-1,2-dichloroethylene (t-1,2-DCE), chloroform, benzene and xylene. Some hexavalent chromium was also found in a limited area north of Los Reales Road. (The levels of chromium found north of Los Reales Road do not exceed the Safe Drinking Water Act Maximum Contaminant Level (MCL), while the MCL is exceeded at and adjacent to AFP44.) Table 1 lists the contaminants detected in the groundwater north of Los Reales Road, the range of values detected and the number of detections.



LEGEND

AREA OF CONTAMINATION IN UPPER AQUIFER OF REGIONAL DIVIDED AQUIFER

AREA OF CONTAMINATION IN REGIONAL UNDIVIDED AQUIFER

APPROXIMATE BOUNDARY BETWEEN REGIONAL DIVIDED AND UNDIVIDED AQUIFER

APPROXIMATE LIMITS OF TCE CONTAMINATION DURING 1984 (DASHED WHERE UNKNOWN OR INFERRED)

0 0.5 1

SCALE IN MILES

N

FIGURE 6
GROUNDWATER REMEDIATION AREAS ADDRESSED BY THE FEASIBILITY STUDY
TUCSON INTERNATIONAL AIRPORT AREA
RECORD OF DECISION

TABLE 1

CONCENTRATION RANGES AND NUMBERS OF DETECTIONS FOR CONTAMINANTS FOUND NORTH OF LOS REALES ROAD*

Chemical	Concentration Range (µg/l)	Number of Detections
trichloroethylene	0.3 - 409	435
1,1,1-trichloroethane	0.12 - 5.6	2
1,1-dichloroethylene	0.3 - 31	77
t-1,2-dichloroethylene	1.2 - 13	70
1,1-dichloroethane	0.7	1
1,2-dichloroethane	2.1 - 8	3
1,2-dichloropropane	0.4 - 0.9	2
isophrone	9	1
carbon tetrachloride	0.5 - 0.8	2
chloroform	0.53 - 54	58
chromium (VI)	10 - 40	48
bis(2-ethylhexyl) phthalate	12 - 265	4
di-n-butyl phthalate	82	1
3,3-dichlorobenzidene	5	1
2-chloroethyl vinyl ether	3 - 6	2
benzene	1.2 - 14	13
toluene	3	1
total xylenes	2.7 - 21	5
napthalene	5	1
2-methylnapthalene	5	1
trichlorofluoromethane	1 - 4	2
tetrachlbroethylene	0.9	1
chlorobenzene	1	1

* Concentration ranges and numbers of detections represent data collected from municipal, private and monitoring wells north of Los Reales Road from May 1981 through February 1986.

Beginning in 1981, the City of Tucson has been closing all wells that exceed the State Action Level for TCE of 5 parts per billion (ppb). As a result, no one using the municipal supply system has been exposed to water with TCE concentrations above 5 ppb since 1981. (The water served by the city has also been in compliance with all other federal and state requirements, including the MCLs and State Action Levels for chemicals other than TCE.) However, the RI also identified several private wells that were contaminated above MCLs and State Action Levels. While all known private well users have been notified of the potential risks of using their private wells, there is no reliable mechanism for determining the extent of continued private well use.

While the focus of the RI was on groundwater, limited soil data are available. Although the available data do not suggest that soil contamination is an immediate public health threat, there is not enough data at this time to conclude that there are no soil areas that are continuing sources of groundwater contamination. Further investigation will clarify the need for response actions for soils.

7.0 BASELINE SITE RISKS

The no action risk baseline was calculated in the Public Health Evaluation to be approximately 10^{-5}. This number represents the risk due to exposure to groundwater from the upper divided aquifer north of Los Reales Road and from the regional undivided aquifer. While the city of Tucson by law cannot serve water that exceeds MCLs, the public health evaluation hypothetically removes this institutional control and assumes ready access to the contaminated water via municipal supply wells.

While more than 20 chemical contaminants have been detected at elevated concentrations in the TAA, many of these were not carried through all calculations during the Public Health Evaluation because of (1) low frequency of detection, (2) low concentrations when detected or (3) a combination of low frequency and low concentrations.

In the Public Health Evaluation, TCE, 1,1-DCE, t-1,2-DCE, chloroform, benzene and hexavalent chromium were selected as indicator chemicals. However, t-1,2-DCE and hexavalent chromium are not considered potential carcinogens in water; therefore, they do not contribute to the baseline number stated above. In addition, because of equivocal evidence of carcinogenicity, 1,1-DCE was not considered a carcinogen for the Public Health Evaluation for this site. Therefore, TCE, chloroform and benzene are the chemicals from which the baseline carcinogenic risk was derived.

