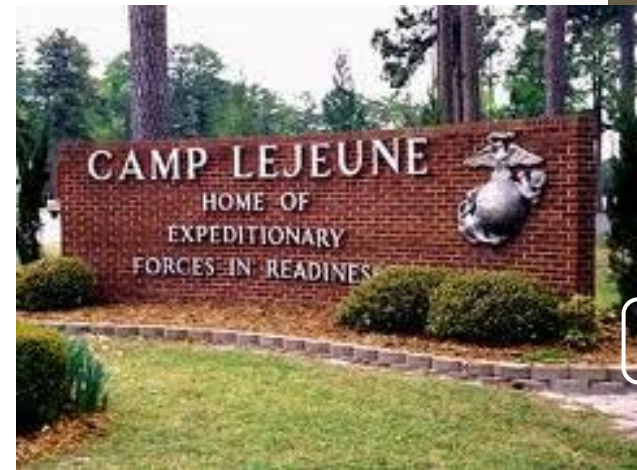


The History of Camp Lejeune Water Contamination



August 2017
SME Training
Louisville, KY



What happened at U.S. Marine Corps Base Camp Lejeune?

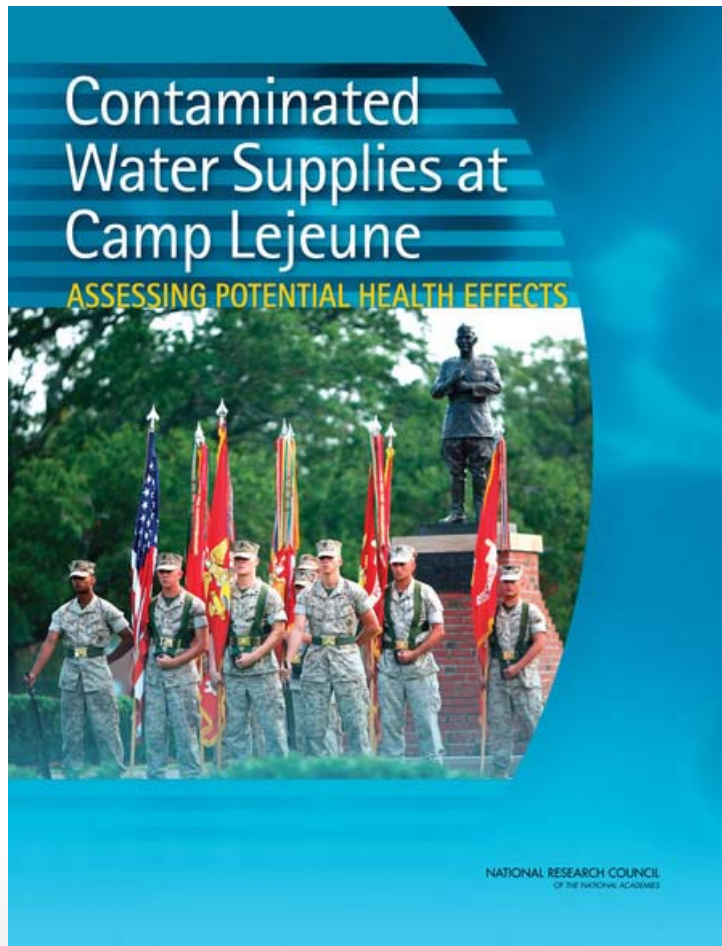
From the 1950s through the 1980s, people living or working at the U.S. Marine Corps Base Camp Lejeune, NC, were unknowingly exposed to drinking water contaminated with volatile organic compounds (VOCs).



- Over 1 million individuals potentially exposed (Service Members, Families and Civilians)
- EPA: Placed Camp Lejeune on the National Priorities List in 1989
- DoD: Created a registry to notify Veterans of possible exposure
- ATSDR:
 - ✓ Issues a periodic Public Health Assessment (PHA) (01/20/2017)
 - ✓ With funding from DoD, conducts ongoing epidemiology studies
 - ✓ Leads a Community Assistance Panel (CAP) for concerned Veterans and Family Members

- Veterans Affairs:
 - Contracted with the National Academies of Science for several studies related to potential contamination-one study remaining on current contract
 - National Research Council (NRC) 2009:
 - Institute of Medicine (IOM), 2015:
 - Reviewed the Clinical Guidelines utilized by VHA to evaluate claims under the Honoring America's Veterans and Caring for Camp Lejeune Families Act of 2012.
 - Recommended Parkinson's disease as a "neurobehavioral effect".
 - Collaborates with ATSDR to conduct a hazard evaluation of the chemicals of interest, which included a review of assessments done by EPA, NTP, NAS and IARC.

In 2009 the National Research Council (NRC aka IOM aka NAM)
published a report:
Contaminated Water Supplies at Camp Lejeune: Assessing Potential Health Effects



The report concludes that available scientific evidence does not provide sufficient basis to determine if the population of Camp Lejeune suffered adverse health effects as a result of exposure to contaminants in the water supply.

