UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE COMPANY, ET AL.	)	Docket Nos. STN 50-528 STN 50-529 STN 50-530
	)	
(Palo Verde Nuclear Generating Station, Units 1, 2, and 3))	)	

TESTIMONY OF EDWIN K. SWANSON

Q. What is your name and business address?

A. My name is Edwin K. Swanson, and I work at 1740 West Adams, Phoenix, Arizona.

Q. What is your current position?

A. I am the Manager of the Ambient Water Quality Unit of the Bureau of Water Quality Control for the Arizona Department of Health Services.

Q. What is the purpose of your testimony?

A. I am testifying about the contamination of groundwater documented by the Department of Health Services in the Phoenix area and the likelihood that this contamination will increase and become a greater problem in the near future. This documented contamination of municipal well water sources is having adverse effects on the delivery of water to the public.

Q. What is your prior work experience?

A. I have been with the Bureau of Water Quality Control for nine years. In January, 1979, I became manager of the unit after performing assignments in the areas of planning, engineering and the review of proposed water and wastewater facilities for compliance with design requirements.

Prior to coming to work for the Bureau of Water Quality Control I worked as a senior engineer for Westinghouse Nuclear Energy Systems Division, Monroeville, Pennsylvania.

Q. Describe your educational background and any professional societies to which you belong.

A. I received a bachelor of sciences degree in mechanical engineering. I am a registered professional engineer in Pennsylvania and Arizona. I am currently a member of the American Society of Mechanical Engineers and the American Water Resources Association. I was chairman of the Arizona section for the American Water Resources Association for the 1981 to 1982 period. I formerly was a member of the National Society of Professional Engineers and the Air Pollution Control Association.

Q. What are your duties and responsibilities in your present position?

A. I supervise a unit consisting of three professionals with experience and expertise in wastewater, toxicology,

chemistry, biology, and limnology. The Unit deals with ambient water quality, both of surface and groundwater. The unit attempts to identify problems associated with water quality, assess possible solutions for these problems, and implement these solutions whenever possible.

In general our goals are to protect human health and to ensure that surface water quality is adequate to protect the food chain.

Q. What is TCE?

A. TCE, or trichloroethylene, is a solvent for fats, waxes, resins, oils, rubbers, paints, and varnishes with a multitude of uses. It is commonly used as a degreaser in industry, and for dry cleaning, paint stripping, automobile body polishing and decaffeinating coffee. TCE was typically used, prior to 1970, in the aerospace and materials industries.

TCE is a suspected carcinogen for humans because it has produced cancer in some, although not all, laboratory animals.

Q. At what levels of concentrations is TCE a public health concern for the Department of Health Services?

A. According to statistics from the Environmental Protection Agency ("EPA") the excess cancer risk for lifetime exposure of 1×10^{-6} is reached at a level of 5 ppb. This estimated risk means that in a population of one million people, during their lifetimes, the statistical probability is that one person

will contract cancer by drinking water containing 5 ppb of TCE.

In several other states, 4 or 5 ppb for longterm exposure have been considered sufficient levels to condemn a water source.

It is the policy of Arizona to minimize pollutants in drinking water and aim for exposure risks of carcinogenic materials of not more than 1×10^{-6} excess cancer risk for lifetime exposure.

Therefore under this standard TCE is a chemical of concern to the Department at levels of greater than 5 ppb, expecially since EPA does not regulate TCE in the drinking water supplyprogram. TCE is an unregulated chemical under the Federal Safe Drinking Water Act.

The TCE "action level" of 5 ppb is an alarm or early warning signal that groundwater pollution exists and that steps should be taken to assure a safe water supply and to investigate the source and magnitude of the pollution.

Q. Describe the efforts of the Department of Health Services to detect and analyze TCE in the Phoenix area.

A. On October 1, 1981, the City of Phoenix initiated analyses for TCE. On October 10, 1981, resampling was conducted in an area served by the 64th Street reservoir. Three of the ten wells sampled exhibited varying levels of

TCE. On October 27, 1981, the Department was informed of the results, and samples were collected for confirmation of the results by the State Laboratory. Wells Nos. 35 and 36 were taken off line until the extent of the problem was fully determined.

On October 29, 1981, the Department met with representatives from the Cities of Phoenix, Scottsdale and Tempe to discuss further monitoring.

From October 30, 1981, to the present the Department is participating in an extensive monitoring program of all identified wells in the area to define the full extent of contamination.

See Trichloroethylene, Briefing Document, January, 1982, attached hereto as Exhibit A.

Q. What wells sampled by the Department have shown TCE at levels above the state action level of 5 ppb?

A. Two wells in Phoenix, Nos. 35 and 36; two wells in Scottsdale, Nos. 6 and 31; three wells in Tempe, Nos. 4, 6, and 8; and one well in the Phoenix-Litchfield Airport Area, No. 3., have shown TCE at levels above 5 ppb. In addition four Salt River Project irrigation wells were found to contain TCE at levels above 5 ppb. See Summary of Arizona's TCE-Contaminated Wells, May 28, 1982, attached hereto as Exhibit B.

Q. Which of these wells provided drinking water?

A. The wells identified above as wells operated by Phoenix, Scottsdale, and Tempe, and the well located in the Phoenix-Litchfield Airport Area provided drinking water. I would estimate that more than 200,000 people were served by these wells and may be affected by the shutdown of these wells.

Q. What action did the Department of Health Services take with respect to these eight wells after determining that the TCE level exceeded state action levels?

A. All of these eight wells were ordered shut down, except for well No. 36, for which Phoenix is able to blend well water with other water containing less or no TCE. Well No. 3 has not been shut down although the Department of Health Services has ordered that bottled water be served for all drinking water use.

Q. What were the flow volumes of the wells which were shut down?

A. Well No. 35 had a flow volume of approximately 1800 gpm; Scottsdale well No. 6 had a flow volume of approximately 1200 gpm; and Well No. 31 had a flow volume of approximately 2500 gpm. Tempe Well No. 6 had a flow volume of approximately 1200 gpm.

Q. What is DBCP?

A. DBCP, or dibromochloropropane, is a constituent of pesticides sold under the trade names of Nemagon, Fumazone,

Nemafume, Nemaset, Nematox, BBC 12 and OS-1897. It has reportedly been used since the mid-1950's to control nematodes, worms which feed on plant roots, particularly citrus, cotton, and grapes. DBCP has been linked to male sterility in workers involved in its manufacture and handling and to cancer in laboratory animals.

Q. What is the concentration or level of DBCP for an excess cancer risk rate of 10^{-6} for 70-year, lifetime exposure?

A. The concentration or level of DBCP for such an excess cancer risk is between .01 and .005 ppb.

Q. What is the current policy or practice of the Department of Health Services regarding DBCP?

A. The current policy of the Department is to minimize human exposure to DBCP whenever possible.

The Department is considering as interim standards for materials in drinking water an excess cancer risk of not greater than 1×10^{-6}.

A permit will not be issued by the Department for a public water supply source if that source is within 1.5 miles of a citrus-growing area or a DBCP-contaminated well unless the well has been analyzed for DBCP and the DBCP level has been found to be below .01 ppb.

Q. Describe the DBCP well sampling program conducted by the Department of Health Services from June through September, 1979.

A. A DBCP well sampling program was conducted in response to an EPA request to survey groundwater supplies in areas where it was suspected that DBCP had been used. EPA's request was based upon the discovery of DBCP in drinking water in California in citrus growing areas.

A total of 107 water samples were taken from 93 wells and one surface water source. Of the 93 wells sampled in Maricopa County, 26 (28%) were found to be contaminated with DBCP, in excess of .01 ppb. Five percent of the wells contained DBCP in levels greater than 1 ppb. The surface water sample contained less than .01 ppb of DBCP. See Dibromochloropropane (DBCP) Well Sampling Program For Maricopa County, attached hereto as Exhibit C.

Q. What action did the Department of Health Services take after conducting the above analyses of well samples?

A. The Department advised owners with wells containing DBCP levels of greater than 1.0 ppb to seek alternative water supplies for all domestic uses. Owners of wells with DBCP levels of less than 1.0 ppb but greater than .01 ppb were advised to seek alternative water supplies for drinking and culinary purposes and to minimize human contact for all other uses. The Department recommended that three municipal wells be removed from their systems. Two of the wells were disconnected from the water systems.

Q. What other potentially carcinogenic organic chemicals have been found in wells or water systems in the Phoenix area?

A. Other potentially carcinogenic organic chemicals found in wells or water systems are PCE or pentachloroethane, DCE, or dichloroethylene, and trihalomethanes, including chloroform.

Trihalomethanes are created when chlorine reacts with trihalomethane precursors such as humic acid, fulvic acid, and other products produced by the breakdown of algae and other organisms. Trihalomethanes include such compounds as chlorinated hydrocarbons.

EPA guidelines state that the entire class of trihalomethanes are potential carcinogens and that the level of these compounds should not be more than 100 ppb in delivered water supplies.

The level of trihalomethanes in delivered water in the Phoenix area is within the range of 0 to 100 ppb at the present time, and averages about 42 ppb.

Plants treating surface water for public water supply systems have had to modify their processes to minimize the formation of trihalomethanes to ensure that the level is kept below 100 ppb.

Q. Have you found other organic chemicals in wells sampled by the Department of Health Services?

A. Yes. We have found a number of chemicals, including, most notably, in nine wells tested, phthalates, a constituent in plasticizers.

Phthlates have been found in concentrations ranging from 25 to 100 ppb with an average of about 61 ppb in Maricopa County. Although the excess cancer risk of 1×10^{-6} for this material is 15,000 ppb, my staff has concern about phthalates because they are a material that should not be present in groundwater.

Q. Why are volatile chemicals an important concern in groundwater contamination?

A. Volatile chemicals have been shown to move very rapidly through soils, either together with water or possibly as a vapor. The are not absorbed into soils as readily as are materials with larger molecules.

As a group, volatile chemicals tend to be linked to cancer. About one-half of volatile organics contained in the EPA Priority Pollutant List are known or suspected carcinogens.

Q. How does groundwater contamination spread?

A. Contaminated groundwater, in traveling from the surface or point of contamination near the surface, follows the path of least resistance, through voids and porous

zones. Contamination moves areally until it reaches the top of a saturated zone. Some contaminants are believed to migrate downward through the saturated zone to bedrock or other impervious basement materials. Pollutants deposited in the upper parts of the saturated zone move with the direction of groundwater flow. Groundwater flow can either be in the direction of natural flow or toward wells that are pumping.

When a pumping well is shut off, the groundwater flow is toward another pumping well or in the direction of natural flow. Groundwater flow is also altered by natural events such as infrequent flooding or wet periods which recharge groundwater in one area causing flow away from the recharge area.

This movement is not predictable for a number of reasons including: extremes in meterological conditions and runoff events.

Moreover, at the present time, no state regulatory program exists to manage groundwater flow for pollution plume management.

Q. Can you detect the amount and effects of groundwater pollution precisely?

A. No, detecting groundwater pollution is not an exact science. Often contaminants do not follow surface contours of the land.

Visual observation of contamination is not possible. Moreover, in order to take samples, one must construct a sample point that requires drilling a hole and completing a sampling well. Often the existing sample points are not properly located and constructed for investigatory purposes.

Also, because groundwater moves very slowly, and cannot be observed, material which is now detectable could have been discharged into the groundwater possibly more than 20 years ago.

Q. Do you expect groundwater contamination to become a greater problem in the future in terms of discontinuing the use of public water supply wells?

A. Yes. I believe that the Department, with increased capability to detect different chemicals and contaminants in water, expect to find more chemicals incompatible with public health. It becomes increasingly likely that other contaminants will be regulated as their presence becomes known and their effects on human health are determined.

One of the ways being considered by the Department of Health Services to deal with currently unregulated chemicals in the public drinking water supply is a proposed regulation to establish emergency action levels so the Department can set limits for certain chemicals on an emergency basis when it determines these chemicals endanger the public health.

In addition, the current quality control program for public water supplies is currently overseen by the State of Arizona. Water system owners, however, have the responsibility to collect all water samples, submit the samples to a laboratory for analysis, and report the results to the Department. The Department periodically conducts random checks of these test results. The Department may enforce the quality control program more strictly if it were to conduct its own collection an analysis of all samples.

Q. What is the cost of correcting or remedying groundwater contamination?

A. Corrective action is very costly because the contaminant spreads over a large area; typically the wells in Arizona are very deep, over 200 feet; and the source of contamination is difficult to locate with precision.

TRICHLOROETHYLENE

Briefing Document

Prepared by:

Environmental Health Services Division
Department of Health Services

January 1982

TCE - TOXICITY AND HEALTH EFFECTS

Trichloroethylene is a solvent for fats, waxes, resins, oils, rubbers, paints and varnishes with a multitude of uses. It is most commonly used as degreaser in various industries. Other applications include dry cleaning, paint stripping, automobile body polishing and decaffeinating coffee. Historically TCE has been used extensively in the aerospace and electronics industries.

1,1,2 Trichloroethylene (U.S.E.P.A.)

Symptoms:

- Small quantities of TCE inhaled cause dizziness, drowsiness, nausea and vomiting
- High concentrations may cause heart fibrillation and sudden death, "Turning On"
- Prolonged exposure causes hepatorenal failure, abdominal cramps, vomiting, cardiac arrythmia, coma
- Chronic exposure may lead to double vision, color misinterpretation and blindness
- Skin contact: Vesicular lesions (finger paralysis from hand immersion)

Organs Affected

Respiratory system
Cardiovascular
Central nervous system
Digestive system
Urinary system

Carcinogenicity (National Cancer Institute, 1976)

Cancer was produced in mice but not in rats.

Teratogenicity and Mutagenicity were also documented after long-term exposure in experimental animals.

Risks:

No Federal or State standards have been developed for TCE. The excess lifetime cancer risks computed by EPA from the NAS model at various exposures assuming the 70 kg adult drinking two liters of water per day for 70 years at the indicated concentration are as follows:

Concentration	Excess Risk
4.5 ug/l	one in 1,000,000
45 ug/l	one in 100,000
75 ug/l	approximately two in 100,000

For water quality guidance in several other states, 4 or 5 ppb were considered sufficient cause to condemn a water source.

SENATE BILL 1055 - TCE SUPERFUND

Senator Usdane has introduced a bill which would result in the establishment of a State Superfund specifically for trichloroethylene contamination of drinking water supplies. It requests the allocation of 1.5 million dollars which would be made available to political subdivisions for the removal or reduction of TCE on a priority basis. The Arizona Department of Health Services would be responsible for the administration of the Superfund. Additionally, authority would be given to the County Attorney to impose a civil penalty not to exceed $10,000 for each day that any person unlawfully disposes of TCE.

The Bill passed the Senate Health, Welfare and Aging Committee on January 19 and is now in the Senate Appropriations Committee.

PROPOSED AMENDMENTS TO HAZARDOUS WASTE REGULATIONS

Regulatory controls on wastes containing TCE are being tightened as a result of the recent discoveries of TCE in groundwater used for drinking water.

Currently the EPA, and Arizona, only regulate TCE as a hazardous waste in concentration above 85%. The Department proposes to amend the hazardous waste regulations to control TCE in concentrations above 50 ppm.

The second proposed amendment to the regulations will change the small quantity generator maximum generation rate to 250 kg per month for TCE waste generators. The current rate is 1,000 kg per month. Persons generating in excess of 250 kg per month will be required to use recognized hazardous waste facilities for disposal.

Additional proposed amendments to the regulations will require all small quantity generators to submit annual reports to the Department identifying wastes generated and final disposition of those wastes.

The proposed amendments will serve to locate more of the TCE currently being generated and to better anticipate potential problems with hazardous wastes.

DEPARTMENT OF DEFENSE PROGRAM

EPA ACTION AGAINST HUGHES

In July 1981, EPA requested certain information regarding hazardous wastes from Hughes Aircraft Co. under Section 3007(a) of the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (RCRA). EPA requested all information about analyses of soil, water, groundwater, TCE, DCE, and hexavalent chromium conducted on the Hughes property or in the vicinity of the Tucson International Airport. In addition EPA requested Hughes' results on split (duplicate) samples collected by representatives of Ecology and Environment, Inc., consultants for EPA, at wells in the vicinity of the airport in March and May 1981. Hughes responded in August 1981, refusing to release the information. They claimed that the allegations were vague, ambiguous and overly broad, that the EPA was not authorized by Section 3007 to seek disclosure of such result, that any tests conducted were covered by confidentiality, the attorney-client privilege and the work product rule, and were not properly subject to the disclosure under Section 3007. Hughes was served, on October 7, 1981 with a Complaint and Compliance Order which alleged that Hughes did not provide the information requested and is thereby in violation. Hughes subsequently filed a Motion to Dismiss, but on December 29, 1981 Administrative Law Judge, Marvin E. Jones, in Kansas City ruled in favor of EPA. He stated that the information sought consisted of necessary data and records germane to a regulatory action in which the public interest outweighed the individual interest. He also rejected Hughes' claim of confidentiality because of the relevance of the information to the regulatory proceeding. Hughes was ordered to supply the information by January 14, 1982. However, Hughes again appealled and a further hearing was held on January 20, 1982 in San Francisco, at which Hughes was given a temporary stay pending a

hearing on or about April 6, 1982.

The Department of Defense Hazardous Waste Program has implemented a nationwide Installation Restoration Program (IRP) to clean up military sites at which toxic materials pose an environmental hazard. The program has three phases: Phase I is a complete analysis of background information and data on the groundwater pollution; Phase II is quantification of the problem and indepth studies; Phase III is corrective action, such as cleanup or confinement of the contaminated aquifer. Hughes has contracted with a private engineering firm to produce a report, due February 1, 1982, which is equivalent to both Phase I and II of the IRP. It is unknown when the report will be made available to the State or EPA, but IRP reports are public information, therefore a delay of more than a few months is unlikely. At a January meeting of the Department of Defense in Washington, D.C., the Hughes plant was designated as top priority in this project. If cleanup is deemed necessary, funding could take as long as two years if the normal budget cycle is followed. However, there is a possibility of emergency funding if appropriate.

There will be a meeting on February 4, 1982 with DOD representatives to discuss IRP and the ongoing or proposed studies at Davis Monthan and Hughes Aircraft in Tucson.

HISTORY - TUCSON

March 5, 1981: EPA Field Investigation Team - uncontrolled hazardous waste sites - Hughes selected by EPA, Region IX and ADHS based upon Surface Impoundment Assessment completed in December 1979

April 15, 1981: Analyses of 3 industrial wells and 8 wells in surrounding area are completed. Two industrial and one municipal well indicate presence of TCE

May 1981: Resampling and new sampling conducted - all 129 Priority Pollutants done

June 1981: Industrial wells contained

TCE 100 - 1000 ppb
1,1 - dichloroethylene 200
1,1,1 - trichloroethane 100

- SC-7 contained
TCE 77
1,1 - dichloroethylene 13

- C-62 contained
TCE 60

Since then ADHS conducted sampling of 68 Tucson Water wells, all Tucson Water reservoirs, selected distribution system samples and 25 private or industrial wells.

Shallow and deep soil samples are being collected in an effort to identify potential sources. Sampling sites were selected on the basis of information on known disposal areas.

Tucson Water has taken over the responsibility for routine monitoring of wells that are still in use within the defined study area. Three abandoned wells on Tucson Airport Authority property are currently

being renovated by Tucson Water. Samples from these wells should aid in further defining the characteristics of the plume.