At sufficiently high exposure levels, the noncarcinogens, along with some of the carcinogens, have chronic (noncarcinogenic) health effects associated with them. However, the contaminant concentrations in the TAA are all below levels believed to have the potential to result in noncarcinogenic health effects.

The primary exposure pathway is considered ingestion of groundwater. For the indicator chemicals, dermal contact is not a demonstrated pathway of concern. Inhalation of vapors during activities such as showering would tend to increase the baseline risk from ingestion, and may, in fact, approach it in magnitude. However, the risk from this pathway is not currently quantifiable.

The risks calculated in the Public Health Evaluation also reflect the assumption that the ongoing Air Force remedial action is meeting its goals for groundwater containment and treatment. Therefore, the higher levels of contamination that have been observed south of Los Reales Road have not been incorporated into the baseline risk for the current remedial action. Instead, it is assumed that groundwater "crossing" Los Reales Road has maximum levels of contamination that are equivalent to the Air Force's treatment goals. However, based upon TCE concentrations that are generally one to two orders of magnitude higher in the southern area, the baseline risk would have approached at least 10^{-4} if these higher levels had been incorporated.

8.0 CHANGES TO THE PROPOSED PLAN

This decision document presents one substantive change to the preferred remedy described in the proposed plan. In addition, some uncertain aspects that were included in the proposed plan are clarified herein.

The proposed plan released on February 25, 1988 recommends extraction of groundwater from both the upper divided aquifer and the regional undivided aquifer. The remedy includes the sealing of wells that form conduits between the upper and lower aquifers. Treatment of groundwater -- to an overall risk level of 10^{-6} -- would take place at a single packed column aeration facility. The municipal distribution system would receive the treated water by gravity flow.

The one significant change to the remedy summarized above is that a reasonably available control technology (RACT) will be proposed for reduction of emissions from any new packed column facility having the potential to emit in excess of 2.4 pounds per day of airborne volatile organic compounds (VOCs). In this case, RACT may consist of granular activated carbon (GAC). This change is made in order to comply with Pima County Air Quality Control Regulation 17.12.090 Sub-Paragraph E. (See the ARARs section on

page 11.) Consistency with the Pima County rule is supported by the city, county and state. Control of air emissions was also a major community concern voiced during the public comment period.

The proposed plan discusses several aspects of the remedy that may require adjustments during design. For instance, continuing discussions with the Air Force may reveal greater viability of the AFP44 reclamation system for some portion of the water from north of Los Reales Road. Any water treated at AFP44 would likely be injected back into the aquifer rather than put directly into the distribution system. In addition, partial use of AFP44 might make one or more wellhead treatment facilities a reasonable alternative. Depending upon the final configuration of the extraction system and treatment facility(ies), therefore, it may be necessary to reinject some water while putting other treated water to direct use through the municipal distribution system. Finally, as mentioned in the proposed plan, some refinement of extraction well locations and capacities is expected during design.

The remedy for Area B, as proposed, is basically a smaller scale copy of the remedy for Area A. As stated in the proposed plan, however, the Area B recommendation is considered preliminary, based upon a more limited data base. Therefore, there may be some changes in the remedial strategy for Area B as more information becomes available, providing that the changes maintain the same level of protection of human health and the environment and the same level of compliance with ARARs as does the selected remedy.

9.0 DESCRIPTION OF ALTERNATIVES

The project management committee for the TAA Feasibility Study developed objectives for response actions in the TAA:

- -- To manage migration of contaminants,
- -- To achieve public acceptance of the remedy,
- -- To protect public health and the environment,
- -- To attain consistency with ARARs,
- -- To determine the most environmentally sound, technically feasible, and cost-effective remedy, which can be implemented in a timely manner, and
- -- To ensure consistency with AFP44 remedial actions.

The natural conditions at the TAA, including the desert environment and the depth to the water table, limit the range of available response actions for contaminated groundwater. For instance, no surface water control options were developed in detail because of the lack of flowing surface waters. Containment options such as slurry walls and sheet piling were inappropriate because of the areal extent of contamination and the depth to groundwater (generally >120 feet).

The remedial alternatives (except the no action alternative) that were developed in detail for the Tucson International Airport Area consist of three main components: groundwater control measures, treatment of contaminated groundwater and an end use for treated water.