5 categories used by IOM to classify associations:

Sufficient Evidence of a Causal Relationship

Evidence from available studies is sufficient to conclude that a causal relationship exists between exposure to a specific agent and a specific health outcome in humans, and the evidence is supported by experimental data. The evidence fulfills the guidelines for sufficient evidence of an association (below) and satisfies several of the guidelines used to assess causality: strength of association, dose-response relationship, consistency of association, biologic plausibility, and a temporal relationship.

Sufficient Evidence of an Association

Evidence from available studies is sufficient to conclude that there is a positive association. A consistent positive association has been observed between exposure to a specific agent and a specific health outcome in human studies in which chance and bias, including confounding, could be ruled out with reasonable confidence. For example, several high-quality studies report consistent positive associations, and the studies are sufficiently free of bias, including adequate control for confounding.

Limited/Suggestive Evidence of an Association

Evidence from available studies suggests an association between exposure to a specific agent and a specific health outcome in human studies, but the body of evidence is limited by the inability to rule out chance and bias, including confounding, with confidence. For example, at least one high-quality study reports a positive association that is sufficiently free of bias, including adequate control for confounding. Other corroborating studies provide support for the association, but they were not sufficiently free of bias, including confounding. Alternatively, several studies of less quality show consistent positive associations, and the results are probably not due to bias, including confounding.

Inadequate/Insufficient Evidence to Determine Whether an Association Exists

Evidence from available studies is of insufficient quantity, quality, or consistency to permit a conclusion regarding the existence of an association between exposure to a specific agent and a specific health outcome in humans.

Limited/Suggestive Evidence of No Association

Evidence from well-conducted studies is consistent in not showing a positive association between exposure to a specific agent and a specific health outcome after exposure of any magnitude. A conclusion of no association is inevitably limited to the conditions, magnitudes of exposure, and length of observation in the available studies. The possibility of a very small increase in risk after exposure studied cannot be excluded.

Study Findings

- *Sufficient Evidence of a **Causal Relationship***
 - No outcomes
- *Sufficient Evidence of an **Association***
 - No outcomes
- Limited/Suggestive evidence of no **Association**
 - No outcomes

The NRC review found 14 conditions with limited/suggestive evidence of an **Association**

Esophageal cancer (PERC)

Lung cancer (PERC)

Breast cancer (PERC)

Bladder cancer (PERC)

Kidney cancer

Adult leukemia (solvent mixtures)

Multiple myeloma (solvent mixtures)

Myelodysplastic syndromes (solvent mixtures)

Renal toxicity (solvent mixtures)

Hepatic steatosis (solvent mixtures)

Female infertility (with concurrent exposure to solvent mixtures)

Miscarriage (with exposure to PCE during pregnancy)

Scleroderma (solvent mixtures)

Neurobehavioral effects (solvent mixtures)

The specific VOCs that ATSDR evaluated are:

Tetrachloroethylene (PCE/PERC)-a dry cleaning solvent

Trichloroethylene (TCE)-a metal degreasing solvent

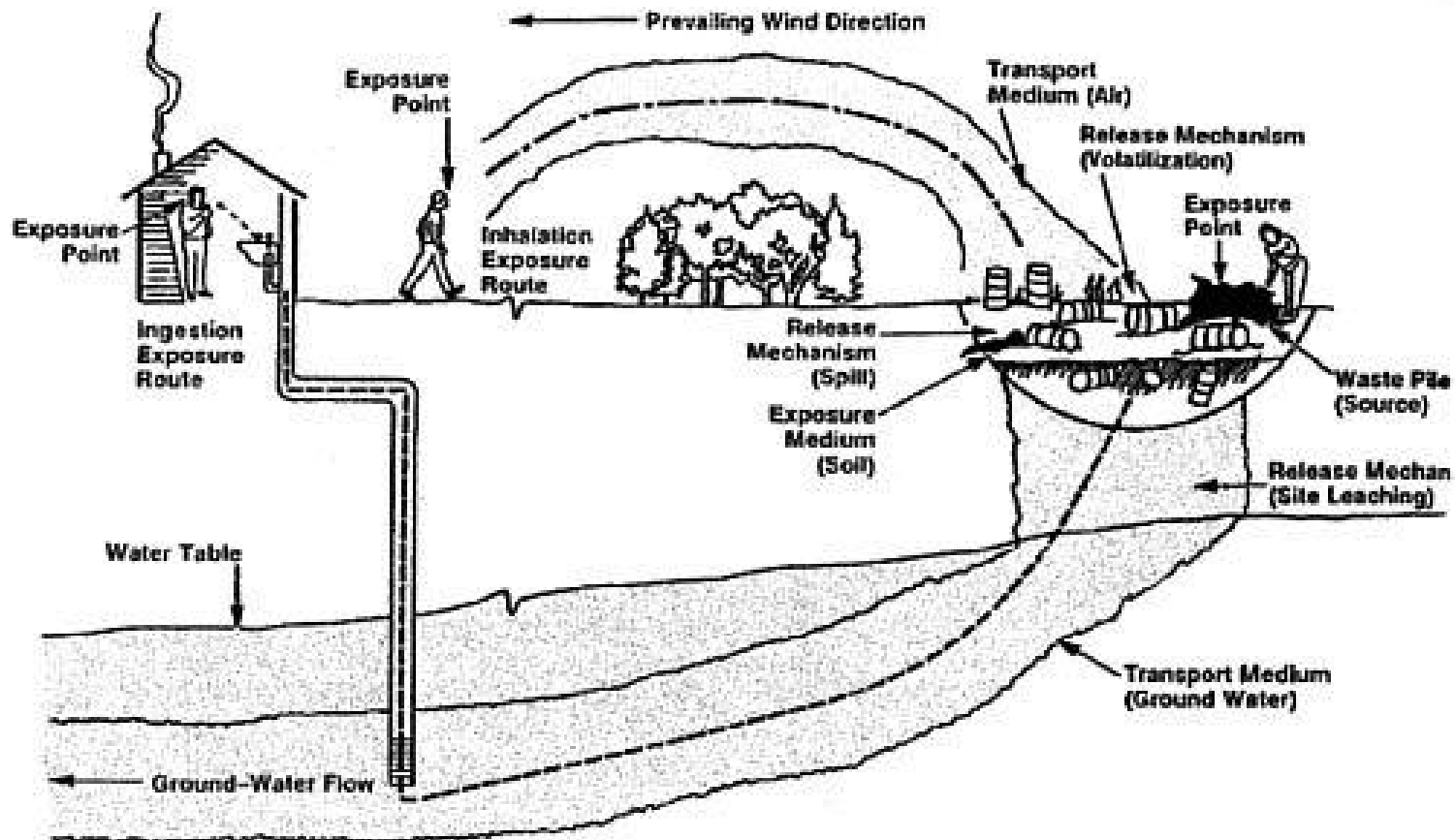
Benzene-a fuel component

Vinyl chloride- forms when TCE/PERC break down

Trans 1,2-dichloroethylene (1,2-tDCE)- forms when TCE/PERC break down

http://www.atsdr.cdc.gov/sites/lejeune/chapterA_factsheet.html

Environmental contamination from solvents and exposure pathways. Source: EPA 1989.



Schematic of Water Supply:

Groundwater wells → Water Treatment Plant → Mixed & treated
→ Stored above/below ground → Pumped as needed to offices, schools, etc.