HISTORY - VALLEY

October 1, 1981:	City of Phoenix initiated analyses for TCE.
October 10, 1981:	Resampling is conducted in "problem area" served by 64th Street reservoir. Three of the ten wells sampled exhibit varying levels of TCE.
October 27, 1981:	ADHS is informed of the results. Samples are collected for confirmation of results by the State Laboratory. Wells #35 and 36 are taken off line until the extent of the problem is defined.
October 29, 1981:	ADHS meets with representatives from the Cities of Phoenix, Scottsdale and Tempe to discuss further monitoring.
October 30 to Present:	Extensive monitoring of all identified wells in the area are sampled in an effort to define the extent of contamination and identify other areas of concern. Shallow and deep soil samples have been collected in selected locations in the Indian Bend Wash area.

STATUS - CONTAMINATED WELLS

City of Tucson		TCE ppb
5 wells closed		
SC-7	Tucson Nogales Highway	70-122
C-62	6th & South of Valencia	55-107
C-64	5th & Bilby	2.4 - 9.7
B-101	13th & Nebraska	7.1 - 33.5
B-87	10th & Utah (S. of Irvington)	2.9 - 6.6
B-85	13th & Tennessee (N. of Irvington)	0.4 - 6.6

City of Phoenix	
2 wells closed	
Booster station - NE corner 52nd St. & Thomas	8.1 - 20.4
64th St. & Thomas - SW Corner reservoir	1.0 - 21.2
Well #36 - SE Corner Thomas & Miller	100 - 143
Well #35 - SW Corner Thomas & Indian Bend W.	7.2 - 223
Well #34 - NW Corner Indian School & Hayden Road	1.6 - 3.8

City of Scottsdale	
2 wells closed	
Well #31 - 82nd St. & Earle (3100N)	5.0 - 6.7
Well #6 - 82nd St. & Osborn (3400N)	18.0 - 22.5

City of Tempe	
2 wells closed	
Well #6 - McKellips & 78th Street	2.1 - 8.7
Indian Bend Booster 1/4 mi. E & 1/4 mi. N of Hayden & McKellips (SRP well)	ND - 0.9
Rural Road & Lemon Road	10

Salt River Project - irrigation wells	
Miller and Roosevelt	35.5
Miller & McDowell	440 - 510
Granite Reef & McDowell	700 - 900
(A sample has been submitted to be analyzed for the 129 priority pollutants)	
Thomas & 74th Street	35.5 - 47.00

Phoenix-Litchfield Airport Area	TCE ppb
1 well closed	
Well #3	116
Goodyear Aerospace #2	2.6
Goodyear Aerospace #4	1.0

Other Analyses: Monitoring of all wells serving the communities of Mesa, Goodyear and Kingman have been sampled for TCE. The results were all below the detection level.

Defined study area - Tucson

South - Hughes Access Road
East - Swan
North - Tucson - Benson Highway
West - LaCholla

Defined study area - Phoenix-Scottsdale

South - Salt River
East - Pima Road
North - Chaparral Road
West - Scottsdale Road

ADHS PLAN OF ACTION

In response to the TCE problem, a special Task Force has been formed within ADHS and has coordinated activities with the municipalities, DWR, the Attorney General's Office, industries, county health departments and EPA. Various individuals in ADHS have been assigned to work on the TCE issue full time. The basic steps that are necessary to address the problem of groundwater contamination have been identified. The first concern is to ensure the protection of the public's health; second, to protect the groundwater quality.

1 - monitor all drinking water wells to ensure public safety

2 - monitor all other identified wells to further define the extent of contamination and characteristics of plume

3 - evaluate historical and current land use in the area - SIA, landfills injection wells, complaints

4 - inspect and investigate potential source

5 - conduct extensive monitoring including

.. shallow and deep soil samples

.. monitoring wells for vertical testing

.. measurement of static water levels

.. analyses for other contaminants

6 - evaluate potential for cleanup of significant sources that may be contributing to the contamination

7 - define the alternatives for future use of the aquifer including

.. treatment alternatives

.. aquifer management

.. alternative sources

.. seasonal

In mid February an interim report will be released. It will include: an evaluation of current and historical chemical quality data; a health risk

assessment; evaluation of treatment alternatives; analysis of historical and current land use.

STATE ORGANICS GROUP

Additionally, it is apparent that groundwater contamination may be a problem throughout the State and that TCE may not be the only contaminant. A State Organics Group has been organized to develop an approach to identifying these areas of concern. It is broken into seven subgroups.

1. Laboratory Network
2. Education
3. Health Effects Assessment
4. Implementation/Regulation/Guidance
5. Surveillance/Monitoring
6. Control Option Development
7. Enforcement & Legal Counsel

SCOPE OF WORK

I. HYDROGEOLOGICAL STUDY

A. Well inventory
B. Determination of Static Water Levels
C. Definition of Subsurface Geology
   1. Interpretation of Data
D. Determination of Aquifer Characteristics
E. Development of Water Budget for Industries
F. Evaluation of Current Chemical Quality
G. Evaluation of Historical Chemical Quality
H. Conduct Borehole Geophysical Study
   1. Interpretation of Data
I. Preparation of Report - Draft
                          Final

II. WASTE STREAM/SOURCE STUDY

A. Analysis of Aerial Photography
B. Evaluation of Historical Landuse & Industrial Practice
C. Characterization of Solid Waste

III. PLUME IDENTIFICATION

A. Determination of Geographic Extent
B. Determination of Vertical Extent

   1. Existing wells
   2. New wells

C. Vadose Zone Sampling

IV. MONITORING WELLS

A. Development of Monitoring Wells
B. Identification of Origin of Plume (Source)

GUIDELINES

ADHS Guidelines for TCE and Other Organic Contaminants in Municipal and Community Water Supplies have been developed.

The Guidelines are a cooperative effort between the ADHS and public water suppliers to deal with the problem of TCE and other organic contaminants in groundwater. The major concern is to protect the public from the possible carcinogenic effects of long-term consumption of low levels of these compounds.

The Guidelines defined the procedures for:

Initiation of monitoring in high risk areas based upon landuse, waste disposal, hydrologic factors, pollution history

Reporting requirements

Resampling

Considerations for use

- further analyses
- alternative sources
- feasibility of blending
- seasonal use*
- treatment
- aquifer management

*e.g. If no other carcinogens beside TCE are present, the following levels are presently under consideration:

TCE Concentration in Water Delivered to Consumers	Use Period/Yr.
1 to 2 X action levels	no more than 6 mos/yr.
2 to 4 X action levels	no more than 3 mos/yr.
4 to 8 X action levels	no more than 1 1/2 mos/Yr.
8 to 10 X action levels	no more than 30 days/yr.

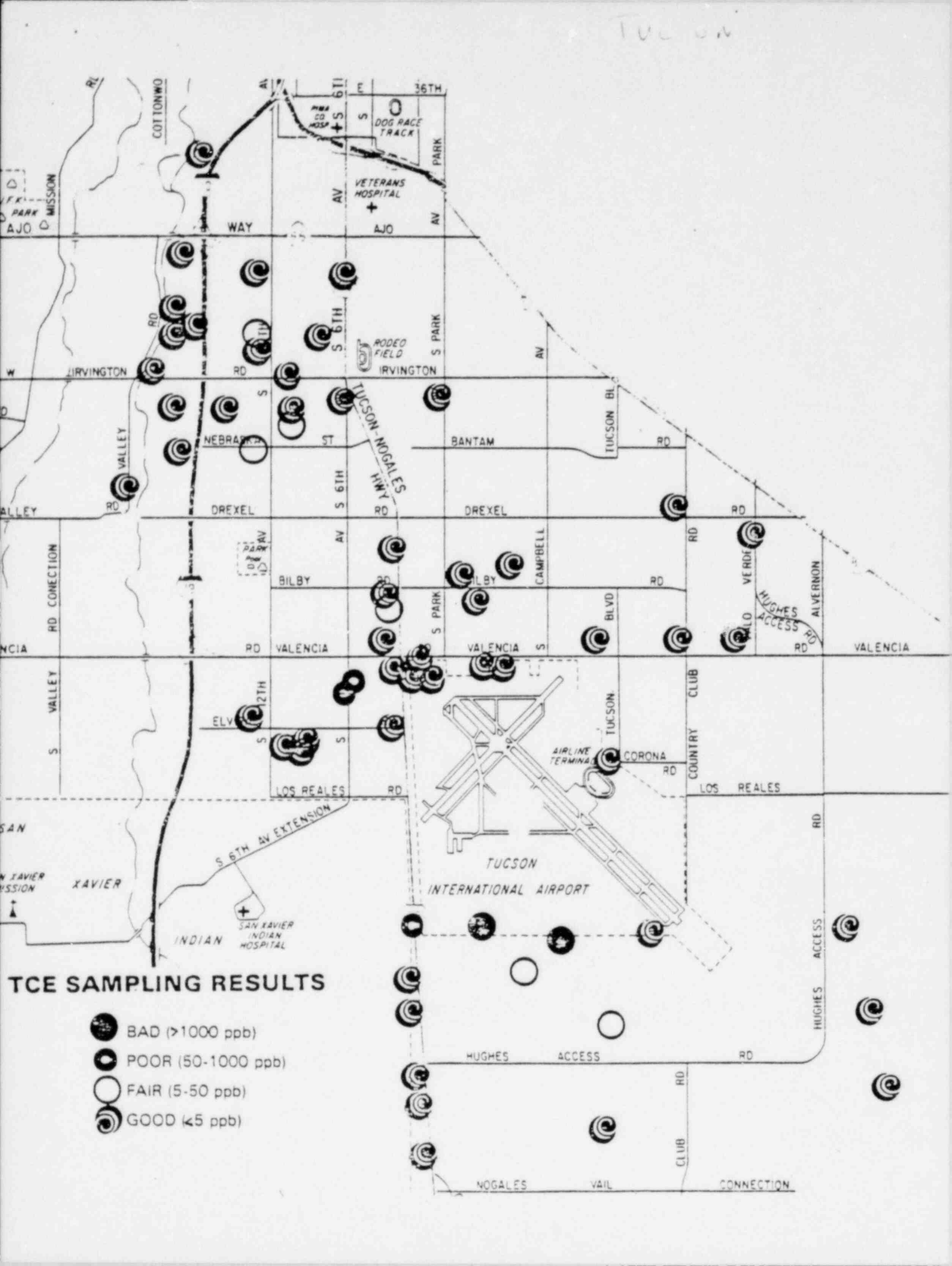
TCE TREATMENT ALTERNATIVES

The two most common methods of treatment for TCE are Aeration (Packed tower) and Adsorption (Granular activated carbon). Boiling is a possible method of removal as an emergency measure. Combining aeration and adsorption or blending may prove to be the most economical and practical, providing the system will allow a combination scheme.

"Packed tower" aeration is being used in the Eastern U.S.A. to solve TCE pollution problems in drinking water systems. These systems obtain removal efficiencies consistently in the range of 90-98 percent. Amortized capital and operation and maintenance costs of treatment using "Packed tower" aeration range from 8-10 cents per 1000 gallons treated (system size @ 5.0 MGD) to 50-60 cents per 1000 gallons treated (system size @ 100,000 GPD).

Granular activated carbon (GAC) is also being used in the Eastern U.S.A., e.g. Atlantic City, N.J., to solve TCE pollution problems in drinking water systems. These systems obtain removal efficiencies consistently in the range of 96 - 100 percent. Amortized capital and operation and maintenance costs of treatment using GAC range from 25 cents per 1000 gallons treated (system size @ 5.0 MGD) to $1.50 per 1000 gallons treated (system size @ 50,000 GPD).

Treatment combinations of partial treatment (using aeration) followed by blending, and diffused aeration followed by GAC have been used as treatment schemes in removing TCE. The combination used would depend on the influent TCE concentration, the layout of the system (wells, storage tanks, and service connections), volume of water to be treated, and the effluent quality desired. Use of treatment combinations will tend to be more economical and practical when able to incorporate into the treatment process.


TUCSON
COTTONWO
AJO
WAY
VETERANS HOSPITAL
DOG RACE TRACK
PARK
MISSION
RODEO FIELD
IRVINGTON
S 6TH
S PARK
AV
TUCSON BL
NEBRASKA ST
BANTAM
TUCSON-NOGALES HWY
VALLEY
DREXEL
BILBY
CAMPBELL
VERDE
HUGHES ACCESS
ALVERNON
VALENCIA
RD
BLVD
CLUB
COUNTRY
CORONA
AIRLINE TERMINAL
ELVD
12TH
LOS REALES
S 6TH AV EXTENSION
TUCSON INTERNATIONAL AIRPORT
XAVIER
INDIAN
SAN XAVIER INDIAN HOSPITAL
NOGALES
VAIL
CONNECTION
TCE SAMPLING RESULTS
BAD (>1000 ppb)
POOR (50-1000 ppb)
FAIR (5-50 ppb)
GOOD (<5 ppb)

BRIEF CHRONOLOGY OF EVENTS - SCOTTSDALE TCE

Date	Agency	Product/Activity
Dec. 1979	ADHS	Surface Impoundment Assessment Report (SIA)
Spring 1980	ADHS	Prioritization of Surface Impoundments
June 1980	ADHS/EPA	FIT Investigation of Motorola GED
October 1980	ADHS	Motorola stops using surface impoundment
Spring-Summer 1981	ADHS	Motorola removes heavy metal residue in old surface impoundment
October 1981	ADHS	Motorola conducts test borings/sampling
October 1981	Phoenix	TCE detected in drinking water system
November 1981	ADHS	Motorola submits results of sampling
Nov.-Dec. 1981	ADHS/SRP/Munic.	Additional samples collected for analysis(Att.
Dec. 1981	ADHS	TCE presence confirmed by State Laboratory
Dec. 16, 1981	KOY	Bob Scott letter to ADHS discussing perched water theory
Dec. 18, 1981	ADHS/SRP	Sample cascading water in SRP well at McDowell and Granite Reef
* Dec. 21 & 22, 1981	ADHS	Soil sampling at Motorola
* Jan. 5-7, 1982	ADHS	Soil sampling in Indian Bend Wash
Jan. 4, 21, 1982	ADHS/DWR	Discuss groundwater investigation problems & possible solutions
March 4, 1982	ADHS/DWR U of A	Discuss groundwater investigation w/DWR and cities and outline new field investigation techniques
March 16, 1982	ADHS	TCE Guidelines released (Attachment 2b)
* March 17-19, 1982	ADHS/U of A	Field testing of new investigation techniques using Gas Chromatograph
March 30, 1982	ADHS, DWR, SRP, U of A, Munic.	Draft work plan developed for coordinated project (Attachment 4b)

Date	Agency	Product/Activity
April 5-13, 1982	City of Phoenix/SRP ADHS	Test pumping of Well #35 and monitoring TCE values. Analyze for purgeable organics. (Attachment 5b)
May 4, 1982	DWR/U of A	Install soil drive points for soil gas sampling

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* Large expenditures of resources by ADHS

(a) Dec. 21 & 22, 1981 $9,000
(b) Jan. 5-7, 1982 $5,000
(c) Mar. 17-19, 1982 $2,000

Special expenditures of resources for testing by Motorola GED at ADHS' request
Oct. - Dec. 1981 $7,000 - $10,000

Work Plan - ADHS, DWR, SRP, U of A, Phoenix, Scottsdale, Tempe

Phoenix - compile and evaluate historical well data
- long term pumping
  water level
  water quality
- pull pump
  tv scan
  gamma neutron logs
  sample cascading water
- pumping test w/ larger pumps
- monitoring wells in perched system

SRP
- compile and evaluate data
- drive point for soil gas near well
- auger holes for soil gas to perched system
- long term pumping
  water level
  water quality

Phoenix action plan (Attachment 3b)

- 192 priority pollutants analyses for all 3 wells - duplicates to State Lab
- continue use of #34 (<5 ppb), #35 (220 ppb) trade-off with SRP
- use #36 (130 ppb) on seasonal basis; blends with 40 MGD Verde System

Scottsdale action plan

Step 1: abandon wells if possible; Step 2: blend lower concentration well (#31), taking 12 hour samples for TCE analysis

Tempe action plan

Seek alternate sources for now

Rough Estimate of Hydrological Investigation in Indian Bend Wash area of Scottsdale/Tempe

Monitoring Well Construction	$150,000
Laboratory Analysis of Samples	84,000
Hydrologic Report (consultant)	50,000
Personnel Costs (State)	25,000
Administrative Costs (State)	7,500
	$316,500

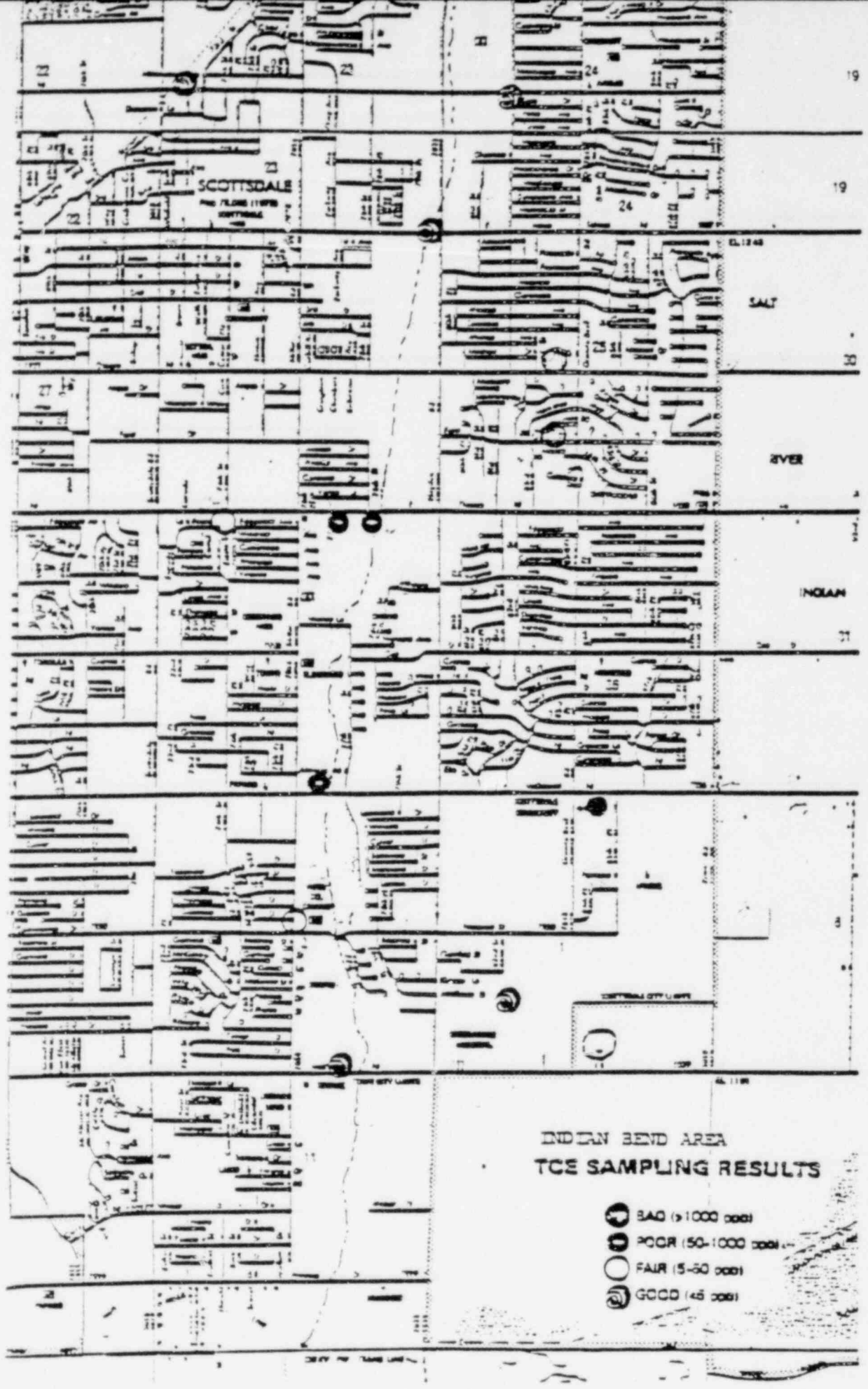
CAUTION

DATA IS NOT VERIFIED OR INTERPRETED

FOR PRELIMINARY USE ONLY

Preliminary TCE Results for Maricopa County March 29, 1982

Contents


SCOTTSDALE
SALT
RIVER
INDIAN
INDIAN BEND AREA
TCE SAMPLING RESULTS
BAD (>1000 ppb)
POOR (50-1000 ppb)
FAIR (5-50 ppb)
GOOD (<5 ppb)