As shown in Table 2, the groundwater control options consist of variations of the areas from which water would be pumped. Extraction from the upper aquifer only, from the undivided aquifer only and from both the upper and undivided aquifers were considered. Options entailed extraction rates from 650 gpm to 4,200 gpm for Area A and a rate of 300 gpm for Area B. Extraction options were developed with and without reinjection.

Several treatment methods underwent detailed analysis:

-- Packed column aeration,
-- Packed column aeration with vapor phase granular activated carbon,
-- Liquid phase granular activated carbon, and
-- Treatment at AFP44.

UV/ozone oxidation was considered but was eliminated due to questionable performance in treating to the low levels required and due to a lack of cost-effectiveness when compared to other remaining treatment options. In-situ aerobic biodegradation was also dropped from consideration because of questionable implementability and because of cost estimates of up to an order of magnitude higher when compared to the technologies listed above.

Treatment at a central facility (one each for Area A and Area B) and at each wellhead were analyzed. The FS assumed that each treatment method would be sized according to the selected pumping option. Based upon TCE's chemical characteristics and upon regulatory requirements for TCE, treatment alternatives were analyzed over a range of treatment levels from attainment of MCLs down to EPA laboratory method detection limits.

In many instances, several end uses for treated water are theoretically available in the development of response actions. In this case, however, the aquifer of concern has been designated a Sole Source Aquifer under the Safe Drinking Water Act, and according to the Groundwater Management Plans for the Tucson Active Management Area, any water withdrawn from the aquifer must be put to its highest beneficial use. Therefore, the end use options were limited to direct drinking water use or reinjection for drinking water use at a later time.

TABLE 2

GROUNDWATER CONTROL ALTERNATIVES CONSIDERED IN THE FEASIBILITY STUDY

ALTERNATIVE*	EXTRACTION#	REINJECTION	ESTIMATED PROJECT TIME
Area A			
A-3	3 wells in the upper divided aquifer	NONE	20 yrs
A-4	3 wells in the upper divided aquifer & 2 wells in the undivided aquifer	NONE	20 yrs
A-5	2 wells in the undivided aquifer	NONE	20 yrs
A-6	3 wells in the upper divided aquifer	50% reinjected 4 wells in the upper divided aquifer	15 yrs
A-7	3 wells in the upper divided aquifer & 2 wells in the undivided aquifer	50% reinjected 4 wells each in the upper divided and undivided aquifers	15 yrs
Area B			
B-2	2 wells in the upper divided aquifer	NONE	20 yrs
B-3	2 wells in the upper divided aquifer	at least 50% reinjected -- 2 wells	15 yrs

*Letter/number designations for alternatives are those used in the FS.
#The number of wells actually indicates the number of locations for one or more wells -- the exact number and location will be determined in design.

Estimated costs for alternatives that were developed in detail for Area A ranged from about 1.5 to 14.2 million dollars. The range for Area B is from about 0.9 to 2.3 million dollars. Tables 3 and 4 give a summary of capital and operations and maintenance costs for the alternatives.

10.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

The Groundwater Management Plans mentioned above are an important ARAR, limiting the potential uses of any groundwater withdrawn during remediation. The requirements of Title 45 of the Arizona Code and Environmental Quality Act are also applicable for actions in the TAA. In addition, all of the Safe Drinking Water Act MCLs are applicable at the site. Arizona has its own State Action Levels, a few of which are more stringent than the MCLs. While the State Action Levels are not promulgated and are not, therefore, ARARs, they have been taken into consideration during the development of remedial alternatives. Table 5 lists the MCLs and State Action Levels for indicator chemicals from the Public Health Evaluation.

Table 5 also lists the Maximum Contaminant Level Goals (MCLGs) for the indicator chemicals. MCLGs, which are based only upon health criteria, are not directly applicable as chemical-specific requirements because they are not enforceable standards. The MCLs are considered the chemical-specific ARARs because they are (1) the enforceable drinking water standards, (2) required to be set as close to the MCLGs as is feasible, taking into consideration the best technology, treatment techniques and other factors (including cost), and (3) protective of public health to within EPA's acceptable risk range of 10^{-4} to 10^{-7}.

Pima County Air Quality Control Regulation 17.12.090 Sub-Paragraph E is also an important ARAR in the TAA. The ordinance requires a proposal of reasonably available control technology (RACT) in the event that any stationary source has the potential to emit a total of 2.4 pounds per day of volatile organic compounds (VOCs).