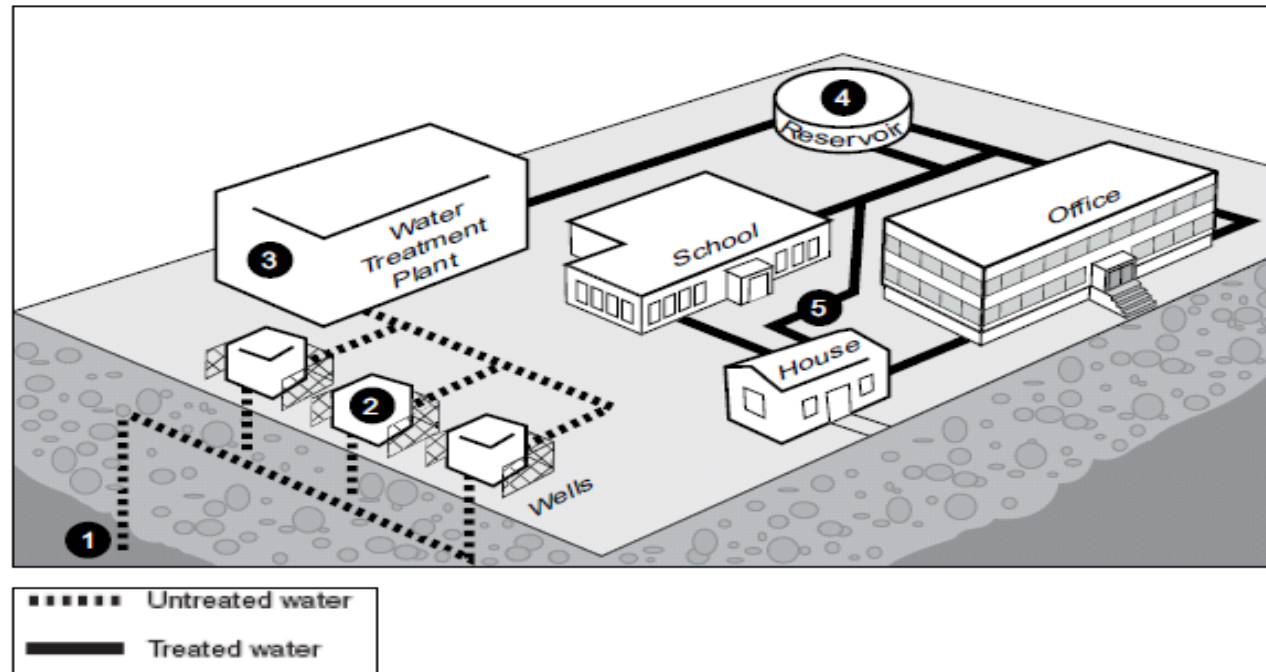


FIGURE 1 Conceptual model of a Camp Lejeune water system. (1) The drinking water at Camp Lejeune is obtained from groundwater pumped from a freshwater aquifer located approximately 180 feet below the ground. (2) Groundwater is pumped through wells located near the water-treatment plant. (3) In the water-treatment plant, the untreated water is mixed and treated through several processes: removal of minerals to soften the water, filtration through layers of sand and carbon to remove particles, chlorination to protect against microbial contamination, and fluoride addition to help to prevent tooth decay. (4) After the water is treated, it is stored in ground and elevated storage reservoirs. (5) When needed, treated water is pumped from the reservoirs and tanks to facilities such as offices, schools, or houses on the base. Source: GAO. 2007. Defense Health Care: Activities Related to Past Drinking Water Contamination at Marine Corps Base Camp Lejeune. GAO-07-276. Washington, DC: U.S. Government Accountability Office.

8 water treatment plants served Camp Lejeune

Contaminated:

- **Hadnot Point (HP)**
 - Began operation in 1942
 - Areas served:
 - Main side barracks
 - Hospital Point family housing
 - Family housing at Midway Park, Paradise Point, and Berkeley Manor until June 1972
- **Tarawa Terrace (TT)**
 - Began operation in 1952
 - Shut down in March 1987
 - Areas served:
 - Tarawa Terrace family housing
 - Knox trailer park

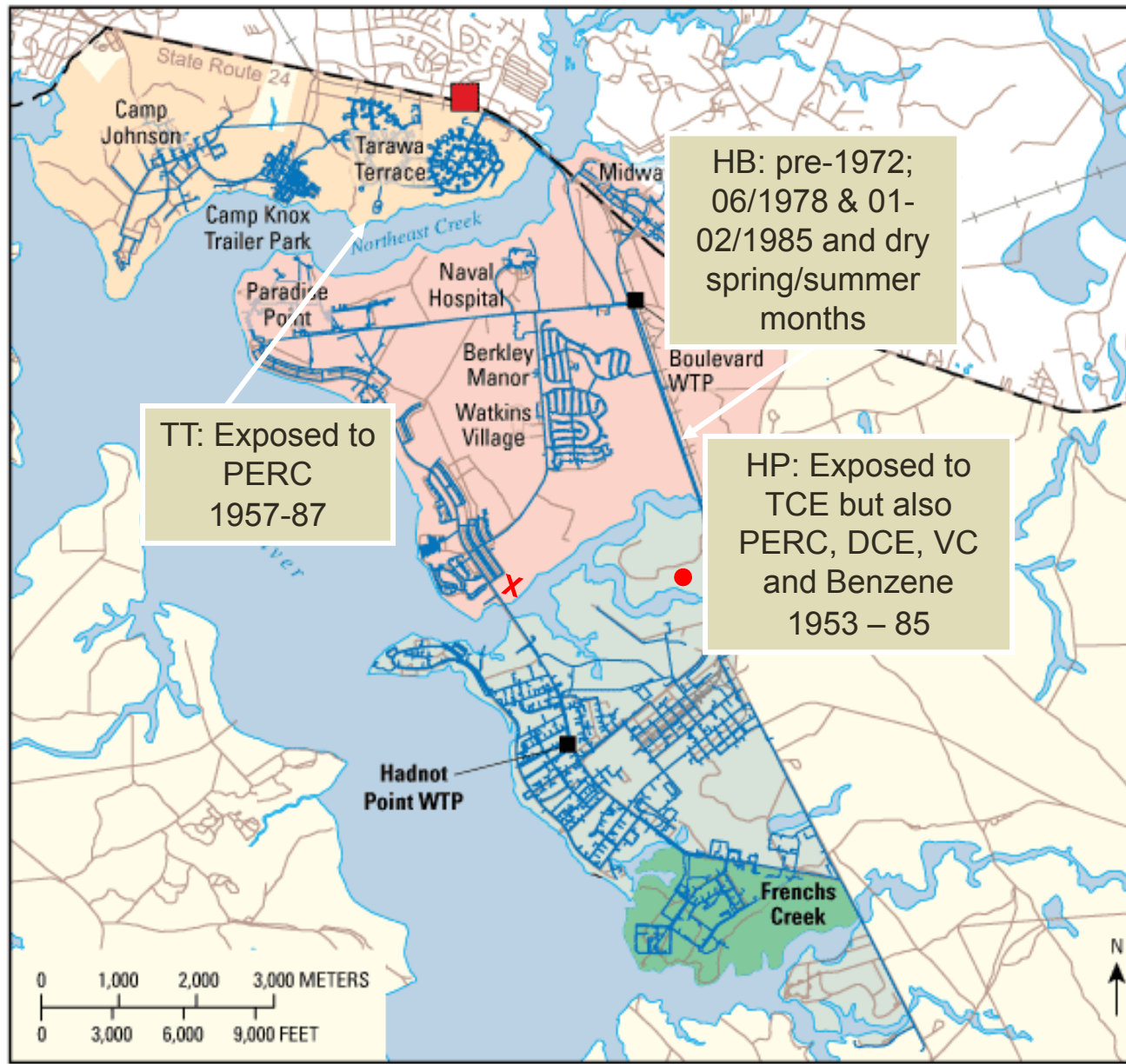
Cross-contaminated:

- **Holcomb Boulevard (HB)**
 - Began operation in June 1972
 - Areas served:
 - Family housing at Midway Park, Paradise Point, Berkeley Manor, and Watkins Village
 - Tarawa Terrace family housing after March 1987

Uncontaminated:

- **Courthouse Bay**
- **Rifle Range**
- **Onslow Beach**
- **Montford Point/Camp Johnson**
- **New River**

*For presumptives entire CL considered as contaminated










TT: Exposed to PERC 1957-87

HB: pre-1972; 06/1978 & 01-02/1985 and dry spring/summer months

HP: Exposed to TCE but also PERC, DCE, VC and Benzene 1953 – 85

EXPLANATION

-  Camp Lejeune Military Reservation
- Present day (2004) water-distribution system**
-  Tarawa Terrace
-  Holcomb Boulevard
-  Hadnot Point
-  Water pipeline
-  Water-treatment plant (WTP)
-  ABC One-Hour Cleaners

TT: Tarawa Terrace
 HB: Holcomb Blvd.
 HP: Hadnot Point

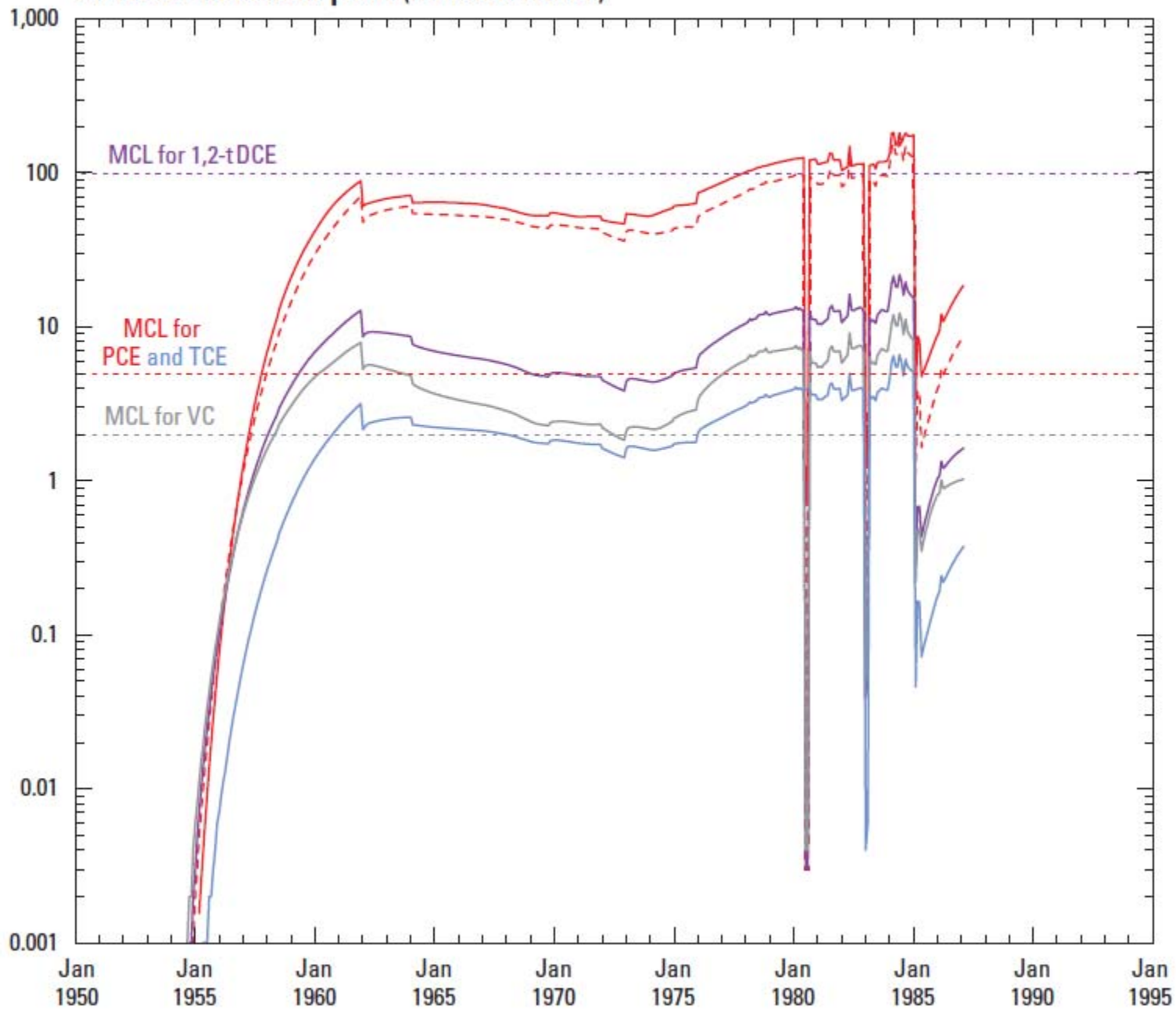
How and when were issue detected?