CITY OF PHOENIX SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
7	Verde Well Field	COP	9/30/81	ND	ND	
18	8791 E. Indian School	COP	9/30/81	ND	ND	
19	8601 E. Indian School	COP	9/30/81	ND	ND	
20	8201 E. Indian School	COP	9/30/81	ND	ND	
23	2916 N. 84th St.	COP	9/30/81	ND	ND	
34	7992 E. Indian School	COP	9/30/81	2.9	ND	
		COP	10/9/81	3.8	ND	
		COP	10/29/81	3.4		
		ADHS	10/29/81	1.6		
		ADHS	10/29/81	4.9		
35	7825 E. Thomas	COP	9/30/81	221	1.8	
		COP	10/9/81	223	5.5	Off-line
		COP	10/29/82	8.7		Pumped 2 hr
		ADHS	10/29/81	7.2		
		ADHS	10/29/81	6.3		
		ADHS	11/2/81	134		Pumped 24 hr.
36	7601 E. Thomas	COP	9/30/81	100	0.8	Off-line 10/8
		COP	10/9/81	102	5.1	
		COP	10/29/81	128		
		ADHS	10/29/81	143		
		ADHS	10/29/81	103		
110	4530 N. 17th Ave.	COP	9/30/81	ND	ND	
180	13009 N. 56th St.	COP	9/30/81	ND	ND	

CITY OF PHOENIX

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
	7th St. & Broadway	COP	10/11/81	12.9	ND	
	16th St. & Baseline	COP	10/10/81	5.8	ND	
	18th St. & Buckeye	COP	10/10/81	15.0	4.5	
	40th St. & Baseline	COP	10/10/81	7.8	ND	
	40th St. & Van Buren	COP	10/3/81	+	+	
	40th St. & Washington	COP	10/10/81	1.6	ND	
	Booster 52nd St. & Thomas	COP	10/9/81	20.4	ND	
		COP	10/29/81	8.2		
		ADHS	10/29/81	8.1		
	52nd St.	COP	10/9/81	2.0	ND	
	Booster at 64thSt. & Thomas	COP	10/10.81	21.2	4.5	
		COP	10/29/81	5.3		
		ADHS	10/29/81	5.1		
		ADHS	11/3/81	1.0		
	Papago Booster at 64th St.	COP	10/9/81	20.6	ND	
	Scottsdale & Indian School	COP	10/10/81	13.0	ND	
	Scottsdale & Indian School (Benihana)	COP	10/10/81	0.1	ND	

CITY OF SCOTTSDALE

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
1		ETL	11/6/81	1t2.5		
2	82nd St. & Camelback	ETL	10/29/81	2.9		
		ADHS	10/30/81	1t0.3		
		ETL	10/30/81	1t2.5		
		ETL	11/6/81	1t2.5		
3	Pima & Jackrabbit	ETL	10/29/81	1t 2.5		
		ADHS	10/30/81	1t0.3		
		ETL	10/30/81	1t2.5		
		ETL	11/02/81	1t2.5		
		ETL	11/06/81	2.9		
4	Pima & McDowell	ETL	10/29/81	1t2.5		
		ETL	10/30/81	1t2.5		
		ADHS	10/30/81	1t0.3		
		ETL	11/2/81	1t2.5		
5	82nd St. & AZ Canal	ETL	10/29/81	2.8		
		ETL	10/30/81	1t2.5		
		ADHS	10/30/81	1t0.3		
		ETL	11/6/81	1t2.5		
6	82nd St. & Osborn	ETL	10/29/81	18.1		off line 10/30
		ADHS	10/30/81	22.5		
		ETL	10/30/81	21.5		

CITY OF SCOTTSDALE

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
7		ETL	11/2/81	1t2.5		
9		ETL	11/2/81	1t2.5		
10		ETL	11/2/81	1t2.5		
11		ETL	11/2/81	1t2.5		
12	McCormick Parkway	ETL	11/29/81	2.5		
14	Scottsdale and Indian Bend Road	ETL	10/29/81	1t2.5		
18		ETL	11/2/81	1t2.5		
19		ETL	11/2/81	1t2.5		
20		ETL	11/2/81	1t2.5		
21		ETL	11/2/81	1t2.5		
22		ETL	11/2/81	1t2.5		
23		ETL	10/29/81	2.9		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
23		ETL	11/2/81	1t2.5		
27		ETL	11/2/81	1t2.5		
28		ETL	11/2/81	1t2.5		
29		ETL	11/2/81	1t2.5		
31	82nd St. & Earl	ETL	10/29/81	6.7		off-line 10/31
		ADHS	10/30/81	5.0		
		ETL	10/30/81	13.7		
32		ETL	10/29/31	1t2.5		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
1	College & Railroad	WCT	12/2/81	0.2		
3	7th & College	WCT	12/2/81	0.2		
4	lemon at Rural Rd.	WCT	12/2/81	10		off-line 12/10
		ETL	12/11/81			
		ADHS	12/11/81	8.5		
6	McKellips & 78St.	ETL	10/30/81	5.9		
		ADHS	11/2/81	2.1		
		ETL	11/2/81	1t2.5		
		WCT	11/3/81	3.2		
		WCT	12/2/81	4.0		
		WCT	12/4/81	13.0	~~DCE~~, methylene chloride 4/5	off-line12/10
		ADHS	12/04/81	8.7		
		ADHS	12/11/81	2.6		
		ETL	12/11/81	2.5		
7	Smith St.& Canal	WCT	12/2/81	0.3		
8	Elem. St + McArthur	WCT	2/05/82	6.0		off line 12/5/81 added to N
9	Calle de Caballos	WCT	12/2/81	1t0.1		
10	Price & Southern	WCT	12/2/81	1t0.1		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
Indian Bend Well	McKellips, E of Hayden	ETL	10/30/81	1t2.5		
		ETL	11/2/81	1t2.5		
		ADHS	11/2/81	1t0.3		
		WCT	11/3/81	0.8		
		WCT	12/2/81	0.9		
		ADHS	12/17/81	0.7		
	Broadway & Rural	WCT	12/2/81	1.4		
		ADHS	12/10/81	0.9		
		ADHS	12/17/81	1t0.3		
	NE Carter & College	WCT	11/3/81	2.8		
	NW Elna Rae & Priest	WCT	11/3/81	1.1		
	SE McAllister & Continental		11/3/81	0.9		
	SW 56th St. & Carmen	WCT	11/3/81	1t0.5		
	SE Rural & Knox	WCT	11/3/81	1t0.5		
	6600 S. Price	WCT	11/3/81	1.5		
	NE Broadway & Price	WCT	11/3/81	0.5		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
	NE Encanto & College	WCT	11/3/81	1t0.5		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
21.5E, 8N		ADHS	11/10/81	1t0.3		
22E,1.9N		ADHS	1/15/82	1.1		
22.1E,8.5N		ADHS	11/10/81	1t0.3		
22.3E,7N		ADHS	11/10/81	38.5		
22.5E,5.5N		ADHS	11/10/81	35.5		
22.5E,6N		ADHS	11/10/81	510		
23.6E,6N		ADHS	11/10/81	600-1000		
		ADHS	12/8/81	992		Cascading water at 113 ft. Sample also sent for PP
24.3E,3N		ADHS	1/15/82	1t0.3		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	LOCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
1		ADHS	11/24/81	1t0.3		
2		ADHS	11/24/81	1t0.3		
3		ADHS	11/24/81	1t0.3		
5		ADHS	11/24/81	0.4		
6		ADHS	11/24/81	1t0.3		
7		ADHS	11/24/81	1t0.3		
Phoenix-Litchfield Municipal Airport						
	Distribution system	ADHS	11/24/81	47.3		
2		ADHS	12/9/81	1t0.3		
3		ADHS	12/9/81	116		off-line
Goodyear Aerospace						
2		ADHS	12/9/81	2.6		
4		ADHS	12/9/81	1.0		
Park Shadow Apartments						
1		ADHS	12/9/81	1t0.3		

SAMPLES ANALYZED FOR VOLATILE ORGANICS

SYSTEM NUMBER	OCATION	LAB	DATE	TCE PPB	PCE PPB	NOTES
SR BIA	McKellips & 92nd St.	ADHS	11/30/81	1t0.3		
Cuthbertson,	5135 E. Whittier	ADHS	11/3/81	1t0.3		
AAA,		ADHS	1/8/82	1t0.3		
Brock,	2150 E 1st St. Tempe "	ADHS	1/8/82	1t0.3		
Century,	100 S Price Rd. Tempe	ADHS	1/8/82	1t0.3		
Donais		ADHS	1/8/82	1t0.3		
Redimix		ADHS	1/8/82	1t0.3		
Webber		ADHS	1/8/82	1t0.3		
	Elliot & Price SE	ADHS	1/8/82	1t0.3		

ARIZONA DEPARTMENT OF HEALTH SERVICES

Division of Environmental Health Services

BRUCE BABBITT, Governor
JAMES E. SARN, M.D., M.P.H., Director

March 16, 1982

TO: All Interested Parties

FROM: J. Wesley Clayton, Assistant Director
Environmental Health Services

RE: Final Guidelines for TCE in Public Water Supplies

Enclosed please find the final "Guidelines for TCE in Public Water Supplies." I appreciate the assistance provided in reviewing the draft versions and hope that the final meets with your approval. The cooperation given the Health Department by public water suppliers has been excellent. I hope the Guidelines will serve to direct our activities for the benefit of the public and the protection of drinking water supplies. If you have questions regarding the Guidelines, please call Sandra Eberhardt at (602)255-1172.

JWC:SE:md
Enclosure

tate Health Building 1740 West Adams Street Phoenix, Arizona 85007

3/11/82

ARIZONA DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL HEALTH SERVICES
GUIDELINES FOR TCE IN PUBLIC WATER SUPPLIES

ATTACHMENTS

ARIZONA DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL HEALTH SERVICES
GUIDELINES FOR TCE IN PUBLIC WATER SUPPLIES

I. GENERAL DESCRIPTION

The Guidelines were written by the Environmental Health Services (EHS) Division of the Arizona Department of Health Services (ADHS) with comments incorporated from public water suppliers and other outside reviewers. They are neither regulatory nor mandatory but represent a cooperative effort to provide safe drinking water to the public. The Guidelines may be replaced by regulations at a later time.

The Guidelines specifically address trichloroethylene (TCE), which often precedes or accompanies other organic pollutants. These organic compounds have acute toxic effects and chronic effects including suspected carcinogenesis. The suspected carcinogenic properties of organic compounds are of primary concern.

The Guidelines define the procedures for initiation of well monitoring by the public water supplier, resampling and reporting. The various considerations and alternatives for further use of a contaminated well are also discussed. Where contamination is found, ADHS will, within its resources and in conjunction with other agencies, participate in activities to ensure a safe drinking water supply, define the extent of contamination and characteristics of the plume, identify potential sources, assist in the elimination of those sources, and define the alternatives for future use of the aquifer. Where pollution sources can be pinpointed and legal liability can be assessed, ADHS will take action against the discharger to ensure the cleanup or containment of contaminated groundwater and cleanup of disposal areas which pose a threat to groundwater.

II. ACTION LEVEL

A. Definition of Action Level

Since there is no federal standard, the ADHS has set a TCE action level of 5 ppb (ug/l). This corresponds with an estimated 70-year lifetime carcinogenic risk of 1 in 1 million, based upon consumption of two liters of water per day. The action level serves as an alarm or early warning signal that industrial groundwater pollution exists, and that steps should be taken to assure a safe water supply and to investigate the source and magnitude of the pollution. The action level is not the limit beyond which safety and public health are endangered, but rather the level at which action should commence.

B. Definition of Average Value

The average value is used to determine compliance with the action level. The average value for TCE at a particular sampling location is defined as the average of the last five samples

collected on five different dates or the total number of samples collected to date if less than five have been analyzed. The individual analyses, reported to the nearest 0.1 ppb, should be averaged and the result rounded to the nearest whole number. All reported "none detectable" or "less than" values shall be calculated as one-half, to the nearest 0.01 ppb, of the minimum detectable level reported by the analytical laboratory. If more than one sample is collected on the same date, the average of all samples collected on that date shall be used as one data point for calculating the overall average.

III. ALLOWABLE LEVELS IN DRINKING WATER

The goal is to deliver water to the consumer with minimum risk, preferably less than one excess cancer per million population. This corresponds to an average concentration of 5 ppb or less of TCE. With ADHS approval, water exceeding the action level may be delivered based upon the following schedule, assuming no other contaminants are present and the concentration is less than 5 ppb for the remainder of the year.

Table I

	TCE Concentration in Water Delivered to Consumers - ppb	Allowable Use - mo/any 12-mo. period
1.	< 5	12
2.	< 10	no more than 6
3.	< 20	no more than 3
4.	< 40	no more than 1½
5.	< 50	no more than 1
6.	> 50	should not be used

Only one level greater than 5 ppb can be used in any 12-month period. If other suspected carcinogens are present, the risks will be treated as additive and the calculations will be more complex. In determining total risk, ADHS will consult health effects data from various sources, including the EPA Office of Drinking Water, Criteria and Standards Division.

IV. WATER SUPPLY SYSTEM TESTING

A. Initial Testing

1. Testing by ADHS

ADHS will evaluate all available information (e.g., surface impoundment assessments, hazardous waste generator reports, underground injection well survey) relating to waste disposal practices, land use, industrial activity, etc. to identify areas in the State which have a high risk of TCE contamination. ADHS will initiate testing in identified areas.

2. Testing by Public Water Suppliers:

In high-risk areas, ADHS will notify public water suppliers to initiate TCE testing.

a. Time Frame:

The monitoring of on-line systems is to commence within three months of notification, or at the next trihalomethane (THM) sampling, whichever is first. When wells are put on-line, they should be tested within three months. If a new well is drilled in a known contamination area, a registered geologist or engineer should supervise drilling and sampling of soil and water. The quality of the final aquifer tapped should be tested before the permanent pump is installed.

b. Sampling Sites:

The water system managers may use their discretion in selecting sampling points. Ideally, individual wells should be sampled. However, systems with a large number of wells may use several distribution system sampling locations. The sampling site should be located such that all wells serving that portion of the system contribute significantly to the sample collected. The same sites collected for THM analysis may be used. Sampling should be performed during normal operating conditions in accordance with the procedures given in Attachment 1. For information regarding sampling site selection, call the Compliance Unit Manager at (602)255-1254.

B. Follow-Up Testing

1. Less Than 5 ppb TCE

Wells containing less than 5 ppb TCE may remain on-line and will be resampled on the following schedule:

a. Every Three Months (along with THM sampling)

1) Wells located near a contaminated well or a known TCE source. System wells to be sampled shall be determined by the ADHS.

2) Wells containing TCE above 2.5 ppb.

b. Once Per Year

Other wells should be sampled for TCE on the same schedule and at the same sampling locations required by THMs, provided that at least 1 sample per year is collected.

2. Greater Than 5 ppb TCE

a. Well Samples

Any well with an average value greater than 5 ppb TCE should immediately be resampled and the sample should be sent to the ADHS Laboratory at 1520 W. Adams, Phoenix, Arizona 85007 for analysis of purgeable priority pollutants and general chemistry. A purgeable priority pollutant sample should also be collected at the nearest consumer's tap served by the contaminated well, or at a representative point in the distribution system as close as possible to the nearest consumer's tap served by the contaminated well. Call the TCE Coordinator at (602)255-1134 to schedule the sample analysis.

b. Distribution System Samples

When the action level is equaled or exceeded in the average value for a distribution sample, the water supplier should, within one week, sample all individual wells significantly contributing to that sampling point. When TCE is detected in a distribution sample but at a concentration less than the action level, the water supplier should sample all individual wells significantly contributing to that sampling point within six months.

V. LABORATORY REQUIREMENTS

The ADHS Laboratory Certification and Licensure Section is setting up a program to approve commercial and private laboratories to perform organic chemical analysis. Until this program is established, the ADHS Laboratory will accept samples from public water suppliers for TCE analysis at no charge. Such sample submittals should be scheduled in advance by calling Mr. Jerry McCarty, manager of the ADHS Laboratory Chemistry Section at (602) 255-1188.

VI. ANALYTICAL REPORTING REQUIREMENTS

All analytical results will be shared between ADHS and the water supplier.

A. Telephone

All water system TCE results greater than 5 ppb action level will be reported by telephone within one work day of receipt. Water suppliers will report to the ADHS TCE Coordinator at (602) 255-1134. ADHS will report water analyses by telephone to the water system manager.

B. Mail

1. All TCE or related analytical results, regardless of level found, will be reported in writing within one week. Water suppliers will mail results to the TCE Coordinator, Environmental Health Services, 1740 W. Adams, Phoenix, Arizona 85007. ADHS Laboratory will mail reports to the water system managers. All written reports should include the name of the utility, the sampling site identification, the date and time of sample collection, the name of the analyzing laboratory, date of laboratory report and analytical result. In addition, information should be available regarding the USGS well number or legal description of the sampling point, and the pumping time prior to sampling. An analysis report form is included for convenience (Attachment 2).

2. All TCE samples analyzed prior to the establishment of these Guidelines should also be reported so that both parties have complete records.

VII. STEPS TO PROTECT WATER SUPPLIES

When a well exceeds the action level, the following steps should be taken:

A. Remove from Service

The well should be taken off-line if possible while investigations are conducted and alternatives are considered.

B. Gather Information

The water supplier and ADHS should confer regarding the feasibility of returning the well to service. ADHS and the water supplier should work together to gather information and data needed for this determination.

C. Assess Alternatives and Safeguards

ADHS and the water supplier should review the alternatives and required safeguards given in the following section. Decide which alternatives are feasible and how the safeguards could be met.

D. Submit Plans

1. Written Plan of Action

The water supplier should submit a written plan of action giving in detail what will be done with the well and how the safeguards will be met in accordance with Section VIII. Relevant information should be given, such as dates, concentrations, flows, diagrams, blending and treatment capacity, hydrologic data, estimated population affected, estimated number of service connections, type of water use (residential, industrial, etc.),

estimated residence time of the population, and any other pertinent information. The plan is to be submitted to the TCE Coordinator.

2. Engineering Plan

Engineering plans and specificationss needed to carry out the plan of action should be submitted to ADHS for approval.

VIII. ALTERNATIVES AND SAFEGUARDS FOR USE OF WELLS HIGHER THAN THE ACTION LEVEL

A. Alternatives

The following alternatives for use of wells higher than the TCE action level may be employed by water suppliers with the approval of ADHS. The alternatives may be employed singly or in combination. Regardless of the resources expended, if the water does not meet the allowable levels given in Table I, p. 2, it should not be delivered to the consumer.