With certain exclusions, the Arizona Environmental Quality Act (EQA) delegates air pollution control authority to the counties. Therefore, having been duly promulgated by the Pima County Board of Supervisors in accordance with the EQA, Pima County Air Quality Control Regulation 17.12.090 Sub-Paragraph E constitutes a promulgated state requirement under a state environmental law -- as set forth in §121(d) of CERCLA -- and is generally applicable.

TABLE 3

SUMMARY OF PRESENT WORTH COSTS OF REMEDIAL ALTERNATIVES
(CENTRAL FACILITIES)

	A-3	A-4	A-5	A-6	A-7	B-2	B-3
Packed Column Aeration							
Capital	1.68	2.83	1.56	3.45	6.97	0.66	1.09
O & M	0.71	1.86	1.42	1.20	4.18	0.36	0.62
Total	$2.39	$4.69	$2.98	$4.65	$11.15	$1.02	$1.71
Packed Column with GAC							
Capital	1.90	3.10	1.90	3.70	7.48	0.88	1.48
O & M	1.37	3.34	3.12	2.27	6.71	0.50	0.77
Total	$3.27	$6.44	$5.02	$5.97	$14.19	$1.38	$2.25
Liquid Phase GAC							
Capital	2.00	3.70	2.29	3.92	8.83	0.81	1.24
O & M	1.87	3.55	2.06	3.06	7.08	0.43	0.69
Total	$3.87	$7.25	$4.35	$6.98	$15.91	$1.24	$1.93
Treatment at AFP44							
Capital	1.57	2.44	1.30	3.47	6.43	----	----
O & M	1.39	4.14	3.03	2.31	8.15	----	----
Total	$2.96	$6.58	$4.33	$5.78	$14.58	----	----

Costs are in millions. Operations and maintenance costs assume a discount rate of 10% over 20 years for A-3, A-4, A-5 and B-2. A 10% discount rate over 15 years is assumed for A-6, A-7 and B-3.

TABLE 4

SUMMARY OF PRESENT WORTH COSTS OF REMEDIAL ALTERNATIVES
(WELLHEAD FACILITIES)

	A-3	A-4	A-5	B-2	B-3
Packed Column Aeration					
Capital	1.65	2.49	1.29	0.68	1.15
O & M	0.82	2.03	1.47	0.41	0.60
Total	2.47	4.52	2.76	1.09	1.75
Packed Column with GAC					
Capital	2.48	3.61	1.76	1.12	1.58
O & M	1.51	3.52	2.27	0.60	0.78
Total	3.99	7.13	4.03	1.72	2.36
Liquid Phase GAC					
Capital	1.72	3.95	1.95	1.11	1.57
O & M	1.95	3.72	1.99	0.61	0.79
Total	3.67	7.67	3.94	1.72	2.36

Costs are in millions. Operations and maintenance costs assume a discount rate of 10% over 20 years for A-3, A-4, A-5 and B-2. A 10% discount rate over 15 years is assumed for B-3.

TABLE 5

MCLs, MCLGs & STATE ACTION LEVELS FOR CONTAMINANTS IN THE TAA
($\mu g/l$)

CHEMICAL	MCL OR PROPOSED MCL	MCLG OR PROPOSED MCLG	STATE ACTION LEVEL*
trichloroethylene	5	zero	5
1,1-dichloroethylene	7	7	7
chloroform	100	---	3
chromium (VI)	50	120	---
t-1,2-dichloroethylene	---	70	70
benzene	5	zero	5

*State Action Levels are set by the Arizona Department of Health Services.

However, the EQA reserves for the state exclusive air pollution control authority with respect to facilities operated by the state or a subdivision of the state. Therefore, because the extent of state involvement in the operation of the proposed treatment system(s) has not been determined, the Pima County rule may not be applicable to all remedial actions in the TAA. But regardless of who operates any treatment facility(ies), the county rule remains relevant with respect to conditions in the TAA. In addition, because the county's rule would be applicable in the case of privately-operated facilities, it is appropriate that state-operated facilities should comply with the same requirements. In all cases, therefore, Pima County Air Quality Control Regulation 17.12.090 Sub-Paragraph E is a requirement that is applicable or relevant and appropriate.