- VOCs detected in HP and TT wells during 1980-85:
 - Samples collected by Camp Lejeune staff starting in early 1980 noted to be contaminated; specific VOCs identified in 1982- however contaminants were unregulated in drinking water (EPA limits established 1989 and 1992)
 - Contamination of wells began many years before detection indicated by ATSDR modeling (2007 TT and 2013 HP/HB)
- Contamination of HP and TT drinking water systems was intermittent:
 - Wells rotated in and out of service
 - Each system had more wells than necessary to supply water on any given day

Tarawa Terrace Treatment Plant 1952 to March 1987

- PERC/PCE (perchloroethylene or tetrachloroethylene) was the main contaminant
- Maximum level detected in drinking water was 215 parts per billion (ppb) in February 1985 (odor threshold in air is 1000 ppb ATSDR; 47000 ppb AIHA [sharp sweet odor])
- Source of contamination was ABC One-Hour Cleaners, an off-base dry cleaning firm
- The most contaminated wells were shut down in February 1985
- ATSDR used water modeling to estimate past exposure levels completed in 2007
 - PCE concentration exceeded the current EPA maximum contaminant level of 5 ppb in drinking water for 346 months during November 1957-February 1987*

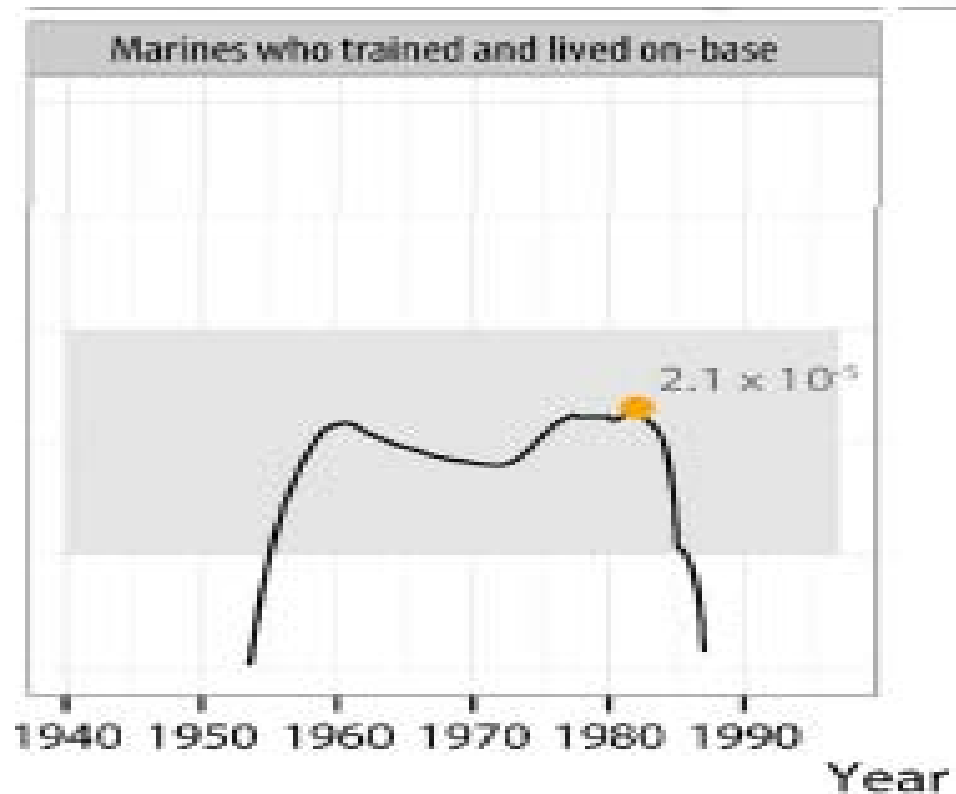
b. Water treatment plant (finished water)



Tarawa Terrace: Estimated Lifetime Cancer Risk by Age Group over Time Based on 3-Year Exposure (PHA 2017)