ADHS will provide technical information and will seek aid and funding for water treatment. However, the ultimate responsibility for delivery of acceptable water rests with the water supplier.

1. Well Not Used

Leave the well off-line or use it for other non-drinking water purposes. This is a possibility where other water sources are available at reasonable cost. The health risk of the alternative water supply should also be examined and determined by ADHS to be less than that of the supply being abandoned.

2. Blend

Mix the contaminated water with other sources to obtain a final product within the allowable level at all consumer's taps. The other source should be analyzed and determined to be of a lesser health risk than the water being blended. Submit engineering plans to ADHS for approval.

3. Seasonal Use

The well can be used during periods of high demand in accordance with the allowable levels previously given in Table I, page 2.

4. Well Modification

It is possible that, in some cases, well modifications may result in improved water quality. This would require site-specific evaluations of hydrologic conditions. Submit engineering plans to ADHS for approval.

5. Treatment

There are several methods for TCE removal. The two most common methods are aeration (packed tower) and adsorption on granular activated carbon (GAC). Combinations of partial treatment followed by blending, and diffused aeration followed by GAC have also been used.

6. Continued Use

If necessary, the well may be used "as is" if it is determined by ADHS that it is the only source of supply or that it is not feasible to blend or treat the water. Notice should be provided as given in the following section.

7. Other

Any other proposal that meets the intent of safeguarding the consumers will be considered by ADHS.

B. Required Safeguards for Use of Wells Above the Action Level

If a well higher than the action level is to be used as a water supply, the following safeguards should be employed:

1. Monitor

The distribution system and source well should be monitored on a regular basis, initially every day until a trend is defined, and then less often after stable conditions are established according to the written plan of action submitted by the water supplier.

2. Meter

Water suppliers should record and report to ADHS the volume of water pumped from the well.

3. Notice

Consumers should be given notice when water containing more than the allowable level of TCE is delivered. Notice should be given in the next set of bills and repeated quarterly as long as the condition exists. For non-billing water systems, notification may be given by posting, publication, or direct mail. ADHS will assist utilities in developing notice and establishing other related requirements such as methods of notification and frequency. For assistance, call the ADHS TCE Coordinator at 255-1134. A sample notice is given in Attachment 3.

ATTACHMENT 1

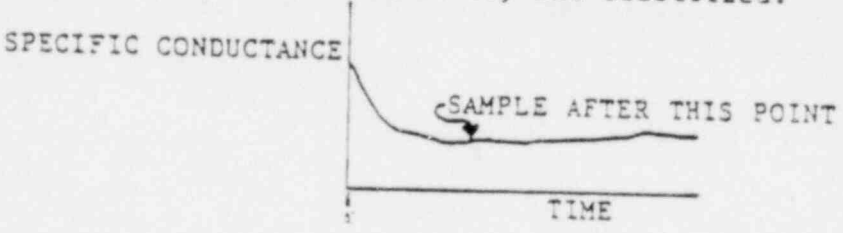
TCE SAMPLE COLLECTION INSTRUCTIONS

Items Needed:

1. Field notebook
2. Pen
3. Marking pen (waterproof)
4. Clean Pierce vials supplied by the analyzing laboratory (at least two samples)
5. "Blank" vials supplied by the laboratory (at least one for each group of samples to be analyzed)
6. Ice chest
7. Ice or blue ice
8. Labeling tape
9. Strapping tape for sealing the ice chest
10. Map (USGS 7½ minute map is recommended) for plotting well location
11. Stainless steel cup
12. Conductivity meter for measuring salt content
13. Well sounder for measuring water levels

Prepumping the Well

In order to obtain a sample that is representative of the groundwater, the well should be pumped for a period of time before collection because the water within the well casing and in the immediate vicinity of the well may differ significantly from the quality of the groundwater. The length of time required to pump should be sufficient to remove a minimum of 3-5 bore volumes. The bore volume in gallons equals the casing diameter in inches times casing height in inches times 3.14159 times 0.004329. Ideally, the wells should be pumped for several hours before a sample collection if the well has been out of operation. The change in conductivity should be recorded with time and the sample should be collected after the conductivity has stabilized.



Sample Collection

If possible, the sample should be collected directly from the well discharge, otherwise as close to the discharge point as possible. Since TCE is extremely volatile, precautions must be taken to reduce the extent of aeration that occurs during sample collection. The tap should first be opened full and allowed to run for a couple of minutes. The valve should then be closed until a slow, steady, clear non-aerated stream of water is flowing. To avoid aeration, the glass sampling vial should be held at an angle so that the stream of water flows down the side. Fill the vial until it overflows to eliminate any air bubbles and replace the teflon-lined cap. Be very careful not to contaminate the inside cap or the mouth of the vial. A stainless steel cup, rinsed before and after each use, may be used to fill the vial, if necessary. Two vials should be collected for each sample.

Turn the vial upside down and tap it to check for air bubbles. If there are any bubbles, top off the vial and check for air bubbles again. Repeat this procedure until an acceptable sample is obtained.

Sample Identification

All samples must be clearly labeled with a waterproof pen on labeling tape with an identifying number and date. The sample ID, date, time, location, pumping time before sampling, exact sampling point and name of sampler and witness should be recorded in a record book in ink (Attachment 2). The well locations should be given by both system name and number and USGS well number (or township, range, section and quarter, quarter, quarter) so that the data can be correlated.

Sample Preservation and Transportation

Place the samples in an ice chest with 10 pounds of ice or blue ice to maintain a cold temperature and prevent volatilization. The vials need not be placed in contact with the ice. Seal the ice chest and ship or deliver it to the laboratory within 48 hours. Also, include two blank control samples—these are vials filled with distilled water by the lab and are carried along with the rest of the vials to pick up any volatile materials encountered along the way. Coordinate timing with the shipper and lab so that samples can be analyzed within the 14-day holding time. The sample submittal form should indicate the test(s) to be performed and where the report(s) are to be mailed.

Other Information

Measure and record static water level and pumping water level if possible. Record all other available information, including date drilled, total depth, casing diameter and depth, yield in GPM, surface elevation, well use and perforated interval.

TCE ANALYSIS REPORT FORM

Reported _____

Utility Name _____

Address _____

City, Zip Code _____

Phone No. ( ) _____

Lab Name _____

Address _____

City, Zip Code _____

Phone No. ( ) _____

e	Exact Sample Location *	Sample Type **	Sample Date	Prior Pumping Time, Hours	Lab. Report Date	ppb TCE	Notes

Give Township, Range and Quarter, Quarter, Quarter or USGS Well Number

Give sample type as W for Well, D for distribution system.

SANTA MONICA
CALIFORNIA

OFFICE OF THE DIRECTOR OF GENERAL SERVICES
1685 MAIN STREET, 393-7973
SANTA MONICA, CALIF. 90401

Dear Resident:

No doubt you are aware of the detection of trichlorethylene (TCE) and the presence of trihalomethane (THM) and asbestos in the water in Southern California. The City has chosen to inform you of the facts and answers to some to the pertinent questions so that misunderstandings may be alleviated.

Question: What is TCE?
It is an industrial solvent that is currently used by many automobile repair shops and by most industrial shops. It is listed by the National Academy of Sciences as one of the chemical substances that has produced cancer in laboratory animals and is consequently suspected as a possible carcinogen in humans. In the work place and industrial environments, exposure from handling or breathing of concentrated TCE, (greater than 100,000 parts per billion (ppb)) has led to serious damage to health in humans.

Question: What is the situation concerning TCE in Santa Monica Water?
Traces of TCE were found in two of the City's water wells, and the City took immediate steps to control and reduce those levels. The two wells have not been used for several months. There is no indication the amount of TCE which reached consumers when the wells were in use exceeded California Department of Health or Environmental Protection Agency limitations. Tests indicate the maximum amount was less than 5 parts per billion. Water from the affected wells was aerated and blended with other water as a normal part of the water treatment process before being allowed to enter the distribution system.

Question: What are the health risks connected with drinking water containing TCE?
Although no limit has been established, the U.S. Environmental Protection Agency (EPA) projects that drinking water containing 4.5 ppb of TCE will increase a person's risk of dying of cancer by one chance in 1,000,000, if consumed at the rate of 2 liters (½ gallon) a day for 70 years. The risks may be compounded when the drinking water also contains other organic substances.

To compare EPA's estimated risk with other known risks, consider the following (from statistical information published by Purdue University):
In a population of one million people, during their lifetimes the statistical probability is that —
- 28 people will die in hurricanes.
- 35 from being struck by lightning.
- 700 by air travel.
- 2,300 by drowning.
- 17,500 by motor vehicle accidents.
- 1 by drinking water containing 5 ppb of TCE for 70 years.

Question: What are Trihalomethanes (THMs)
Unlike TCE which is an industrial product found in some well water, THMs are a by-product found in imported water which has been chlorinated. Santa Monica uses from 40-70% imported water which is purchased from the Metropolitan Water District. Surface water supplies (such as MWD supply in Northern California) pick up organic materials from weeds, grass, and leaves as it travels through the San Francisco delta area. When the organic material comes in contact with chlorine during the disinfection process THMs are formed.

Question: How much THM is in Santa Monica Water and what are the health risks associated with this contaminant?
The MWD water frequently contains from 80-120 parts per billion of THM. Santa Monica blends its well water with this in varying amounts depending on the zone within the City. The resulting water contains from 30-100 parts per billion THMs. The EPA has stated that the maximum contaminant level (MCL) which may not be exceeded is 100 parts per billion, effective in 1982. The same level of risk as TCE. The effects of THMs on the human body are still under study but one test has found very high doses can be carcinogenic to laboratory animals.

two wells, there is no TCE in the water. There are levels of THMs in the water which occasionally exceed the proposed 1982 limits of the EPA (100 ppb).

The presence of significant levels of THMs is related only to the purchased Metropolitan Water District water. All of the cities in Southern California which use MWD water (almost all of Southern California) are experiencing the same situation as Santa Monica. Santa Monica through its representative on the MWD Board has requested the MWD to take steps to control the THM levels.

The City has controlled its TCE level by temporarily closing two wells, but has necessarily purchased larger amounts of MWD water which as discussed above approached maximum allowable levels of THMs.

Question: What is the situation regarding asbestos in the water?

The presence of measurable levels of asbestos fibers in the water is again related only to the water we purchase from MWD and again this affects most all Southern California cities. Safety standards for asbestos concentrations in drinking water have never been set and there has been no link established between asbestos in drinking water and cancer in the body. MWD is currently intensifying the level of filtration of its water to reduce the presence of these fibers.

Question: What is currently being done by the City to better these types of problems?

The City is doing the following:

1. Engaged a consultant to survey 100 businesses which use chemicals, to determine source of purchase, method of use, and method of disposal.
2. Engaged a soils engineer to do investigative drilling, sampling and analysis to try to determine the source(s) of the TCE in the groundwater.
3. Authorized purchase of new laboratory equipment capable of analyzing minute quantities of organic materials in water.
4. Increased frequency of sampling and analysis of drinking water for determination of possible contaminants.
5. Increased surveillance for illegal disposal of substances which would enter the groundwater or storm drain system. Citations are being issued for illegal disposal.

The City can assure you that we will continue to monitor and test the water with the best available analytical technology, and will notify you if the water fails in any way to meet Federal, State, and our own stringent requirements. The safety of our public water supply is our business and more than 1,000 separate quality and safety tests are conducted on our water each month.

Question: What are the alternatives?

Simply stated, if you're not convinced that the water is safe, there are always alternatives.

Some are:

1. Boil the water. TCE and THMs have lower boiling points than water, so this is most effective in removing it from the water.
2. Use commercially bottled water. You may wish to check the quality of this water to see if it meets your requirements.
3. Investigate (carefully) the various makes and types of filters and treatment units which fit on your sink or home plumbing.*

* The City, as a matter of policy, will neither approve nor disapprove any commercial product.

Summary

The water in Southern California contains small concentrations of organic substances. New technology has allowed detection of previously unmeasured materials such as TCE and THMs. Santa Monica water continues to meet State and Federal requirements. Based on these standards, no health risk to the citizens of Santa Monica is indicated at this time.

We will continue to keep you informed of any problems which may arise through the local news media, and you may contact City Hall at 393-9975, extension 224.

S. E. Scholl
Director of General Services

SES:dd

SUMMARY OF ARIZONA'S TCE-CONTAMINATED WELLS
MAY 28, 1982

1. Public Water Supply Wells Off-Line due to TCE Contamination Greater than 5 ppb

Well Name	USGS Well No.	Location	Highest TCE Concentration Analyzed, ppb
Tucson International Airport Area			
Tucson:			
SC-7	(D-15-13)19ccc	8100 S. Tucson-Nogales Highway	122
B-87	(D-15-13)1bcb	499 W. Wyoming St.	6.6
B-101	(D-15-13)12dab	754 W. Dakota Dr.	90
C-64	(D-15-13)12dba	222 W. Bilby Road	9.7
C-62	(D-15-13)13abc	6643 S. Missiondale Rd.	107
North Tucson Area			
Tanner Co.	(D-13-13)17cad	Camino del Cerro & I-10	15.1
Indian Bend Wash Area			
Phoenix:			
35	(A-2-4)35aab	7825 E. Thomas	223
36	(A-2-4)35abb	7601 E. Thomas	143
Scottsdale:			
6	(A-2-4)25bdd	82nd St. & Osborn	49.3
31	(A-2-4)25cdb	82nd St. & Earll	13.7
Tempe:			
6	(A-1-4)11-6	McKellips & 78th St.	13
4	(A-1-4)23-4	Lemon and Rural Rd.	10
Goodyear Area			
Phoenix Litchfield Municipal Airport:			
3	(B-1-1)16acd	North of Buckeye & Litchfield Rd.	577

2. Other Wells with TCE Contamination Greater than 5 ppb

Well Name	USGS Well No.	Approximate Location	Highest TCE Concentration Analyzed, ppb
Tucson International Airport Area			
Tucson:			
B-85	(D-14-13)35dad	4642 S. 13th St.	6.6
B-102	(D-15-13)2dda	Drexel & 12th Avenue	18.1
Tucson Airport Authority:			
TAA-5	(D-15-14)19aac	Tucson International Airport	21.7
Hughes Aircraft Co.:			
H-CU	(D-15-14)19cdc	Hughes Aircraft Credit Union	1,580
H-1	(D-15-14)29bbb	Hughes Aircraft Co.	4,600
H-4	(D-15-14)29bdd	"	108
H-2	(D-15-14)30ada	"	7.7
North Tucson Area			
Ina Rd. Landfill:			
IRL2	(D-13-12)1acb	Ina Road Landfill	1,040
Indian Bend Wash Area			
Tempe:			
8	(A-1-5)19-8	George St. & McArthur	6
Salt River Project:			
22.3E,7N	(A-2-4)35bba	Thomas & 74th St.	38.5
22,5E,5.5N	(A-1-4)2dbb	Miller & Roosevelt	35.5
22.5E,6N	(A-2-4)35bcc	Miller & McDowell	510
23.6E,6N	(A-1-4)1aba	Granite Reef & McDowell	992
Goodyear Area			
None			

Dibromochloropropane (DBCP) Well Sampling Program

For

Maricopa County, Arizona

(June 11 - September 25, 1979)

Prepared by:

Timothy D. Love
Microbiologist II
Ambient Water Quality Unit
Bureau of Water Quality Control
Arizona Department of Health Services
Phoenix, Arizona
December 10, 1979

APPROVED:

E. K. Swanson	[signature]	[signature]
Manager, Ambient Water Quality Unit	Manager, Technical Services Section	Manager, Planning Section

[signature]

Chief,
Bureau of Water Quality Control

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Acknowledgements

The Arizona Department of Health Services, Bureau of Water Quality Control, expresses its appreciation to the municipal water departments of the Cities of Glendale, Mesa, and Phoenix; to the Salt River Project, Roosevelt Water Conservation District and Chandler Heights Citrus Irrigation District; and to various private irrigation and/or domestic well owners for their cooperation during the well sampling program.

The Arizona Water Commission provided a partial inventory of registered wells in Maricopa County with their characteristics, assisted in obtaining search warrants, and assisted in the technical review of this report. Access to aerial photographs provided by the Maricopa County Office of the U.S. Agricultural Stabilization ar ervation Service was helpful in locating citrus growing areas. Maricopa County maps were drafted by the Mapping Division of the State Land Department.

The U.S. Environmental Protection Agency provided funds for conducting the sampling program by contracting with LFE Corporation, Environmental Analysis Division, 2030 Wright Avenue, Richmond, California 94804.

Abstract

This report reviews the dibromochloropropane (DBCP) well sampling program conducted in Maricopa County, Arizona during the months of June through September, 1979. Data indicate that a number of wells associated with citrus growing areas have been contaminated. These wells have been used for irrigation, municipal and/or domestic purposes. Of the 26 wells found contaminated, three were used for public water supply systems. Of these three wells, two were large municipal wells and have been removed from the water supply systems.

DBCP (1,2-dibromo-3-chloropropane) is a constituent of pesticides sold under the trade names of Nemagon (Shell), Fumazone (Dow), Nemafume, Nemaset, Nematox, BBC 12, and OS-1897. It has been reportedly used since the mid-1950's to control nematodes, worms which feed on plant roots, particularly citrus, cotton, and grapes. DBCP has been linked to male sterility in workers involved in its manufacture and handling and to cancer in laboratory animals.

Keywords: Arizona, citrus, contamination, detection levels, dibromochloropropane, groundwater, nematodes, pesticide, wells.

RECOMMENDATIONS

In light of the study results, the Bureau of Water Quality Control recommends that the following things be done:

- The BWQC should require DBCP residual analyses to be conducted prior to approval of any domestic water sources within 2.4 km (1.5 miles) of known DBCP contaminated wells or citrus growing areas as identified in plates 1-4 and refuse to permit sources with any evidence of DBCP contamination.

- The BWQC should establish sampling procedures, identify laboratories certified to perform DBCP analysis, and provide other necessary guidance to water system owners.

- The Board of Pesticide Control should reorganize their records so that information on the amount of pesticides applied can be retrieved by both type and geographic area.

- The BWQC should develop and implement a monitoring program to identify the occurrence of organic contaminants in groundwater.

- The BWQC in cooperation with EPA should develop and adopt drinking water standards for organic chemicals including DBCP.

- The BWQC in cooperation with EPA should investigate the potential use of home water treatment devices to remove DBCP and other organic chemical contaminants.

- The AWC in cooperation with the BWQC should investigate the following specific hydrologic issues relative to DBCP contamination:
    a. Most likely pathways of DBCP transport into the groundwater.
    b. Whether DBCP samples obtained are representative of well point contamination or aquifer wide contamination.
    c. Occurrence and rate of DBCP movement between and within ground water bodies.
    d. Feasibility of eliminating or reducing DBCP contamination through insitu means.

- The AWC should seek authority to establish well construction regulations to ensure that well construction or abandonment does not contribute to pollution of ground water.

- The ADHS Bureau of Epidemiology should investigate the occurence of male sterility problems or unusual occurrences of cancer in individual served by domestic wells in proximity to existing and past citrus growing areas.

This report reviews the dibromochloropropane (DBCP) well sampling program conducted in Maricopa County, Arizona during June through September, 1979. Data indicate that a number of wells associated with citrus growing areas have been contaminated. These wells have been used for irrigation, municipal and/or domestic purposes. Of the 26 wells found contaminated, three were used for public water supply systems. Of these three wells, two were large municipal wells and have been removed from the water supply systems.