While the city of Tucson is in an area that exceeds the level of ambient carbon monoxide allowed by the Clean Air Act (CAA), none of the contemplated remedial actions are expected to affect carbon monoxide levels. But the area is also within 4% of exceeding its CAA limit for ozone; several of the VOCs that have been found in the the groundwater (and that would become airborne during water treatment) act as ozone precursors.

None of the remedial alternatives presents any threat to natural resources or any impact upon the 100-year floodplain. No other site-specific siting requirements have been identified.

11.0 SUMMARY OF ALTERNATIVES ANALYSIS

Several alternatives that were originally developed in the FS were eliminated before detailed development and analysis. Examples are alternatives that include no aquifer cleanup but call for continued groundwater monitoring and alternate water supplies as a means of protecting public health. In general, these options were eliminated because they are less protective of the environment and because they tend to be costly in comparison to alternatives that offer greater protection.

In addition to the information provided in this section, Tables 6 and 7 provide summaries of the analyses of groundwater controls and of treatment technologies, respectivley.

Groundwater Control Alternatives

The groundwater control alternatives involving extraction from only the upper divided aquifer are not considered protective of human health and the environment because they would allow the leading edge of the contaminant plume to continue to migrate and potentially contaminate more wells. Extraction from only the regional undivided aquifer also is not considered fully protective of human health and the environment. This option assumes that all contamination from the upper divided aquifer can

be removed when it migrates to the undivided zone, but subsurface conditions are such that they introduce uncertainty as to the fate of contaminants. This situation supports the more aggressive strategy of pumping from both the upper and the undivided aquifers. Alternatives that include reinjection of treated water are generally eliminated because of cost increases of about 50% and because of concerns about the potential for extensive operations and maintenance requirements for reinjection wells. However, in the event that any water is treated at AFP44, reinjection or some other form of groundwater recharge may be necessary to maintain consistency with current operations at the facility.

Groundwater Treatment Alternatives

All of the treatment technologies that went through detailed analysis are capable of treating the water to desired levels. In addition, all technologies are virtually equal in protection of human health.

Packed column aeration without vapor phase GAC is somewhat less able to decrease the toxicity and mobility of contaminants than are packed column aeration with vapor phase GAC and liquid phase GAC (AFP44 utilizes packed column aeration with some vapor phase controls). However, aeration without emission controls was considered slightly more reliable, with fewer operations and maintenance requirements. Aeration with emission controls is preferred by the community over aeration alone because of a perceived health risk difference between the two. But when calculated in the Public Health Evaluation, this risk difference was not significant. In addition, packed column aeration is at least 25% less in overall project cost than the other three treatment options. However, depending upon well configuration and pump rates, packed column aeration may exceed the 2.4 pounds per day level for VOCs that is referred to in the Pima County air quality regulations.

End Use of Treated Groundwater

As discussed previously, the options for use of groundwater extracted from the Tucson Basin are limited by the Groundwater Management Plans. As a result, after elimination of reinjection alternatives because of high costs (with the possible exception for water treated at AFP44, as stated previously under Groundwater Control Alternatives), there is only one available option: use treated water for drinking water.

TABLE 7

TREATMENT TECHNOLOGIES

Analysis of Alternatives

ALTERNATIVE	PROTECTION OF HEALTH AND ENVIRONMENT		COMPLIANCE WITH ARARS	PERFORMANCE OF TECHNOLOGY	FEASIBILITY OF IMPLEMENTATION	ACCEPTANCE OF ALTERNATIVE		COST
	Short Term	Long Term				State	Community	Capital + O & M Total
Packed Column Aeration	Can treat to 10^{-6}. TCE and other VOCs may act as ozone precursor after being stripped from the water.		May exceed level in Pima Co. air emission rule under some extraction scenarios.	Adequate	Feasible	Yes	No Supported by most PRPs.	560,000 460,000 --- $ 1,020,000
Packed Column Aeration with Vapor Phase GAC	Can treat to 10^{-6}; a very small risk reduction compared to aeration alone over the 20 years of operation. Ozone precursor emissions also reduced.		Full Compliance	Adequate	Feasible Disposal of spent carbon is a potential problem.	Yes Cost share issues have not been fully discussed.	Yes -- most public comments demanded vapor GAC.	825,000 1,471,000* --- $ 2,296,000
Liquid Phase GAC	Can treat to 10^{-6}. Completetly eliminates ozone precursor emissions and exposure to air toxics.		Full Compliance	Adequate	Feasible Disposal of spent carbon is a potential problem.	No	No public comment but would be supported.	1,416,000 2,156,000 --- $ 3,572,000
AFP44: Aeration with some Vapor Phase GAC	Can treat to 10^{-6}. Secondary packed columns emit airborne VOCs.		Not yet certain.	May require additional reinjection wells.	Already in operation; coordination & cooperation are major concerns.	Yes	Public not confident in Hughes.	157,000 2,746,000 --- $ 2,903,000

All analyses assume the same groundwater control alternative (A-4) for each treatment option.