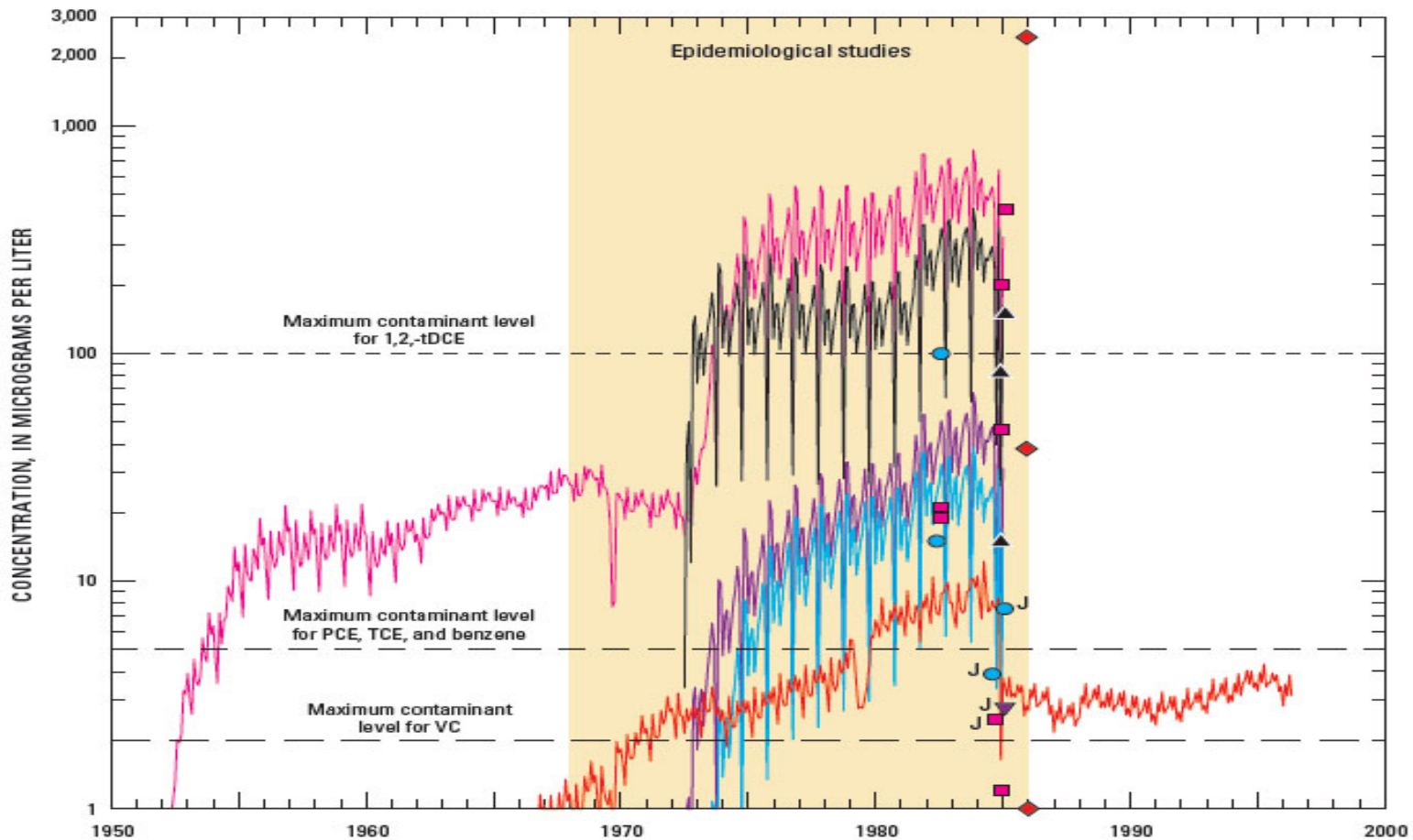
ATSDR PHA 01/20/2017

3-year exposure duration, the estimated upper-bound cancer risk [USEPA's Superfund target cancer-risk range-1 excess case for every 10,000 exposed persons to 1 excess case for every 1,000,000 exposed]



Hadnot Point Treatment Plant 1942-to February 1985

- TCE (trichloroethylene) was the main contaminant
- Maximum level detected in drinking water was 1,400 ppb in May 1982 (odor threshold 28000 ppb ATSDR, 82000 ppb AIHA [sweet odor])
 - The current limit for TCE in drinking water is 5 ppb
- Other contaminants detected included PERC, DCE, VC and benzene
- Multiple sources of contamination
 - Leaking underground storage tanks
 - Waste disposal sites
- The most contaminated wells were shut down by February 1985
- ATSDR-water modeling to estimate past exposure levels (2013)
 - At least one VOC exceeded its current EPA maximum contaminant level in drinking water during August 1953 and January 1985*