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BACKGROUND

The DBCP well sampling program in Yuma and Maricopa Counties was conducted in response to a request by the U.S. Environmental Protection Agency (EPA) on May 31 to survey groundwater supplies in suspected DBCP use areas. EPA's request was precipitated by recent DBCP findings in California.

The initial Maricopa County sampling program conducted on June 11, 1979 sampled wells in proximity to two suspected DBCP use areas--cotton fields and citrus groves. These areas were suspected because there were no readily available data from the Arizona Pesticide Control Board on DBCP use in Maricopa County.

On July 18, 1979 EPA announced plans to suspend the use of DBCP due to health-related concerns. The use of DBCP on some vegetables was banned by EPA in 1977.[1] California banned the pesticide for all uses in 1977 after discovering DBCP in drinking water wells in citrus growing areas.

The July 18 announcement to suspend DBCP use would have become effective within five days after the announcement unless manufacturers and associations representing citrus growing interests requested a hearing. As a result, the ban was delayed 60 days pending the outcome of court hearings in Washington, D.C.

The purpose of the hearing was to determine if an imminent health hazard existed from the use of DBCP. If the data establish DBCP as an imminent health hazard, a temporary ban would have gone into effect immediately. This hearing ended on October 20, 1979, with Judge Gerald Harwood agreeing with EPA staff that the pesticide should no longer be sold for any purpose in the United States.[2] Additional court hearings will be initiated on whether a permanent ban should be imposed.

There are about 6800 hectares (16,800 acres) of citrus growing areas in Maricopa County as of 1972.[3] Pressures from urban population growth and periodic frost damage to citrus is expected to contribute to the reduction of citrus production in Maricopa County. The impact, if any, of a DBCP ban on citrus production cannot be assessed at this time. To date, no alternative pesticide or nematode resistent root stock is commercially available.

Network Design Methodology

After a State DBCP Working Group Meeting of June 22, the Ambient Water Quality Unit, Arizona Department of Health Services began identifying citrus groves in both Yuma and Maricopa Counties in which DBCP contamination was suspected. Although specific information on DBCP use was not generally available, prior surveys conducted in California affirmed citrus groves as target areas. Agencies contacted for purposes of crop data acquisition included: Arizona State Land Department, State Office of the Agricultural Stabilization and Conservation Service (ASCS), County Office of ASCS, and Arizona Department of Transportation.

Verification of citrus grove locations in both counties was made by reviewing aerial photographs furnished by the county office of the ASCS. The aerial photographs for Yuma and Maricopa Counties were taken in 1976 and 1970, respectively. Information on citrus locations were transposed onto county highway maps.

After the citrus groves were delimited, the Arizona Water Commission (AWC) was requested to provide an inventory of registered wells in the target areas and their characteristics. Well locations were correlated with proximity to citrus areas. Further, AWC staff recommended sampling shallow wells in order to sample the upper portion of the saturated aquifer where potential DBCP percolation from the soil was expected to be found. Also, AWC staff advised BWQC staff that small well casing diameters associated with domestic wells would ensure that the capacity of the wells were low and associated cones of depression small. Unfortunately, there

are few such wells in Maricopa County. The 30 to 200 m (100 to 650 ft.) depth to groundwater and continuous drop in the water table has generally made such wells impractical. Therefore, most wells sampled in Maricopa County were large, deep irrigation or municipal wells.

The ADHS requested the cooperation of Maricopa County Health Department (MCHD) in the location and sampling of wells. Because of shortages of MCHD personnel during the period of the study, ADHS personnel conducted the sampling and public information programs in Maricopa County. Considerable help was provided by the municipalities--Glendale, Mesa, and Phoenix; by various irrigation districts--Salt River Project (SRP), Roosevelt Water Conservation District and Chandler Heights Citrus Growers Irrigation District; and by public and private companies such as Consolidated Water Utilities, Inc. and Bob Fletcher Farms.

To ensure that ADHS did not overlook any private well not listed on the Water Commission printout, a news release was issued for any owners of wells located near suspected use areas to contact ADHS (Appendix A).

Collection Methodology

Sampling and collection methodology were conducted according to the following EPA protocol:

> Samples were collected in unused 1-quart commercial mason jars. The dome lids were carefully wrapped in heavy duty aluminium foil to preclude sample alteration by lid materials. Bottles were completely filled so that no air space was left at the top when the lid and screw ring were secured.

At all sampling locations, replicate samples were taken. The water from the private wells were run for approximately 10 minutes before each sample was taken. This procedure was followed to ensure that the water was fresh from the water column. Large irrigation wells or large municipal wells were sampled from a sampling valve or port located as close to the well head as possible. If no sampling valve or port was present or if the distance to the end of discharge pipe was less than 10 meters, samples were taken at the end of the discharge pipe. The sample bottles were rinsed three times with the well water before sampling.

Samples were labeled with the sampling location, date, time and sampler's name and cooled immediately after collection. Other pertinent information relative to well and soil characteristics were included on EPA's "chain of custody and sample history" form (Appendix B). Samples were sealed by adhering paper strips over the top to detect any unauthorized tampering with the samples.

Samples were placed on ice in Igloo-type picnic coolers immediately after collection and later transferred to dry Igloo-type coolers packed with cardboard, polystyrene, or other available packing materials to prevent breakage during shipment. To ensure that the samples remained cool during shipment frozen "blue ice" was used.

Samples were sent by air freight using Federal Express which provided one day, door-to-door service except for one holiday weekend when Hughes Airwest Air Freight was used. LFE Corporation, Environmental Analysis Laboratories, 2030 Wright Avenue, Richmond, California 94804 was the EPA contracted laboratory responsible for DBCP analysis.

GENERAL COUNTY CHARACTERISTICS

Most of the following four sections was either paraphrased or taken verbatim from two United States Department of Agriculture (USDA) Soil Conservation Service soil surveys.[3,4]

Physiography, Relief, and Drainage

Maricopa County is characterized by broad, featureless valleys that are filled with alluvial material as much as several hundred meters thick. Elevations range from 230 to 410 m (750 to 1,350 ft.) in the valleys and from 275 to 1,130 m (900 to 3,700 ft.) in the mountains.

The mountains are generally rugged and steep, though they attain only a moderate height. In parts of Maricopa County there are a few scattered mountains composed of granite and schist of Precambrian age, conglomerate of Cretaceous-Tertiary age, and andesite of Tertiary age. Maximum difference in elevation between the floor of the valley and the tops of the mountains is about 735 m (2,420 ft.). The valley floor is occupied by nearly level or gently sloping soils; in most places slopes are less than 1 percent. Soils in this transitional area are moderately sloping to steep.

Drainage of the Salt River Valley is mainly provided by the Gila River and its Agua Fria River and Salt River tributaries. Except for a few areas between Buckeye and Gillespie Dam, the entire survey area is well drained.

The water table in most areas is below a depth of 60 m (200 ft.) and declining due to pumpage in excess of recharge.

The four general landforms in the area are valley plains; stream channels, flood plains, and low terraces; alluvial fans; and mountains and low hills. The valley plains appear to be level, but rise steadily with increasing steepness from the axial trough toward the marginal mountains. Slope is less than 1 percent near the axial trough and approaches 9 or 10 percent near the mountains.

Stream channels, flood plains, and low terraces are the lowest points on the landscape. They are in or adjacent to the major stream channels. Valley plains and the remnants of a few old stream terraces are at slightly higher elevations. They roughly parallel but are one-fourth to one-half mile from the major stream channels. Near the base of the mountains are alluvial fans that are generally at right angles to the valley plains. They are generally distinct where the ephemeral stream leaves the mountain, but lose their identity downslope where they coalesce, forming a single broad plain. Often, the alluvial fan surface is a complex pattern of old and young alluvium. The areas of old alluvium appear stable because the ephemeral streams in these areas have become deeply entrenched. The recent alluvium can occur at the foot of an older entrenched fan. In various places the alluvial fans are encroaching on the valley plains. Some extend several miles from mountain fronts.

Some places in the area could have been old playas. One is near Luke Air Force Base, and the other is in the southern part of the Harquahala Valley. Both areas now have through-flowing drainage. The area near Luke Air Force Base is underlain by a silica-lime cemented hardpan. The area

in the southern part of the Harquahala Valley is underlain by a highly mottled, highly stratified sediment, and the nearby hills show evidence of having been an old shoreline.

Climate

Maricopa County has a desert-type climate. Relative humidity is low with an annual rainfall of 18 to 25 cm (7 to 10 in.). Average monthly precipitation exceeds 2.54 cm (1 in.) only during August and December. There are generally two separate precipitation seasons which are highly variable. The first occurs from November to March, when the area is subjected to occasional storms from the Pacific Ocean. Yet, there have been occasions when the area generally has little precipitation during this time. An example is the period from December 30, 1971 through June 6, 1972 (a period of 160 consecutive days) when no measurable precipitation was reported at Phoenix Airport.

The second rainfall season occurs in July, August, and most of September, when the area experiences widespread thunderstorm activity. These thunderstorms are extremely variable in intensity and location.

Temperatures are normally high in summer. From early June until mid-September the afternoon maximum temperature commonly exceeds 38° C (100° F) and temperatures of 43° C (110° F) or more are not uncommon. In winter the temperature ranges from 2 to 8° C (36 to 46° F) near daybreak to 18 to 21° C (65 to 70° F) in the afternoon. Freezing temperatures are not common. They generally occur on about 15 mornings in a normal winter.

Farming

The size of farms ranges from 130 to 4050 hectares (320 to 10,000 acres). The main cash crop is generally cotton. Alfalfa and small grain are grown to improve fertility, tilth, and organic content. The main acreage of vegetable crops is restricted to a few farmers who specialize in such crops. Table 1, lists the estimated harvested hectares of the principal crops in Maricopa County.

Soil Description

The U.S. Department of Agriculture, Soil Conservation Service has catalogued the soils in Maricopa County in two surveys.[3,4] The soils are quite diverse and cannot be adequately discussed in this report. The different types of landforms found in Maricopa County make any generalization of soils difficult. If a generalized term is needed the closest description would be sandy clay loam.

RESULTS

A total of 107 water samples from 93 wells and one surface water source were obtained between June 11-September 25, 1979. Of the 93 different wells sampled, 26 (28%) were found to be contaminated with DBCP; 5 (5%) were above 1 ppb DBCP. The surface water sample was found to contain less than 0.01 ppb DBCP. The other water samples were either duplicate or resamples of wells that had been sampled for quality assurance checks or for surveying wells over a period of time. A summary of DBCP results (reported in parts per billion) obtained during this sampling period is found in Table 2.

The detection level for the analyses of the June samples (AM-1 through 13) was 0.1 ppb DBCP. These samples were analyzed by the California State Department of Food and Agriculture laboratory. All subsequential samples were analyzed by LFE Corporation in California with a detection level of 0.01 ppb DBCP.

A compilation of the data collected in Maricopa County is found in Table 3. Information presented includes sample identification number, general location, well type and depth, pump setting, well casing, diameter, proximity to suspected DBCP use, suspect crop, soil type, sampling dates and reported DBCP level detected.

Positive results (≥0.01 ppb DBCP) obtained from the Maricopa County DBCP Well Sampling Program ranged from 0.01-4.5 ppb DBCP. The pesticide contamination was found in wells that have been drilled as deep as 625 m (2,050 ft.), but general well depths were around 305 m (1000 ft.).

Plates 1 through 4, identify the well sampling locations in Maricopa County. The BWQC designated samples with an "AM" number (State of Arizona, Maricopa County). Positive DBCP well sample sites are identified by "solid" circles, while wells in which no DBCP was detected are identified by "clear" circles. Shaded areas located throughout the plates represent citrus growing areas which have been verified by 1970 aerial photographs taken by the U.S. Soil Stabilization and Conservation Service and personal communication with their staff relating to the current status of citrus production.

DISCUSSION

The analysis of the data collected in Maricopa County indicates that DBCP residuals may be associated with large citrus groves. Wherever cotton was the suspected crop no trace of DBCP was found except at one location (AM-35). Possible reasons for these findings are: First, DBCP was not used in cotton areas because it was not economically justified.[5] Second, the amounts used were not great enough for DBCP to be detectable and/or, third, the duration of use was not long enough to reach the groundwater. There is some controversy about whether DBCP has been used on cotton. Bob Dowling, a technical representative for Shell Oil Co., which manufactured the pesticide in the past, stated..."(DBCP) is used in the United States to control nematodes in cotton, and that its use on food crops has been discontinued."[6]

A. South Phoenix Area

The highest levels of DBCP contamination in Maricopa County were from two irrigation wells (AM-26 and AM-27) located in an area of South Phoenix bounded roughly by Baseline Road on the north, 40th Street on the east, South Mountain Park on the south and 35th Avenue on the west. In this area the depth to groundwater is the shallowest in Maricopa County and ranges from 24 to 30 m (80 to 100 ft.). Also, these two wells had not been pumped extensively in the last two years because the irrigation water demand has been generally met by surface water. To the west of these wells are three private wells (AM-25, AM-54 and AM-75). All three were found to be contaminated.

These private wells may be contaminated for a variety of reasons, none of which are conclusive. First, the area was in citrus production five to ten years ago.[7] As a result, DBCP may have percolated down through the soil or cascaded down the well casings. Second, the contamination may have moved from the extensive citrus groves located east of the vicinity of these contaminated wells. This is supported by data compiled by U.S. Geological Survey (USGS) indicating that groundwater movement in this area is from east to west.[8]

The eastern section of this citrus area was not sampled because of the difficulty in finding wells. There are no municipal wells or irrigation wells in this area. The locations, construction specifications, and present owners of private wells were not readily obtainable.

ADHS relied on cooperation from the Arizona Water Commission, Maricopa County Health Department and the general public in locating and contacting owners of private wells in this citrus growing area.

B. East Mesa Area

Detectable levels of DBCP were found in wells sampled in the East Mesa area. Fifteen wells were sampled in this area bounded by Thomas Road on the north, Higley Road on the east, University Drive on the south and Gilbert Road on the west. In this area, four municipal wells used by the City of Mesa were sampled. One was found positive for DBCP (0.05-0.09 ppb)---Falcon Field #2 (AM-18). Although this contamination was near the laboratory detection level (0.01 ppb DBCP) ADHS recommended that the well be removed from the

system because DBCP is a known carcinogen and because of the unavailability of health effects data at low levels of exposure.

The City of Mesa immediately isolated this well from the system upon receiving ADHS recommendations. This well was resampled twice because of the important health aspects and the low level of contamination found. Resampling was accomplished while the well was separated from the system to preclude any further contamination of the municipal system. Six other samples from irrigation wells (AM-2, 30, 33, 40, 71, 73) from this area were all found to be contaminated. Three of these wells belonged to SRP and had not been extensively pumped during the last two years because surface water has been readily available. Two other irrigation wells (AM-30 and 40) located in the area, which had been pumped daily for several months prior to sampling, were also found to be contaminated.

The number of wells that were available to sample in the East Mesa area was limited by two factors. First, the AWC inventory of wells only accounts for mandatory registration of all wells after 1968 and other large wells since 1948. Information relating to these wells is often current only to the date when the well was drilled. Information on present owners of these wells is not updated, nor have abandoned wells been recently updated. Second, there was a lack of public willingness to identify private wells located in this area. Therefore, the number of wells that ADHS could readily identify that were adjacent to other known contaminated wells became an important fact in the sampling program.

An example was the wells of Citrus Heights Farms in the East Mesa area. This citrus farm is surrounded by DBCP contaminated wells (AM-2, 18, 30, 33, 40 and 71). Numerous staff contacts with the farm manager appealing for cooperation were unsuccessful (Appendix C). Therefore, to obtain the needed samples, ADHS had to obtain a search warrant (Appendix D, E and F).

Detailed data analysis may indicate a pattern in the well contamination in the East Mesa area. The Arizona Water Commission staff indicates that the East Mesa area is an area of significant groundwater withdrawal where the local groundwater table is depressed because of extensive pumping. The contaminated area is located near the center of the depression. Further data collection and analysis are necessary for assessment of the hydrologic situation.

C. Chandler Heights Area

About 23 kilometres (14 miles) south of the East Mesa area is another large citrus growing area located around Chandler Heights. The soils of this area is either of the Antho-Valencia association or the Gilman-Estrella-Avondale association.[4] Both are sandy or sandy clay loam soils. The depth to groundwater in this area was 90 to 120 m (300 to 400 ft.) in 1976.[9] Three well samples were found contaminated (AM-39, 64 and 69). One of the contaminated wells was sampled twice (AM-39 and 64) and is used both for irrigation and domestic supply for the Chandler Heights area. The other contaminated sample (AM-69) was taken from a well used only for irrigation. The operators of the Chandler Heights Citrus Irrigation District were informed by telephone and letter about the positive DBCP values found in their wells (Appendix G).

D. Northern Glendale Area

Another large citrus growing area is primarily located within a newly annexed area of the City of Glendale, Arizona. This area is bounded by Pinnacle Peak Road on the north, 51st Avenue on the east, Greenway Road on the south and 91st Avenue on the west. Included in this area are three large farms: Fletcher Farms, Bodine Produce Co., Inc. and Arrowhead Ranch. ADHS personnel were informed by the owner that DBCP has never been used on Fletcher Farms.[10] Yet, two of the six wells sampled (AM-82 and 85) were found to be contaminated.

If DBCP has never been used on this farm, from where did the DBCP come? If there is no perched water in this area, the DBCP contamination is believed to have come from outside this farm either from the south or east. Further sampling, data collection and analysis is necessary for better documentation of this pattern.

Repeated attempts were made to contact the owners of Bodine Produce Co., Inc. requesting permission to sample their wells (Appendix H). Inaction by these owners resulted in affidavits being sworn and a search warrant served to sample the Bodine Produce Company wells (Appendix I through K). Three of the six wells sampled (AM-88, AM-89 and AM-91) were contaminated with DBCP.

The ADHS sampled seven irrigation wells on September 11, 1979 on Arrowhead Ranch under the guidance of Art Martori, manager of Arrowhead Ranch (AM-94 through 100). Of these seven wells, two were found contaminated (AM-94 and 97). After discussions with the City of Glendale staff and their

engineering consultants, it was determined that not all of the wells were sampled on Arrowhead Ranch. On September 25, 1979, the manager again guided ADHS to three additional wells on Arrowhead Ranch (AM-106 through 108). Waters from all three of these wells were found to be contaminated.

The occurrence of DBCP well contamination in the northern Glendale area seems to follow the New River stream bed with highest values located downstream. Surface features have little effect on the state of ground water movement as indicated by the USGS map revealing that the local ground water gradient is toward the north, and the surface gradient is to the south.[3] This factor in addition to the prevalence of the three various soils types (Carrizo-Brios, Gilman-Estrella-Avondale and Mohall-Laveen association) in this area, makes any correlation of DBCP contamination difficult.[3]

Six to eight kilometres (4-5 miles) south of the above described area is a municipal-irrigation well (AM-109) used by the City of Glendale. It is located adjacent to an old citrus grove and was found to contain 0.01 ppb DBCP. Following ADHS health recommendations, the City of Glendale immediately removed the well from their system. The City requested further clarification on what levels of DBCP are deemed safe and what actions are recommended to remove or control DBCP contamination. ADHS has previously asked for such guidance from EPA in a letter from Dr. Suzanne Dandoy, M.D., M.P.H., Director of the Arizona Department of Health Services, to Paul DeFalco, Jr., Regional Administrator, U.S.E.P.A., Region IX (Appendix L). On September 20, Frank M. Covington, Director, Water Division, EPA, Region IX, responded to Dr. Dandoy's request stating, "The information which we have

gathered regarding the feasibility of treating DBCP contaminated water is inconclusive, and we have not yet received a response from EPA Headquarters to our request for an MCL (sic, Maximum Contaminant Level) or interim standard for DBCP. We are continuing to work with our Headquarters and Cincinnati Laboratory to deve'op the information you have requested."