UV/ozone oxidation and in-situ aerobic biodegradation were also considered but did not pass through screening to detailed evaluation. Major negative factors were questionable performance and high costs.

*Annual O&M cost for Packed Column Aeration with Vapor Phase GAC includes the minimum estimate for carbon replacement cost. The high-side estimate for carbon replacement results in 20-year O&M of $1,939,000.

TABLE 6
GROUNDWATER CONTROLS

Analysis of Alternatives

ALTERNATIVE	PROTECTION OF HEALTH AND ENVIRONMENT Short Term	Long Term	COMPLIANCE WITH ARARS	PERFORMANCE OF TECHNOLOGY	FEASIBILITY OF IMPLEMENTATION	ACCEPTANCE OF ALTERNATIVE State	Community	COST Capital + O & M Total
A-3: Pump from upper aquifer	Protective of health only in conjunction with institutional controls; does not stop migration.		Does not satisfy AZ EQA.	Adequate	Feasible	No	No public comment.	1,409,000 561,000 $ 1,970,000
A-4: Pump from upper & undivided aquifers	Protective of health while also controlling contaminant migration.		Full Compliance	Adequate	Feasible	Yes	Yes Most PRPs support.	2,276,000 1,399,000 $ 3,675,000
A-5: Pump from undivided aquifer	Adequately protective of health; some uncertainty about aquifer protection as plume approaches wells.		Does not completely satisfy AZ EQA.	Adequate	Feasible	No	City's preference. No public comment.	1,145,000 1,110,000 $ 2,255,000
A-6: Pump & reinject in undivided aquifer	Offers somewhat more protection than A-5 in that remediation time should be decreased.		Does not completely satisfy AZ EQA.	Somewhat better control of plume migration with reinjection.	Reinjection wells likely to introduce complications during O&M.	No	No public comment.	3,050,000 946,000 $ 3,996,000
A-7: Pump & reinject in upper & undivided aquifers	Offers somewhat more protection than A-4 in that remediation time should be decreased.		Full Compliance	Somewhat better control of plume migration with reinjection.	Reinjection wells likely to introduce complications during O&M.	May support in lieu of A-4.	No public comment.	6,012,000 3,356,000 $ 9,368,000
B-2: Pump from upper aquifer	Protective of health; controls migration.		Full Compliance	Adequate	Feasible	Yes	No public comment.	495,000 263,000 $ 758,000
B-3: Pump & reinject in upper aquifer	Offers somewhat more protection than B-2 in that remediation time should be decreased.		Full Compliance	Somewhat better control of plume migration with reinjection.	Reinjection wells likely to introduce complications during O&M	No	No public comment.	922,000 503,000 $ 1,425,000

12.0 THE SELECTED REMEDY

The selected remedy for Area A includes control of groundwater contamination through extraction from both the upper divided aquifer and the regional undivided aquifer. Wells that form vertical conduits between the upper and lower aquifers will be sealed to limit the spread of contamination to the lower aquifer. The treatment technology will be packed column aeration. Where emissions of airborne VOCs from new packed column facilities have the potential to exceed 2.4 pounds per day, reasonably available control technology, potentially consisting of granular activated carbon, will be proposed for the reduction of emissions. Treated water will be gravity-fed directly into the municipal water distribution system. If any groundwater is treated at AFP44, this water will likely be reinjected or otherwise returned to the aquifer rather than supplied directly to the municipal system.

Extraction from both the upper and undivided aquifers is chosen because this strategy will contain the migration of contamination and will remove high levels of contamination from areas where they are currently believed to be. Packed column aeration is chosen for treatment because this method provides virtually the same public health protection as the other technologies with substantially less cost. Air emission controls will be used to comply with local air quality regulations if VOC emissions are likely to exceed 2.4 pounds per day. Direct drinking water use is chosen as the end use because of the restrictions of the Groundwater Management Plans for the Tucson Active Management Area and because of concerns about the reliability of reinjection wells. However, the option to reinject water treated at AFP44 is preserved in order to maintain consistency with current operations of the facility.

The target TCE concentration for treated water is 1.5 μg/l (1.5 ppb), well below TCE's MCL of 5 ppb and below its 10^{-6} excess cancer risk level of 3.0 ppb. Taking into account the presence of other contaminants, this treatment goal for TCE will result in an overall excess cancer risk of 10^{-6}. With a design for a level of TCE that is less than its 10^{-6} excess cancer risk concentration, treatment will bring the levels of other contaminants well below their respective MCLs, State Action Levels, and 10^{-6} excess cancer risk concentrations. The choice of an overall 10^{-6} level versus treatment to MCLs or to, for instance, the 10^{-6} level for TCE was made because a measurable difference (reduction by 1/2 or more) in risk could be made for less than a 5% cost increase.

For Area B, the remedy will include extraction from the upper aquifer and treatment to an overall excess cancer risk level of 10^{-6}. Packed column aeration will be used unless further information indicates that another treatment method is more cost-

12.0 THE SELECTED REMEDY

The selected remedy for Area A includes control of groundwater contamination through extraction from both the upper divided aquifer and the regional undivided aquifer. Wells that form vertical conduits between the upper and lower aquifers will be sealed to limit the spread of contamination to the lower aquifer. The treatment technology will be packed column aeration. Where emissions of airborne VOCs from new packed column facilities have the potential to exceed 2.4 pounds per day, reasonably available control technology, potentially consisting of granular activated carbon, will be proposed for the reduction of emissions. Treated water will be gravity-fed directly into the municipal water distribution system. If any groundwater is treated at AFP44, this water will likely be reinjected or otherwise returned to the aquifer rather than supplied directly to the municipal system.

Extraction from both the upper and undivided aquifers is chosen because this strategy will contain the migration of contamination and will remove high levels of contamination from areas where they are currently believed to be. Packed column aeration is chosen for treatment because this method provides virtually the same public health protection as the other technologies with substantially less cost. Air emission controls will be used to comply with local air quality regulations if VOC emissions are likely to exceed 2.4 pounds per day. Direct drinking water use is chosen as the end use because of the restrictions of the Groundwater Management Plans for the Tucson Active Management Area and because of concerns about the reliability of reinjection wells. However, the option to reinject water treated at AFP44 is preserved in order to maintain consistency with current operations of the facility.

The target TCE concentration for treated water is 1.5 μg/l (1.5 ppb), well below TCE's MCL of 5 ppb and below its 10^{-6} excess cancer risk level of 3.0 ppb. Taking into account the presence of other contaminants, this treatment goal for TCE will result in an overall excess cancer risk of 10^{-6}. With a design for a level of TCE that is less than its 10^{-6} excess cancer risk concentration, treatment will bring the levels of other contaminants well below their respective MCLs, State Action Levels, and 10^{-6} excess cancer risk concentrations. The choice of an overall 10^{-6} level versus treatment to MCLs or to, for instance, the 10^{-6} level for TCE was made because a measurable difference (reduction by 1/2 or more) in risk could be made for less than a 5% cost increase.

For Area B, the remedy will include extraction from the upper aquifer and treatment to an overall excess cancer risk level of 10^{-6}. Packed column aeration will be used unless further information indicates that another treatment method is more cost-