It has been common practice in Maricopa County to share the use of wells between irrigation and domestic municipal use. Of the 93 wells tested in Maricopa County for DBCP, eight had shared use (Table 4) with four having detectable levels of DBCP. Only one of these contaminated wells has been removed from service (AM-109) despite ADHS recommendations. The others have not been taken out of service because there are no alternative sources of water in those areas.

POSSIBLE WELL CONTAMINATION MECHANISMS

Possible well contamination routes have been discussed by Ham with the most probable avenues of DBCP contamination being related to well design and construction.[11] The first of these is by direct contamination of the well through any break or other opening in the casing or between the casing and the pump base or seal (Figure 1A). The second is by the reversal of contaminated discharge system flow (Figure 1B). The third is the disturbed zone or open area immediately surrounding the casing (Figure 1C). The fourth path similar to the third, may occur if a well was gravel packed during construction. This type of construction necessitates a conduit from the surface into the well bore for replenishment of the gravel (Figure 1D).

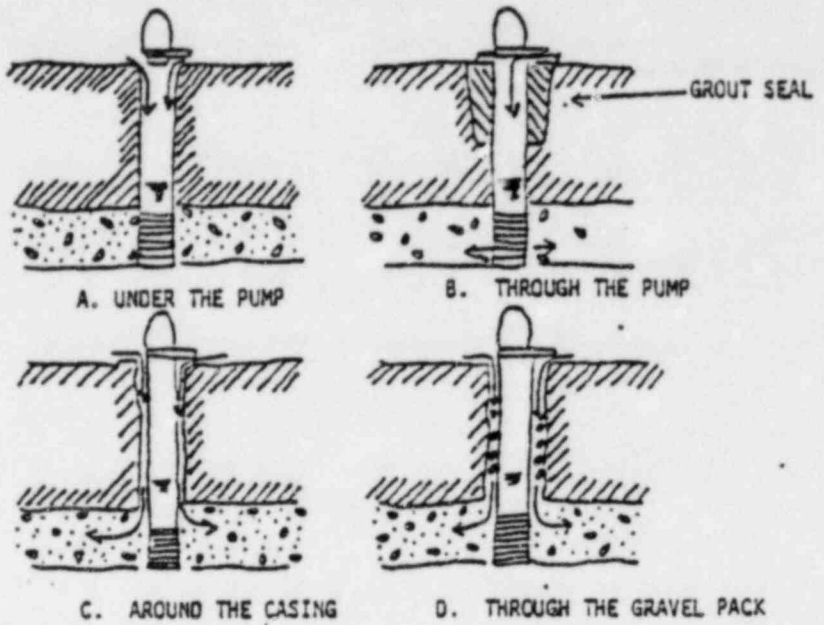

FIGURE 1. Entrance of contaminants, modified from Ham.[11]

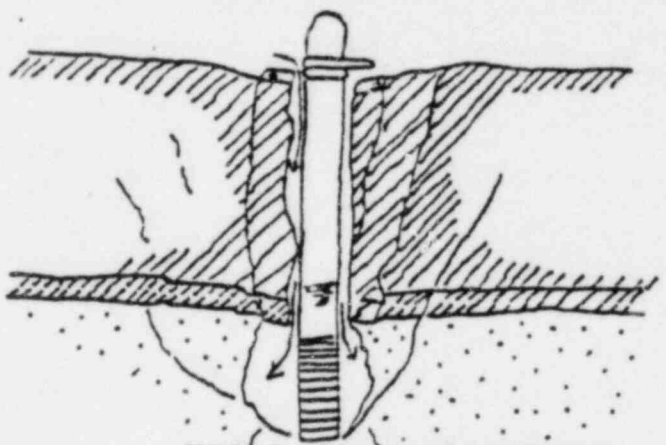

FIGURE 2. Entrance of contaminants resulting from subsidence, modified from Ham.[11]

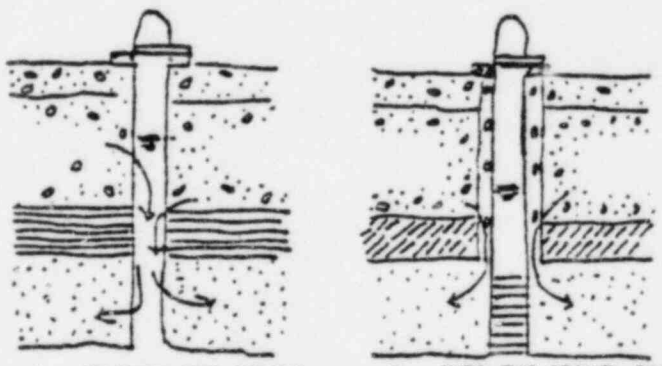

FIGURE 3. Entrance of contaminants, modified from Ham.[11]

Modern well construction methods allow contaminated zones to be avoided. The more advanced of the presently used techniques--sealing off contributing zones of contamination by casing, liner or by grouting---are probably adequate under ideal conditions. However, changing conditions often resulting from improper design or construction, operation or lack of maintenance tend to circumvent the protective techniques. A few of these conditions are:

1. Subsidence, which can cause surface grade reversals, destruction of surface protection and reduction of grout seal protection (Figure 1B).
2. Desication or other factors causing shrinkage, cracking or other alteration of grout material.
3. Breaks or leaks in discharge pipes, leading to erosion and failure of protective facilities.

Under certain hydrologic conditions other routes of contamination other than surface sources are present. Near surface groundwater may enter an opening in the casing and be conveyed into the aquifer in use (Figure 3A). The opening may be a split seam, weld, other joint failure, corrosion pitting or a perforation in the casing. Another pathway may be an inadequately protected gravel pack (Figure 3B).

Another mechanism of contamination of an aquifer other than well design or construction is via the normal percolation through overlying materials. This could be the case here because DBCP is a volatile compound that leaches extensively through soils with low concentrations of clay and silt and diffuses

through soil air spaces.[12] DBCP vapor pressure (0.58 torr, or 0.55 mm) and water solubility (0.12%) are both high relative to other halogenated hydrocarbons and lead to the conclusion that this chemical would be very mobile in soils.[13] DBCP has been found to leach extensively in certain kinds of soils with its distribution and persistence dependent upon soil particle size, amount of organic matter present and whether DBCP is in the vapor phase or in solution.[12,13]

Calculations by EPA staff based on data derived from a known DBCP contaminated aquifer in Adams County, Colorado have estimated that DBCP may be persistent in groundwater for as long as 24 years.[13] If DBCP has such a long persistence in the soils of Maricopa County, a slower rate of DBCP movement may be related to the greater percentages of clay found in Maricopa County soils. Such a condition would have only delayed the eventual contamination of the groundwater. Therefore, from the various data presented, soil percolation cannot be completely ruled out as a possible contamination mechanism.

Samples from two high capacity irrigation wells (SRP 30.5 6N and SRP 31.8E 6.5N) were taken to try to determine the mechanism of their DBCP contamination with no results. For both wells, samples were taken 15 and 30 minutes after starting their pumps (AM-60, 61, 71 and 72). An additional sample was taken from 30.5E 6N after 60 minutes of pumping (AM-62). Temperature and specific conductance were monitored and were found to remain constant after 10 minutes of pumping for both wells.

However, the concentration of DBCP from Well 30.5E 6N taken after 60 minutes (0.12 ppb) was higher than at 15 (0.06 ppb) and 30 minutes (0.06 ppb). The samples from 31.8E 6.5N (AM-71 and 72) had little difference (2.8,, 2.7 ppb). Further analysis and data collection is needed to clarify the possible mechanisms of DBCP contamination of samples from not only these wells but also samples from other contaminated wells in Maricopa County.

CONCLUSIONS

In an August 27 letter from Dr. Suzanne Dandoy, M.D., M.P.H., Director of the Arizona Department of Health Services, to Paul DeFalco, Jr., Regional Administrator, U.S. E.P.A., Region IX (Appendix L), DBCP was recognized to be a public health problem in Arizona. To complement Bureau of Water Quality sampling activities, EPA was requested by ADHS to provide further information and guidance to answer DBCP-related issues.

Frank M. Covington, Director, Water Division, EPA, Region IX, responded to Dr. Dandoy's request in a September 20 letter stating..."The information which we have gathered regarding the feasibility of treating DBCP contaminated water is inconclusive, and we have not yet received a response from EPA Headquarters to our request for an MCL (sic, Maximum Contaminant Level) or interim standards for DBCP. We are continuing to work with our Headquarters and Cincinnati Laboratory to develop the information you have requested."

A review of the data collected on the occurrence of DBCP contamination in well water samples in Maricopa County, Arizona reveals that residues were found in all four citrus-growing areas that were sampled: South Phoenix area

bounded roughly by Baseline Road on the north, 40th Street on the east, South Mountain Park on the south and 35th Avenue on the west; East Mesa bounded by Thomas Road on the north, Higley Road on the east, University Drive on the south and Gilbert Road on the west; two to four kilometre area surrounding Chandler Heights; and northern Glendale bounded by Pinnacle Peak Road on the north, 51st Avenue on the east, Greenway Road on the south and 91st Avenue on the west. Approximately 28% (26) of the 93 well samples collected indicated positive DBCP values of ≥0.01 ppb. Approximately 5% (5) of the wells sampled in Maricopa County, Arizona contained DBCP values ≥1.0 ppb. The latter value was established by the State of California as an administrative "action level" and was adapted for use during this sampling and public notification program. The following notifications were made by ADHS:

Owners with wells containing DBCP levels ≥1.0 ppb were advised to seek alternative water supplies for all domestic uses. Well owners with detectable DBCP levels <1.0 ppb were advised to seek alternative water supplies for drinking and culinary purposes and minimize human contact for all other uses. These advisements also stated the point that the Department's recommendations were conservative.

ADHS had recommended that two municipal wells be removed from their systems and had immediate compliance. These interim health precautions have been established until further information becomes available.

Possible explanations for the presence of the DBCP contamination have not been adequately defined or proven. A number of possible contamination mechanisms did, however, become apparent during this study. Further

investigations in the following areas needed to verify and/or differentiate between these mechanisms:

- Relation of well characteristics (well depth, casing diameter, perforation depth, depth to groundwater, and construction date) to evidence of DBCP;
- Soil characteristics in impacted areas and its ability to allow percolation of DBCP to groundwater table;
- Information on DBCP persistence over time;
- Groundwater movement and its relation to DBCP contamination.

TABLE 1. The estimated harvested acreage in 1972 of the principal crops in Maricopa County.[2]

Crop	Hectares	(Acres) in 1972
Cotton	38 000	(94 000)
Long staple	7 300	(18 000)
Short staple	30 800	(76 000)
Alfalfa	38 000	(94 000)
Barley	25 900	(64 000)
Wheat	22 700	(56 000)
Sorghum and corn	17 400	(43 000)
Safflower	5 160	(12 750)
Sugar beets (sugar and seed)	2 839	(7 016)
Vegetables	15 300	(37 830)
Cantaloupes	542	(1 340)
Honeydew melons	28	(70)
Watermelons	809	(2 000)
Potatoes	4 686	(11 580)
Irish	4 480	(11 080)
Sweet	200	(500)
Lettuce	6 090	(15 050)
Spring	3 300	(8 150)
Fall	2 800	(6,900)
Carrots	1 190	(2 935)
Spring	824	(2,035)
Fall	364	(900)
Cauliflower	249	(615)
Broccoli	405	(1 000)
Cabbage	486	(.1 200)
Onions	825	(2 040)
Dry	421	(1 040)
Green	405	(1 000)

TABLE 1. (continued)

Crop	Hectares	(Acres) in 1972
Citrus	6 780	(16 750)
Navel and sweet	1 500	(3 700)
Valencia	1 860	(4 600)
Grapefruit	2 020	(5 000)
Lemon	810	(2 000)
Tangerine	202	(500)
Tangelos	202	(500)
Other citrus	182	(450)
Grapes	1 610	(3 980)
Thompson seedless	1 040	(2 570)
Cardinals	300	(740)
Exotics	154	(380)
Purlettes	110	(275)
Robins	6	(15)
Apricots	81	(200)

TABLE 2. Summary of positive DBCP results obtained during sampling period June 11-September 25, 1979.

Month	#of wells Sampled	#of wells with positive DBCP Results*	#of wells with DBCP Results >1.0 ppb
June	13	1	0
July	15	6	2
August	49	13	4
September	16	6	0
TOTAL	93	26 (28%)	5 (5%)

NOTES: *Detection limit of 0.01 ppb, except for June, which is 0.1 ppb.

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-1	Sparkling Bottled Water; 12815 N. 39 Ave. T3N R2E Section 15	Industrial 800					Sandy Clay Loam	6/11	<0.1	504
AM-2	Salt River Project 30.5E 6N McDowell & Lehi RDS T1N R6E Section 6	Irrigation 785 perforations 300-760	482	24		Citrus	Sandy Clay Loam	6/11	0.1	334
AM-3	Bohne Water Co. Near El Mirage & Elwood T1N R1W Section 23	Domestic				Cotton	Sandy Clay Loam	6/11	<0.1	80
AM-4	T1N R2W Section 10	Domestic				Cotton	Sandy Clay Loam	6/11	<0.1	---
AM-5	Roosevelt Irr. Dist. 8W 4½ N Citrus RD ¼ mile S. of Van Buren T1N R2W Section 11	Irrigation				Cotton	Sandy Clay Loam	6/11	<0.1	---
AM-6	¼ mile E Citrus RD ¼ mile S Van Buren T1N R2W Section 10	Domestic				Cotton	Sandy Clay Loam	6/11	<0.1	---
AM-7	City of Phoenix #193 T1N R1E Section 18	Municipal 580	280	12		Cotton	Sandy Clay Loam	6/11	<0.1	83

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-8	City of Phoenix #191 T1N R1E Section 18	Municipal 538	267	12		Cotton	Sandy Clay Loam	6/11	< 0.1	83
AM-9	City of Phoenix #196 T1N R1E Section 11	Municipal 384	249	12		Cotton	Sandy Clay Loam	6/11	< 0.1	108
AM-10	Rigby Water Co. T1N R1W Section 36	Domestic				Cotton	Sandy Clay Loam	6/11	< 0.1	---
AM-11	Rigby Water Co. T1N R1E Section 30	Domestic					Sandy Clay Loam	6/11	< 0.1	---
AM-12	Unknown Irrigation Well 5½ WL-24W T1N R1W Section 19	Irrigation				Cotton	Sandy Clay Loam	6/11	< 0.1	---
AM-13	Unknown Irrigation Well T1N R1W Section 17	Irrigation				Cotton	Sandy Clay Loam	6/11	< 0.1	---
AM-16	Turner Ranches Water & Sanitation Co. 1517 S. Power RD T1N R6E SE¼ SE¼ SE¼ Section 36	Domestic 800	620	20" to 350' 16" 350' to 800'		Citrus	Sandy Clay Loam	7/17	< 0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-23	Crystal Bottled Water 3302 W. Earll Dr. T2N R2E Section 26	Industrial 950	450	12			Sandy Clay Loam	7/18	<0.01	---
AM-25	T1S R2E Section 1	Domestic 185 perforations last 40'	165	6			Sandy Clay Loam	7/30	0.17	---
AM-26	Salt River Project 12.5E 0.6S T1S R3E Section 6	Irrigation				Citrus	Sandy Clay Loam	7/30	4.5	---
AM-27	Salt River Project 13E 0.1S T1S R3E Section 6	Irrigation				Citrus	Sandy Clay Loam	7/30	3.8	---
AM-28	City of Mesa Falcon Field #2 T1N R6E Section 10	Municipal					Sandy Clay Loam	7/31	<0.01	15
AM-29	Salt River Project 30E. 4.3N T1N R6E Section 7	Irrigation				Citrus	Sandy Clay Loam	7/31	<0.01	10
AM-30	Roosevelt Conservation 2½ 1 1/8 W T1N R6E, SE ¼ SE ¼ NE ¼ Section 9	Irrigation 870 perforations 400-870	600			Citrus	Sandy Clay Loam	7/31	0.03	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-23	Crystal Bottled Water 3302 W. Earll Dr. T2N R2E Section 26	Industrial 950	450	12			Sandy Clay Loam	7/18	<0.01	---
AM-25	T1S R2E Section 1	Domestic 185 perforations last 40'	165	6			Sandy Clay Loam	7/30	0.17	---
AM-26	Salt River Project 12.5E 0.6S T1S R3E Section 6	Irrigation				Citrus	Sandy Clay Loam	7/30	4.5	---
AM-27	Salt River Project 13E 0.1S T1S R3E Section 6	Irrigation				Citrus	Sandy Clay Loam	7/30	3.8	---
AM-28	City of Mesa Falcon Field #2 T1N R6E Section 10	Municipal					Sandy Clay Loam	7/31	<0.01	15
AM-29	Salt River Project 30E. 4.3N T1N R6E Section 7	Irrigation				Citrus	Sandy Clay Loam	7/31	<0.01	10
AM-30	Roosevelt Conservation 2½ 1 1/8 W T1N R6E, SE ¼ SE ¼ NE ¼ Section 9	Irrigation 870 perforations 400-870	600			Citrus	Sandy Clay Loam	7/31	0.03	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-31	Roosevelt Water Consv. Dist. 1 T2N R6E Section 33	Irrigation 1200 perforations 500-1200	600			Citrus	Sandy Clay Loam	7/31	< 0.01	490
AM-32	City of Mesa Falcon Field #2 T1N R6E Section 10	Municipal				Citrus	Sandy Clay Loam	7/31	0.08	---
AM-33	Salt River Project 31.5E 3.5N T1N R6E Section 17	Irrigation 608		20			Sandy Clay Loam	8/1	0.14	362
AM-34	T2S R6E Section 8	Domestic			100 meters	Cotton	Sandy Clay Loam	8/1	< 0.01	---
AM-35	T2S R6E Section 8	Domestic & Animal			100 meters	Cotton	Sandy Clay Loam	8/1	0.24	---
AM-36	T2S R6E Section 16	Domestic				Cotton	Sandy Clay Loam	8/1	< 0.01	---
AM-37	T2S R6E Section 16	Domestic			20 meters	Cotton	Sandy Clay Loam	8/1	< 0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-38	T2S R6E Section 9	Domestic			20 meter	Cotton	Sandy Clay Loam	8/1	<0.01	---
AM-39	Chandler Heights Irrigation Well #3 T2S R7E Section 31	Irrigation & Municipal 1141	850	20		Citrus	Sandy Clay Loam	8/1	0.24	---
AM-40	Roosevelt Water Consv. Dist. 2 NW T1N R6E Section 4	Irrigation 1200 perforations 500-1200	600	24			Sandy Clay Loam	7/31	0.37	555
AM-41	City of Mesa Well #9 T1N R5E Section 14	Municipal 1000	460	20			Sandy Clay Loam	8/8	< 0.01	---
AM-42	City of Mesa Well #7 T1N R5E Section 22	Municipal 700	410	20			Sandy Clay Loam	8/8	< 0.01	---
AM-43	City of Mesa Well #11 T1N R5E Section 22	Municipal 1006 perforations 371-1006	410	20" 500 16" 506-1006			Sandy Clay Loam	8/8	< 0.01	---
AM-44	City of Mesa Well #12 T1N R5E Section 15	Municipal 1000 perforations 500-1000	460	20" 0-610 16" 340-1000			Sandy Clay Loam	8/8	< 0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-45	City of Mesa Well #8 T1N R5E Section 15	Municipal 870 perforations 494-870	380	20			Sandy Clay Loam	8/8	<0.01	---
AM-46	City of Mesa Well #15 T1N R5E Section 24	Municipal 1000 perforations 600-1000	440	18" 0-600 16" 600-1000			Sandy Clay Loam	8/8	<0.01	---
AM-47	City of Mesa Desert Wells #5 T1N R7E Section 30	Municipal 922	623	16" 0-527 12" 295-922			Sandy Clay Loam	8/8	<0.01	---
AM-48	City of Mesa Desert Wells #6 T1N R7E Section 5	Municipal 1000 perforations 700-1000	660	20" 0-700 16" 700-1000			Sandy Clay Loam	8/8	<0.01	---
AM-49	T1N R6E Section 3	Domestic & Irrigation 800		16		Citrus	Sandy Clay Loam	8/8	<0.01	---
AM-50	City of Mesa Well #16 T1N R6E Section 21	Municipal 1000 perforations 600-1000	450	20" 0-500 16" 500-1000			Sandy Clay Loam	8/8	<0.01	---
AM-51	City of Mesa Well #14 T1N R5E Section 26	Municipal 1030 perforations 630-1030	454	20" 0-496 16" 496-1030			Sandy Clay Loam	8/8	<0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-52	City of Mesa Well #13 T1N R5E Section 22	Municipal 1000 perforations 560-1000	460	20" 0-500 16" 500-1000			Sandy Clay Loam	8/8	< 0.01	---
AM-53	City of Mesa Well #10 T1N R5E Section 22	Municipal 1200 perforations 400-1200	385	20" 0-500 16" 500-1200			Sandy Clay Loam	8/8	< 0.01	---
AM-54	T1S R2E NE¼ NE¼ SE¼ Section 1	Domestic 168	125	6			Sandy Clay Loam	8/13	0.04	---
AM-55	City of Mesa well Falcon Field #2 T1N R6E Section 10	Municipal 1000 perforations 450-1000	620	20	½ mi. to W	Citrus	Sandy Clay Loam	8/13	0.09	---
AM-56	City of Mesa well Falcon Field #2 T1N R6E Section 10	Municipal	620	20	½ mi. to W		Sandy Clay Loam	8/13	0.08	---
AM-57	City of Phoenix Val Vista Treatment Plant	Surface water					Sandy Clay Loam	8/13	< 0.01	---
AM-58	City of Mesa well Falcon Field #5 T1N R6E, SW¼ SE¼ SE¼ Section 17	Municipal 1000 perforations 600-1000		16	50 yards to North	Citrus	Sandy Clay Loam	8/13	< 0.01	384