TABLE 8

DETAILED COSTS OF SELECTED REMEDIES FOR CONTAMINATED GROUNDWATER NORTH OF LOS REALES ROAD

	AREA A	AREA B
CONSTRUCTION		
Piping	819,000	65,000
Wells	385,000	85,000
Aquifer Segregation	40,000	0
Land	37,000	6,000
Concrete Foundation & Clearwell	35,000	35,000
Engineering Overhead & Profit	235,000	31,000
1. SUBTOTAL	$1,551,000	$222,000
PUMPING -- CAPITAL		
Well Pumps	172,000	42,000
Booster Pumps	15,000	15,000
Pump Facilities	475,000	190,000
Installation Cost	8,000	4,000
Contingencies & Shipping	52,000	21,000
2. SUBTOTAL	$722,000	$272,000
PUMPING -- ANNUAL O & M		
Power	112,347	13,797
Materials	10,000	4,000
Maintenance	15,600	7,800
Monitoring	26,360	9,010
SUBTOTAL	164,307	34,607
3. PRESENT WORTH (20 yrs @ 10%)	$1,399,000	$295,000
4. TOTAL CONSTRUCTION & PUMPING COSTS (LINES 1,2 & 3)	$3,672,000	$789,000
PACKED COLUMN AERATION -- CAPITAL		
Excavation	36,000	9,600
Equipment	254,000	88,000
Electrical & Instrumentation	86,000	23,000
Piping & Valves	50,000	13,000
Contingencies	48,000	13,000
Contractor Overhead & Profit	38,000	10,000
Engineering	48,000	13,000
5. SUBTOTAL	$560,000	$170,000
PACKED COLUMN AERATION -- ANNUAL O & M		
Power	19,400	2,300
Labor	9,700	1,100
Maintenance Materials	18,300	2,400
Monitoring	6,600	800
SUBTOTAL	54,000	6,600
6. PRESENT WORTH (20 YRS @ 10%)	$460,000	$56,000
7. TOTAL PACKED COLUMN AERATION COSTS (LINES 5 & 6)	$1,020,000	$226,000
8. TOTAL CONSTRUCTION, PUMPING & PACKED COLUMN AERATION COSTS (LINES 4 & 7)	$4,692,000	$1,015,000

TABLE 8
(CONTINUED)

	AREA A	AREA B
VAPOR PHASE GAC -- CAPITAL		
Contactor	100,000	100,000
Initial GAC	40,000	40,000
Blowers	18,000	6,000
Ductwork	10,000	3,000
Heaters	12,000	4,000
Piping	6,000	2,000
Contingencies	28,000	23,000
Contractor Overhead & Profit	22,000	18,000
Engineering	28,000	23,000
9. SUBTOTAL	$264,000	$219,000
VAPOR PHASE GAC -- ANNUAL O & M		
Heating	38,000	6,000
Power	47,500	7,500
Maintenance Materials	9,500	1,500
Carbon Replacement	23,580 - 78,800	800 - 2,600
SUBTOTAL	118,580 - 173,800	15,000 - 17,600
10. PRESENT WORTH (20 YEARS @ 10%)	$1,010,000 - 1,480,000	$128,000 - 150,000
11. TOTAL VAPOR PHASE GAC COSTS, HIGH ESTIMATE (LINES 9 & 10)	$1,744,000	$369,000
12. TOTAL CONSTRUCTION, PUMPING, PACKED COLUMN AERATION & VAPOR PHASE GAC COSTS (LINES 8 & 11)	$6,436,000	$1,384,000

Costs reflect extraction well configurations A-4 and B-2, as described in detail in the FS and as summarized in Table 2 of this Record of Decision.

Packed column aeration will still be more cost-effective than the other treatment options even if it is necessary to add air emission controls to comply with ARARs. However, from the viewpoint of risk reduction, the incremental costs-to-benefits ratio that accompanies the addition of emission controls (e.g. GAC) is considerably higher than the costs-to-benefits ratio for the use of packed column aeration alone. This is because the risk from air emissions that will be reduced by emission controls is already so small that the effective change in risk is virtually zero.

The selected remedy permanently and significantly reduces the mobility and volume of hazardous substances with respect to their presence in groundwater. The migration of contamination is controlled and contaminants are removed from the groundwater.

Packed column aeration will result in at least a short term increase in the toxicity, mobility and volume of hazardous substances with respect to their presence in the air. TCE, the principal contaminant of concern, is more toxic when inhaled than when ingested. In addition, VOCs are generally more mobile when they become airborne. Finally, packed column aeration increases the volume of contamination in the air by transferring the volume of contamination that was once in the water into the air. Despite these factors, however, the proposed packed column aeration facility is estimated to add virtually no risk to the project via airborne contaminants. The absence of added risk is due largely to (1) dilution of contamination as it exits the packed column, and (2) the remoteness of the proposed facility with respect to populated areas. Furthermore, a point not taken into account in the Public Health Evaluation is that chemicals such as TCE are broken down rather rapidly by natural ultraviolet radiation, thereby reducing their volume in the air, further reducing the opportunity for human exposure. It is notable, however, that the reactivity that gives TCE a short half-life when it is exposed to ultraviolet radiation also makes it a precursor in the formation of ozone in the lower atmosphere.

Packed column aeration will increase the toxicity, mobility and volume of hazardous substances in the air to some degree even if, for compliance with ARARs, air emission controls are added. Controls such as GAC will reduce air emissions by 70 to 90 percent, but will not completely eliminate VOC releases into the air. Emissions controls will, however, simultaneously reduce the risk from air toxics and limit the release of ozone precursors.