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-59	City of Mesa well Falcor Field #5 T1N R6E Section 17	Municipal 1000 perforations 600-1000		16	50 yards to North	Citrus	Sandy Clay Loam	8/13	<0.01	384
AM-60	Salt River Project 30.5 6N	Irrigation		24	Middle of various fields	Citrus	Sandy Clay Loam	8/15	0.06	334
AM-61	Salt River Project 30.5 6N	Irrigation		24			Sandy Clay Loam	8/15	0.06	334
AM-62	Salt River Project 30.5 6N	Irrigation		24			Sandy Clay Loam	8/15	0.12	334
AM-63	Crescent Valley Water System T1S R7E Section 3				20 yards	Cotton	Sandy Clay Loam	8/15	<0.01	---
AM-64	Chandler Heights Well #3 T2S R7E Section 31	Irrigation & Domestic 1141	850	20	70 yards	Citrus	Sandy Clay Loam	8/15	0.17	---
AM-65	Chandler Heights Well #2 T2S R7E Section 31	Irrigation 1215 perforations 392-1215	700	20	70 yards	Citrus	Sandy Clay Loam	8/15	<0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-66	Chandler Heights Well #4 T2S R7E Section 31	Irrigation 1200 perforations 500-1060	690	20	70 yards	Citrus Grapes	Sandy Clay Loam	8/15	<0.01	---
AM-67	Chandler Heights Well #5 T2S R7E Section 31	Irrigation 1200	714	20	100 yards	Citrus	Sandy Clay Loam	8/15	<0.01	---
AM-68	Chandler Heights Well #6 T2S R6E Section 36	Irrigation 973	780	20	170 yards	Citrus	Sandy Clay Loam	8/15	<0.01	---
AM-69	Chandler Heights Well #1 T2S R6E Section 36	Irrigation 1085	760	16	2 yards	Citrus	Sandy Clay Loam	8/15	1.5	---
AM-70	Salt River Project 32.3E 7N T2N R6E Section 33	Irrigation & Domestic 778	532	24	40 yards	Citrus	Sandy Clay Loam	8/20	<0.01	---
AM-71	Salt River Project 31.8E 6.5N T2N R6E Section 32	Irrigation 749(800) perforations 300-785	522	24	20 yards to North	Citrus	Sandy Clay Loam	8/20	2.8	

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-72	Salt River Project 31.8E 6.5N T2N R6E Section 32	Irrigation 749 (800) perforations 300-785	522	24	20 yards to North	Citrus	Sandy Clay Loam	8/20	2.7	
AM-73	Citrus Heights Farms T2N R6E, NW¼ NW¼ SW¼ Section 34	Irrigation 820		24	5 yards	Citrus	Sandy Clay Loam	8/27	0.01	390
AM-74	Citrus Heights Farms T2N R6E, SW¼ NE¼ NW¼ Section 34	Irrigation 731		24	15 yards	Citrus	Sandy Clay Loam	8/27	< 0.01	420
AM-75	T1S R2E NW¼ NW¼ SE¼ Section 1	Domestic 130	105	6			Sandy Clay Loam	8/28	0.01	80
AM-76	City of Phoenix #204, T1S R2E SE¼ NE¼ SE¼ Section 9	Municipal 95	78	8			Sandy Clay Loam	8/28	< 0.01	58
AM-77	City of Phoenix #204	Municipal 95	78	8			Sandy Clay Loam	8/28	< 0.01	58
AM-78	City of Phoenix Desert Well #8	Municipal					Sandy Clay Loam	8/29	< 0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-79	T2N R6E SW¼ NW¼ Section 5	Domestic 580	390	8			Sandy Clay Loam	8/29	< 0.01	300
AM-80	Citrus Heights Well T1N R6E, NE¼ NE¼ NE¼ Section 4	Irrigation 1104		20	5 yards	Citrus	Sandy Clay	8/29	< 0.01	---
AM-81	Citrus Heights Well T1N R6E, NE¼ NE¼ NE¼ Section 4	Irrigation 1104		20	5 yards	Citrus	Sandy Clay Loam	8/29	< 0.01	---
AM-82	Fletcher Farms Well #1 T4N R1E, NW¼ NE¼ NE¼ Section 23	Irrigation & Domestic 848		20	10 yards	Citrus	Sandy Clay Loam	8/30	0.22	---
AM-83	Fletcher Farms Well #2 T4N R1E, SE¼ NE¼ SE¼ Section 14	Irrigation 1280		20	20 yards	Citrus	Sandy Clay Loam	8/30	< 0.01	---
AM-84	Fletcher Farms Well #4 T4N R1E, SE¼ NE¼ NW¼ Section 23	Irrigation 1308		16	15 yards	Citrus	Sandy Clay Loam	8/30	< 0.01	---
AM-85	Fletcher Farms Well #5 T4N R1E, NE¼ NE¼ SW¼ Section 23	Irrigation 1180		16	10 yards	Citrus	Sandy Clay Loam	8/30	0.21	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-86	Fletcher Farms Well #3 T4N R1E, NW¼ NW¼ SE¼ Section 22	Irrigation 1650		16	2 yards	Citrus	Sandy Clay Loam	8/30	<0.01	---
AM-87	Fletcher Farms Well #6 T4N, R1E, NW¼ SW¼ SE¼ Section 22	Irrigation 1977		16	5 yards	Citrus	Sandy Clay Loam	8/30	<0.01	---
AM-88	Bodine Produce Co. Well #1 (most northern well) T4N R1E, NW¼ NW¼ NW¼ Section 35	Irrigation 1198		20	5 yards	Citrus	Sandy Clay Loam	8/31	0.98	---
AM-89	Bodine Produce Co. Well #2 (most southern well) T4N R1E, NW¼ SW¼ NW¼ Section 35	Irrigation 1005		20	3 yards	Citrus	Sandy Clay Loam	8/31	1.7	---
AM-90	Bodine Produce Co. Well #4 T4N R1E, NE¼ NW¼ NE¼ Section 34	Irrigation 1193		20		Citrus	Sandy Clay Loam	8/31	<0.01	---
AM-91	Bodine Produce Co. Well #5 T4N-R1E, SW¼ NE¼ NE¼ Section 34	Irrigation 1060		18		Citrus	Sandy Clay Loam	8/31	1.6	---
AM-92	Bodine Produce Co. Well #8 T4N R1E, NE¼ SE¼ NE¼ Section 22	Irrigation 940			10 yards	Grapes	Sandy Clay Loam	8/31	<0.01	---

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-93	Bodine Produce Co. Well #9 T4N R1E NW¼ SE¼ NE¼ Section 22	Irrigation 1522		20			Sandy Clay	8/31	<0.01	
AM-94	Arrowhead Ranch Well #19 T4N R1E NE¼ NE¼ SE¼ Section 23	Irrigation 2050 perforations 780-1765	860	20		Citrus	Sandy Clay Loam	9/11	0.02	530
AM-95	Arrowhead Ranch Well #18 T4N R1E NW¼ NW¼ NW¼ Section 25	Irrigation 1766 perforations 394-1758	700	20	20	Citrus	Sandy Clay Loam	9/11	<0.01	490
AM-96	Arrowhead Ranch Well #15 T4N R1E NE¼ NE¼ SW¼ Section 24	Irrigation 1164 (1150) perforations 275-1038	789	20	10 yards	Citrus	Sandy Clay	9/11	<0.01	380
AM-97	Arrowhead Ranch Well #21 T4N R1E SE¼ NE¼ NE¼ Section 25	Irrigation 1490 perforations 450-1020	660	20	20 yards	Citrus	Sandy Clay Loam	9/11	0.02	470
AM-98	Arrowhead Ranch Well #30 T4N R2E SE¼ SW¼ SW¼ Section 30	Irrigation 615 perforations 307-615		12		Citrus Grapes	Sandy Clay Loam	9/11	<0.01	464

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-99	Arrowhead Ranch Well #20 T4N R2E SW¼ SE¼ SW¼ Section 30	Irrigation 2017 p-900-2017	750	22		Citrus	Sandy Clay Loam	9/11	<0.01	455
AM-100	Arrowhead Ranch Well #7 T4N R2E SE¼ SE¼ NE¼ Section 30	Irrigation 541 p-160-528		20		Citrus	Sandy Clay Loam	9/11	<0.01	463
AM-101	City of Phoenix Well #149 T3N R2E NE¼ NE¼ NW¼ Section 24	Municipal 811	592	20 to 538 16" open hole to 811			Sandy Clay Loam	9/14	<0.01	552
AM-102	Consolidated Water Co. Well- DV-5 T3N R2E NE¼ NE¼ NW¼ Section 4	Municipal					Sandy Clay Loam	9/14	<0.01	
AM-103	City of Glendale Well #31 T4N R2E, NE¼ NE¼ SW¼ Section 32	Municipal 805	610	18"			Sandy Clay Loam	9/14	<0.01	500
AM-104	City of Glendale Well #33 T4N R2E NE¼ NE¼ NW¼ Section 32	Municipal 935 perforations 535-935	660	16			Sandy Clay Loam	9/14	<0.01	535

TABLE 3

Well Water Sampling for DBCP in Maricopa County, Arizona

I.D.#	Location	Well Type & Depth (ft.)	Pump Setting (ft.)	Well Casing (in.)	Proximity to Suspected DBCP Use	Suspect Crop	Soil Type	Sample Collected (1979)	DBCP Detected (ppb)	Depth to Groundwater (ft.)
AM-105	City of Glendale Well #8 T3N R1[illegible] SE¼ NE¼ NE¼ Section 12	Municipal 1310	570	16			Sandy Clay Loam	9/14	<0.01	490
AM-106	Hillcrest Farms #5 T4N R1E SW¼ SW¼ NW¼ Section 24	Irrigation 2004 perforations 500-2004	765	16		Citrus	Sandy Clay Loam	9/25	0.05	
AM-107	Hillcrest Farms #6 T4N R1E NW¼ SE¼ NE¼ Section 23	Irrigation 2055 perforations 660-1730	645	18	5	Citrus	Sandy Clay Loam	9/25	0.14	
AM-108	Arrowhead Ranch #16 T4N R2E SE¼ SE¼ SW¼ Section 30	Irrigation 1003 perfora[illegible] 176-969	660	20" 0'-637' 16" 637'-969'	5	Citrus	Sandy Clay Loam	9/25	0.01	450
AM-109	City of Glendale #20 (A-3-2) 30-20 (SRP 7 E 13.4N) T3N R2E Section 30	Municipal Irrigation 1000 perforations 450-980	502	20	10	Citrus	Sandy Clay Loam	9/25	0.01	290

TABLE 4. Irrigation Wells that have been used for domestic or municipal use

I.D. Number	Other Use	DBCP Detected
AM-2	Domestic	Yes
AM-20	Municipal	No
AM-39	Municipal	Yes
AM-49	Domestic	No
AM-63	Municipal	No
AM-70	Domestic	No
AM-82	Domestic	Yes
AM-109	Municipal	Yes

ARIZONA DEPARTMENT OF HEALTH SERVICES

Date August 10, 1979

FOR MORE INFORMATION CONTACT:
Ed Swanson 255-1173
John Mark 255-1001

NEWS RELEASE

The pesticide dibromochloropropane (DBCP) has been found in water samples from nine of the 15 wells tested in Maricopa County by the Arizona Department of Health Services from July 30 through August 1.

In two of the wells, the DBCP level was higher than the action limit of one part per billion recommended by California health officials. These wells were reported at 3.8 and 4.5 parts per billion. The lowest level reported in the positive samples was 0.03 parts per billion.

DBCP is used to control nematodes, worms which feed on plant roots, particularly citrus, cotton, grapes and carrots. It has been linked to male sterility in workers involved in the manufacture and handling of the pesticide, and to cancer in laboratory animals.

ADHS has been sampling wells in Maricopa and Yuma counties since June 7, when it was learned DBCP might be contaminating ground water supplies in those areas.

Thus far, DBCP contamination has been found in four areas of Maricopa County and one area in Yuma County.

The highest DBCP levels were found in irrigation wells in Phoenix, in an area approximately one-eighth of a mile north of Baseline Road ranging south to South Mountain Park, between 40th Street and 35th Avenue.

Another area is in East Mesa, bounded by McDowell Road on the north, University Drive on the south, and Gilbert and Higley Roads to the west and east.

The other two areas where DBCP has been found are south of Chandler near the intersection of Alma School and Queen Creek Roads, and within a two-mile radius of Chandler Heights.

-more-

ADHS has contacted owners of wells containing detectable levels of DBCP. Persons with wells containing more than the one-part-per-billion DBCP action limit are advised to use alternative water supplies for all domestic uses. Those served by wells with detectable DBCP levels below the action limit are advised to seek alternative water supplies for drinking and culinary purposes and to minimize human contact for all other uses.

Owners of domestic or irrigation wells located in areas where DBCP may have been used -- particularly where citrus, cotton, grapes or carrots are grown -- are urged to contact the ADHS Bureau of Water Quality Control to have water samples taken. They are asked to supply the following information if possible: well location, well depth, casing diameter, location of pump, depth to ground water, locations of perforations in casing and daytime phone number. Letters should be addressed to Room 200, 1740 West Adams, Phoenix 85007, or call 255-1254.

-30-

APPENDIX B

U.S ENVIRONMENTAL PROTECTION AGENCY
S & A DIVISION, WATER BRANCH
CHAIN OF CUSTODY AND SAMPLE HISTORY

EPA SAMPLE #	DATE	TIME	SOURCE	PRESERV.	ANALYSES DESIRED	DATE OF ANALYSIS	ANALYS'

Well location: Name _____

Address _____

or Tnshp. _____ Range _____ Sect. _____

Well depth: _____

Well pump setting: _____

Well casing: _____

DBCP use history: Application rate _____

Application method _____

Application date _____

Soil type: _____

LOCATION I.D. _____

SIGNATURE OF SAMPLER(S) _____

SEALED BY _____

TRANSFERS a. _____ b. _____
EPA-IX c. _____ d. _____
FORM-671 dbcp e. _____ f. _____

LABORATORY NAME _____ DATE REC'D _____

REC'D BY _____

SEALS INTACT YES__ NO____

Attorney General
STATE CAPITOL
Phoenix, Arizona 85007

Robert K. Corbin

August 20, 1979

Mr. Art Martori
P.O. Box 1029
Glendale, Arizona 85311

Re: Obtaining Data on Wells
Located on Citrus Heights Farms

Dear Mr. Martori:

You have expressed doubt as to the legal authority of State representatives to take water samples from irrigation wells located on Citrus Heights Farms in Maricopa County, in order to determine DBCP concentration.

The Arizona Department of Health Services has such authority pursuant to A.R.S. § 36-136.A.6. The Arizona Water Commission has such authority pursuant to A.R.S. § 45-302. The Arizona Board of Pesticide Control has such authority pursuant to A.R.S. § 3-373. For your convenience, I am enclosing copies of these laws.

Sincerely,

BOB CORBIN
Attorney General

Evelyn R. Epstein

EVELYN R. EPSTEIN
Assistant Attorney General

ERE/bl
Encl.

cc: Wes Steiner, P.E.,
Executive Director
Arizona Water Commission

Suzanne Dandoy, M.D., M.P.H.
Director, Arizona Department
of Health Services

Bill Blackledge, Administrator
Arizona Board of Pesticide Control

bcc: Timothy Nove
Ed Nemec

AFFIDAVIT FOR SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

Your affiant, Edward A. Nemecek, an official of the Arizona Water Commission, being first duly sworn, upon oath, deposes and says:

That the property in Maricopa County, known as Citrus Heights Farms and particularly described as follows:

T1NR6E Section 4, NE 1/4, NE 1/4, NE 1/4

T2NR6E Section 34, SW 1/4, NW 1/4, NW 1/4

T2NR6E Section 34, NW 1/4, NE 1/4, SW 1/4

constitutes lands of a groundwater basin where a well or other works for the withdrawal of groundwater are located.

That in order to obtain factual data in said groundwater basin, and specifically to determine the extent and areal distribution of contamination by dibromochloropropane (DBCP) in the groundwater of said basin, it is necessary that your affiant obtain samples of water from the wells located on the aforedescribed property. So that said samples consist of water from the aquifer, they must be taken when specific conductance has stabilized as determined by a field plot of conductance versus time.

That wells located on Citrus Heights Farms have been selected for sampling pursuant to a general administrative plan derived from objective sources. The Arizona Water Commission has been cooperating with the Arizona Department of Health Services to determine the groundwater areas that have been contaminated by DBCP. When the Arizona Department of Health Services discovers a well of which the water supply contains DBCP contamination, it informs the Arizona Water Commission of the well's location and the level of contamination. Based on hydrological data, the Arizona Water Commission then points out other wells which should be sampled in order to determine the areal distribution of the discovered contamination, and to project the direction in which this contamination will travel through the aquifer.

Pursuant to this general administrative plan, the Arizona Department of Health Services has informed the Arizona Water Commission that a well located in Maricopa County, T1NR6E, Section 4, adjacent to Citrus Heights Farms, contains DBCP contamination, and the Arizona Water Commission has determined that the three wells located on the aforedescribed premises known as Citrus Heights Farms must be sampled in order to determine the areal distribution of the discovered DBCP contamination and to project the groundwater migration of that contamination.

Your affiant has a B.S. degree in Geology, and has been employed by the Arizona Water Commission as a staff hydrologist from 1972 to 1976 and since February, 1979.

_____
Affiant
Arizona Water Commission

SUBSCRIBED AND SWORN TO before me this _____ day of August, 1979.

_____
Judge, Justice of the Peace or Magistrate

AFFIDAVIT FOR SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

Your affiant, Timothy D. Love, an official of the Arizona Department of Health Services, being first duly sworn, upon oath, deposes and says:

That a source and means of water supply, namely, three wells, are located upon the property in Maricopa County, known as Citrus Heights Farms, and particularly described as follows:

T1NR6E Section 4, NE 1/4, NE 1/4, NE 1/4

T2NR6E Section 34, SW 1/4, NW 1/4, NW 1/4

T2NR6E Section 34, NW 1/4, NE 1/4, SW 1/4

That your affiant has probable cause to believe and does believe that pesticides containing dibromochloropropane (DBCP) have been used upon said property, and that said source and means of water supply may contain concentrations of DBCP.

That in order to examine said source and means of water supply, and specifically to determine whether said source and means has been contaminated by DBCP, and the areal distribution of such contamination, it is necessary to obtain samples of water from said wells.

That wells located on Citrus Heights Farms have been selected for sampling pursuant to a general administrative plan derived from objective sources. Prior to realization of the health hazards it posed, dibromochloropropane was used to combat nematode infestation of citrus crops. To determine the extent of groundwater contamination by DBCP, employees of the Arizona Department of Health Services, including your affiant, have therefore identified large citrus-growing areas in the State, and are presently sampling wells within those areas. Citrus Heights Farms is located in a large citrus-growing area, and thus wells located on that property are included among those to be sampled pursuant to the foregoing general administrative plan.

That a further aspect of the general administrative plan pursuant to which your affiant is acting is that, when DBCP contamination is discovered in groundwater, the Arizona Department of Health Services samples wells in adjacent areas both to determine the extent of existing contamination and to project the movement of this contamination through the aquifer. Samples from a well in an area adjacent to Citrus Heights Farms (T1NR6E, Section 4) show that the groundwater supplying that well has been contaminated by DBCP. The wells on Citrus Heights Farms must be sampled in order to ascertain the extent of that existing contamination, and to project the direction in which the contamination is likely to travel through the groundwater.

Your affiant has an M.S. degree in Botany. He is employed as a microbiologist by the Arizona Department of Health Services, and is presently assigned to the Bureau of Water Quality Control of the Arizona Department of Health Services.

_____
Affiant
Arizona Department of Health Services

SUBSCRIBED AND SWORN TO before me this _____ day of August, 1979.

_____
Judge, Justice of the Peace or Magistrate

79-0409

SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

TO ANY PEACE OFFICER IN MARICOPA COUNTY, STATE OF ARIZONA

Proof by affidavit having been made this day before me by Timothy D. Love and Edward A. Nemecek, there is probable cause for believing that on the premises known as Citrus Heights Farms in Maricopa County, the following-described property:

Groundwater supplying the wells located on Citrus Heights Farms, (T1NR6E, Section 4, and T2NR6E, Section 34)

is subject to search and inspection by officials of the Arizona Department of Health Services and the Arizona Water Commission, in the interest of public health, safety or welfare, according to A.R.S. § 13-3912.

YOU ARE THEREFORE COMMANDED, in the daytime, to make a search of the above-named premises for the hereinabove property or things and, pursuant to A.R.S. § 13-3916.E, to make or cause to be made scientific tests of the groundwater supplying said wells, performed upon water obtained when specific conductance has stabilized as determined by a field plot of conductance versus time, and to retain the evidence of said scientific tests in your custody, or in the custody of the agency you represent or the Arizona Department of Health Services or the Arizona Water Commission, as provided by A.R.S. § 13-3920.

RETURN this warrant to me within five days of the date thereof, as directed by A.R.S. § 13-3918.

GIVEN UNDER MY HAND and dated this 27th day of August, 1979.

ARIZONA DEPARTMENT OF HEALTH SERVICES

Division of Environmental Health Services

September 21, 1979

Chandler Heights Citrus
Irrigation District
P. O. Box 38
Chandler Heights, Arizona 85227

Gentlemen:

In the past few months, the Arizona Department of Health Services (ADHS) has conducted a well sampling program for dibromochloropropane (DBCP) and had sampled your wells which are listed on the enclosed form. The reported results are from a United States Environmental Protection Agency (EPA) contracted laboratory and are expressed in parts per billion (ppb) DBCP.

The State of Arizona is recommending that individuals served by wells with DBCP levels equal to or greater than 1.0 ppb utilize alternative water supplies for all domestic uses. For wells containing detectable DBCP (0.01 ppb or greater) and less than one part per billion, the State is recommending that the water not be used for drinking and culinary purposes and to minimize human contact for all other uses. Owners of wells containing less than detection (less than 0.01 ppb) are advised that there are no recommendations for its use.

No standards have been established for drinking water supplies by either EPA or the State of Arizona although recent data indicate medical concern. The ADHS has asked EPA to set drinking water standards and to recommend acceptable methods for DBCP removal from contaminated waters. In the meantime, if you have any further questions, please feel free to contact me at (602) 255-1173. Thank you for your help and services in aiding us in our DBCP program.

Sincerely,

Timothy D. Love

Timothy D. Love
Ambient Water Quality Unit
Bureau of Water Quality Control

TDL:jle

Enclosure

State Health Building 1740 West Adams Street Phoenix, Arizona 85007

Chandler Heights Citrus Irrigation District
P. O. Box 38
Chandler Heights, Arizona 85227

Well	Date Sampled	DBCP Detected in ppb
#1	8/15/79	1.5
#2	8/15/79	<0.01
#3	~~8/15/79~~ 8/1/79 TDL 4/2/80	0.24
#3	8/15/79	0.17
#4	8/15/79	<0.01
#5	8/15/79	<0.01
#6	8/15/79	<0.01

< stands for less than

August 28, 1979

Mr. Ralph Bodine
Bodine Produce Co., Inc.
10451 W. Palmeras
Suite 217
Sun City, Arizona 85373

Dear Mr. Bodine:

The Arizona Department of Health Services, Bureau of Water Quality Control called your office the weeks of August 13, 20, and 27 and left messages for Messrs. Bodine and Lopez to return our call to this office.

The purpose of the call was to solicit your cooperation in allowing water samples to be taken from well sites within your citrus growing areas. The nature of this statewide sampling is to test for the presence of the pesticide dibromochloropropane (DBCP) in groundwater supplies.

Sincerely,

Samuel J. Hadeed
Ambient Water Quality Unit
Bureau of Water Quality

SJH:jle

APPENDIX I

AFFIDAVIT FOR SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

Your affiant, Edward A. Nemecek, an official of the Arizona Water Commission, being first duly sworn, upon oath, deposes and says:

That the property in Maricopa County, particularly described as follows:

T4NR1E Section 22, NE 1/4, NE 1/4, NE 1/4
T4NR1E Section 22, NE 1/4, SE 1/4, NE 1/4
T4NR1E Section 22, NW 1/4, SE 1/4, NE 1/4
T4NR1E Section 34, SW 1/4, NE 1/4, NE 1/4
T4NR1E Section 34, NW 1/4, NE 1/4
T4NR1E Section 34, NE 1/4, NW 1/4, NE 1/4
T4NR1E Section 35, NW 1/4, NW 1/4, NW 1/4
T4NR1E Section 35, NW 1/4, SW 1/4, NW 1/4
T4NR1E Section 35, NW 1/4, NW 1/4, SW 1/4

constitutes lands of a groundwater basin where a well or other works for the withdrawal of groundwater are located.

That in order to obtain factual data in said groundwater basin, and specifically to determine the extent and areal distribution of contamination by dibromochloropropane (DBCP) in the groundwater of said basin, it is necessary that your affiant obtain samples of water from the wells located on the aforedescribed property. So that said samples consist of water from the aquifer, they must be taken when specific conductance has stabilized as determined by a field plot of conductance versus time.

That wells located on the above-described premises have been selected for sampling pursuant to a general administrative plan derived from objective sources. The Arizona Water Commission has been cooperating with the Arizona Department of Health Services to determine the groundwater areas that have been contaminated by DBCP. The Arizona Department of Health Services identifies large citrus-growing areas and the Arizona Water Commission then reviews

its records and locates wells in that area that should be tested in order to determine whether the groundwater has been contaminated by DBCP, and the areal distribution of such contamination.

That pursuant to this general administrative plan, the Arizona Department of Health Services has informed the Arizona Water Commission that the aforedescribed premises constitute a large citrus-growing area and the Arizona Water Commission has reviewed its records and identified ten wells on that property. The water supplying these wells must be sampled in order to determine whether the aquifer has been contaminated by DBCP and the areal distribution of such contamination, and to project the groundwater movement of that contamination.

Your affiant has a B.S. degree in Geology, and has been employed by the Arizona Water Commission as a staff hydrologist from 1972 to 1976 and since February, 1979.

_____

Affiant
Arizona Water Commission

SUBSCRIBED AND SWORN TO before me this ____ day of August, 1979.

_____

Judge, Justice of the Peace or Magistrate

APPENDIX J

AFFIDAVIT FOR SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

Your affiant, Timothy D. Love, an official of the Arizona Department of Health Services, being first duly sworn, upon oath, deposes and says:

That a source and means of water supply, namely, ten wells, are located upon the property in Maricopa County, particularly described as follows:

T4NR1E	Section 22, NE 1/4, NE 1/4, NE 1/4
T4NR1E	Section 22, NE 1/4, SE 1/4, NE 1/4
T4NR1E	Section 22, NW 1/4, SE 1/4, NE 1/4
T4NR1E	Section 34, SW 1/4, NE 1/4, NE 1/4
T4NR1E	Section 34, NW 1/4, NE 1/4
T4NR1E	Section 34, NE 1/4, NW 1/4, NE 1/4
T4NR1E	Section 35, NW 1/4, NW 1/4, NW 1/4
T4NR1E	Section 35, NW 1/4, SW 1/4, NW 1/4
T4NR1E	Section 35, NW 1/4, NW 1/4, SW 1/4

That your affiant has probable cause to believe and does believe that pesticides containing dibromochloropropane (DBCP) have been used upon said property, and that said source and means of water supply may contain concentrations of DBCP.

That in order to examine said source and means of water supply, and specifically to determine whether said source and means has been contaminated by DBCP, and the areal distribution of such contamination, it is necessary to obtain samples of water from said wells.

That wells located on the aforedescribed premises have been selected for sampling pursuant to a general administrative plan derived from objective sources. Prior to realization of the health hazards it posed, dibromochloropropane was used to combat nematode infestation of citrus crops. To determine the extent of groundwater contamination by DBCP, employees of the Arizona Department of Health Services, including your affiant, have therefore identified large

citrus-growing areas in the State, and are presently sampling wells within those areas. The aforedescribed premises are located in a large citrus-growing area, and thus wells located on that property are included among those to be sampled pursuant to the foregoing general administrative plan.

Your affiant has an M.S. degree in Botany. He is employed as a microbiologist by the Arizona Department of Health Services, and is presently assigned to the Bureau of Water Quality Control of the Arizona Department of Health Services.

_____

Affiant
Arizona Department of Health Services

SUBSCRIBED AND SWORN TO before me this ____ day of August, 1979.

_____

Judge, Justice of the Peace or Magistrate

SEARCH WARRANT

COUNTY OF MARICOPA

STATE OF ARIZONA

TO ANY PEACE OFFICER IN MARICOPA COUNTY, STATE OF ARIZONA

Proof by affidavit having been made this day before me by Timothy D. Love and Edward A. Nemecek, there is probable cause for believing that the groundwater supplying wells located on the following-described premises in Maricopa County:

T4NR1E Sections 22, 34 and 35

is subject to search and inspection by officials of the Arizona Department of Health Services and the Arizona Water Commission, in the interest of public health, safety or welfare, according to A.R.S. § 13-3912.

YOU ARE THEREFORE COMMANDED, in the daytime, to make a search of the above-named premises for the hereinabove property or things and, pursuant to A.R.S. § 13-3916.E, to make or cause to be made scientific tests of the groundwater supplying said wells, performed upon water obtained when specific conductance has stabilized as determined by a field plot of conductance versus time, and to retain the evidence of said scientific tests in your custody, or in the custody of the agency you represent or the Arizona Department of Health Services or the Arizona Water Commission, as provided by A.R.S. § 13-3920.

RETURN this warrant to me within five days of the date thereof, as directed by A.R.S. § 13-3918.

GIVEN UNDER MY HAND and dated this 23rd day of August, 1979.

Judge, Justice of the Peace or Magistrate

ARIZONA DEPARTMENT OF HEALTH SERVICES
Office of the Director

J. E. BABBITT, Governor
...NE DANDOY, M.D., M.P.H., Director

August 27, 1979

Mr. Paul De Falco, Jr.
Regional Administrator
U.S. Environmental Protection Agency
Region IX
215 Fremont Street
San Francisco, CA 94105

Dear Mr. De Falco:

This letter concerns the involvement of the Arizona Department of Health Services in the U.S. Environmental Protection Agency study of dibromochloropropane (DBCP) in groundwater. The Bureau of Water Quality Control responded to a request from your Agency to initiate a program to identify suspected DBCP use areas, select wells for sampling, and obtain and forward samples.

During the period of June 7 through 11, 31 samples were collected in Yuma and Maricopa counties. Of these samples, 11 were reported at or above the 0.05 parts per billion DBCP detection level. Based upon the high percentage of DBCP positive results and substantial public interest, a more exhaustive (Phase II) study was proposed to EPA staff. Since the State is not able to analyze samples for DBCP, EPA was requested to provide laboratory services for up to 200 samples.

Reported results for the Phase II study (at 0.01 parts per billion DBCP detection level) have generally confirmed the positive results of the initial sampling program. During this program, 54 additional groundwater supplies were sampled in Yuma County with 17 showing detectable DBCP levels. The Maricopa County sampling program has included nearly 50 additional groundwater supplies as of August 10. Although the laboratory has not completed its analysis of these samples, several have been reported positive.

...ate Health Building 1740 West Adams Street Phoenix, Arizona 85007

As the results are reported to the Bureau of Water Quality Control staff, owners and operators of DBCP positive wells are being notified of the reported results and of precautionary actions for domestic water supplies. Recommended actions are based upon (a) the State of California's "Action Level" per a May 31, 1979 letter from John M. Gaston, California Department of Health Services, to Marcia Williams, EPA Office of Toxic Substance, and (b) the concern of Alexander Kelter, M.D., Chief of the ADHS Bureau of Chronic and Environmental Disease Epidemiology, that DBCP is a known carcinogen and that detectable concentrations should be avoided by humans. In addition, these notifications include an advisory that there are no State or EPA health standards established for DBCP in drinking water supplies. Because ADHS has not determined whether DBCP can be removed from contaminated water supplies, our recommendations urge discontinuation of the use of such water supplies for domestic purposes. When additional information becomes available, our recommendations will be modified.

As a result of these notifications, over 20 water supplies have been identified as not suitable for all domestic uses. The City of Mesa has shut down one municipal well.

We believe that DBCP is a public health problem in Arizona. The Bureau of Water Quality Control is conducting the necessary sampling studies to identify contaminated aquifers and is properly notifying affected water users. To complement these activities, we believe EPA should provide us with further information and guidance to answer the DBCP related issues, outlined below:

1. The feasibility of treating DBCP contaminated waters to permit unrestricted domestic use.

2. The results of EPA sponsored engineering studies.

3. The feasibility of treating individual and municipal water supplies.

4. An EPA established maximum contaminant level for DBCP in drinking water supplies. If such standards require more research, an interim standard should be established as expeditiously as possible.

APPENDIX L

If this information is available in a timely manner, we believe the public can follow a reasonable course of action when dealing with DBCP contamination in groundwater supplies. We look forward to your reply and assistance in advising us in this area of concern.

Sincerely,

Suzanne Dandoy, M.D., M.P.H.
Director

SD:RBS:jle

cc: Alexander Kelter, M.D.
Maricopa County Health Department
Yuma County Health Department

References

1. Federal Register, 42 FR 48915, September 26, 1977.

2. "Judge Approves Ban on Pesticides Used Against Nematodes" Arizona Republic, October 21, 1979, page B-17.

3. U.S. Department of Agriculture, Soil Conservation Service, "Soil Survey of Maricopa County, Arizona, Central Part," (September, 1977).

4. U.S. Department of Agriculture, Soil Conservation Service, "Soil Survey, Eastern Maricopa and Northern Pinal Counties Area, Arizona," (November, 1974).

5. Personal Communication, Jim Carter, Agriculture and Horticulture Commission.

6. "Section of Freeway Closed by Leak from Truck Loaded with Pesticide," Arizona Republic, September 30, 1979.

7. Personal Communication, Mrs. Bruce Westburg, Phoenix, Arizona.

8. Ross, P. P., "Maps showing groundwater conditions in the western part of the Salt River area" Department of the Interior, U.S. Geological Survey, Water-Resources Investigation 78-40, March 1978.

9. Laney, R. L., Ross, P. P., and Litter, G. R., "Maps showing Groundwater Conditions in the eastern part of the River Valley area. Maricopa and Pinal Counties, Arizona - 1976." Department of the Interior, U.S. Geological Survey, Water-Resources Investigations 78-61, April 1978.

10. Personal Communication, Bob Fletcher, Fletcher Farms, Glendale, Arizona.

11. Ham, H. H., "Water Wells and Ground Water Contamination", Bulletin of the Association of Engineering Geologists VIII (1): 79-90, 1971.

12. Hodges, L. R., Lear, B., "Persistence and Movement of DBCP in Three Types of Soil", Soil Science 118 (2): 127-130, 1974.

13. Cohen, S. Z., "Direct Testimony of Mr. Stuart Z. Cohen", In Re: Notice of Intent to Suspend Registration of Dibromochloropropane (DBCP), U.S. EPA, FIFRA Docket No. 485, 1979.

14. Hodges, L. R. and Lear, B., "Distribution and Persistence of 1.2-Dibromo-3-Chloropropane in Soil After Application by Injection and in Irrigation Water" Nematologies 19: 146-158, 1973.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ARIZONA PUBLIC SERVICE	)	
COMPANY, ET AL.	)	Docket Nos. STN 50-528
	)	STN 50-529
(Palo Verde Nuclear Generating	)	STN 50-530
Station, Units 1, 2, and 3))		

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Testimony of Edwin K. Swanson has been served upon the following persons by deposit in the United States mail, first class, postage prepaid, or by other means as specified, this 16th day of June.

**DOCKETING AND SERVICE SECTION
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

CHAIRMAN, MARICOPA COUNTY
Board of Supervisors
111 South Third Avenue
Phoenix, Arizona 85004

** DR. RICHARD F. COLE
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

**ATOMIC SAFETY AND LICENSING
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**ATOMIC SAFETY AND LICENSIN
BOARD PANEL
U.S. Nuclear Regulatory
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Washington, D.C. 20555

** LEE SCOTT DEWEY, ESQ.
Office of the Executive
Legal Director
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Lynne Bernabei

*VIA EXPRESS MAIL
**HAND DELIVERED
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