Concentration in finished water at water treatment plant

Contaminant	Measured	Reconstructed
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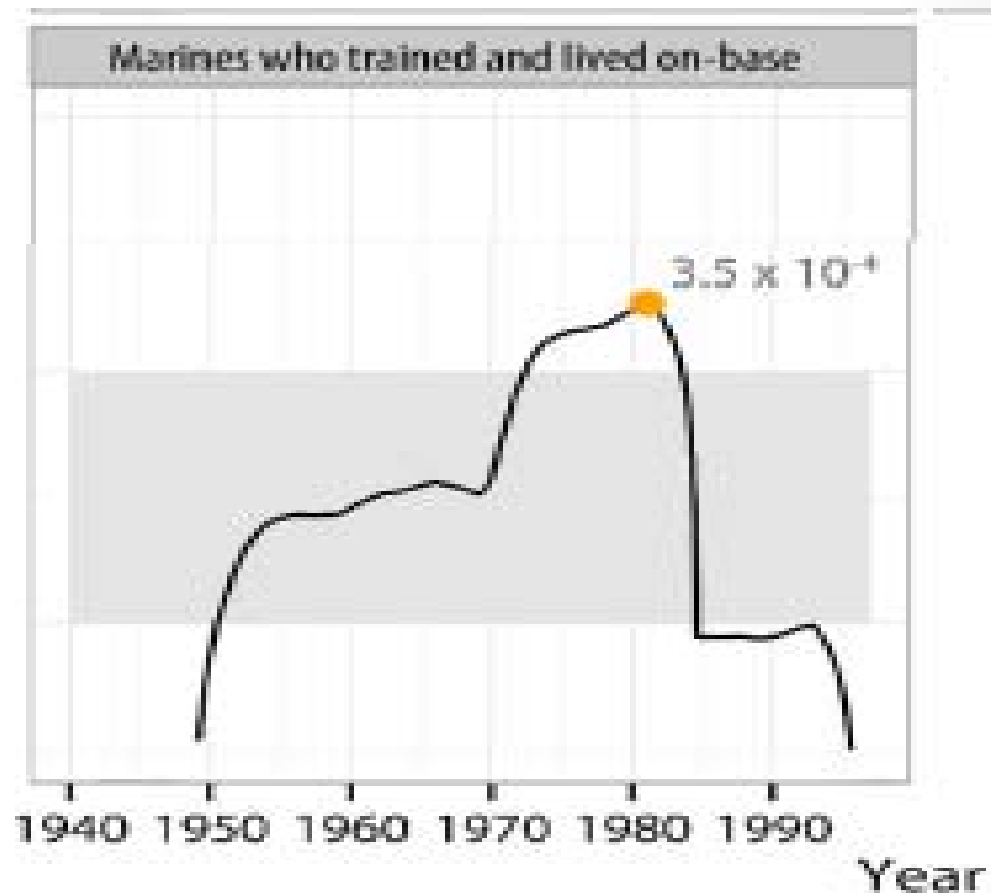
PCE	●	—
TCE	■	—
1,2-tdDCE	▲	—
VC	▼	—
Benzene	◆	—

J = estimated concentration

Estimated Lifetime Cancer Risk by Age Group over Time Based on 3-Year Exposure (PHA 2017)

ATSDR PHA 01/20/2017
Marines in-training had an increased cancer risk, with the highest estimated risk of up to four additional cancer cases among 10,000 exposed individuals.

*Published after CLCW Presumptives were finalized



Holcomb Boulevard

- HB service area received water from HPWTP prior to construction in 1972
- Contaminated water from the Hadnot Point (HP) water treatment plant supplied the HB drinking-water system June 1978, and when the HB plant was shut down during January 27-February 7, 1985*
- Contaminated water from HP water treatment plant was used intermittently to supplement the HB drinking-water supply during dry spring and summer months when demand was high

Other Exposures

- Marines and civilians training and recreating at indoor swimming pools
- Civilians working at laundry facilities
- Marines and civilians working in dining halls
- In all three scenarios, TCE and benzene exceeded their ATSDR intermediate and chronic minimal risk level (MRLs), and PCE exceeded its acute, intermediate, and chronic MRL.

ATSDR Timeline of Public Health Activities at Camp Lejeune, May 2016

- **1989 – Camp Lejeune and ABC One-Hour Cleaners – Superfund Sites**

The US Environmental Protection Agency lists US Marine Corps Base Camp Lejeune and ABC One-Hour Cleaners as Superfund sites and adds both sites to the National Priorities List.

- **1990 – ABC One-Hour Cleaners Public Health Assessment**

ATSDR finds that PCE is the main contaminant of concern detected in the Tarawa Terrace drinking water system. Although contaminated wells have been removed from the Tarawa Terrace water system, on- and off-site groundwater is contaminated. Groundwater and subsurface soils remain a public health concern.

- **1997 – Camp Lejeune Public Health Assessment**

ATSDR identifies a past health hazard from exposures to contaminated water in Tarawa Terrace and Hadnot Point water systems. ATSDR scientists also identify a short time frame when the Holcomb Boulevard system was contaminated. ATSDR recommends a health study to assess risk to children from maternal exposure during pregnancy.

- **1998 – Reproductive Health Study**

ATSDR completes its first study on health of children born from 1968-1985 whose mothers were exposed to contaminated drinking water during pregnancy. This study is published in 2001 in the *American Journal of Epidemiology*. In 2007, ATSDR reports an error in the exposure assessment and declares its intention to re-evaluate the results.

- **1999-2002 – ATSDR Parent Phone Survey**

ATSDR conducts a telephone survey of 12,598 parents of children born to women who were pregnant while living at Camp Lejeune from 1968-1985. Survey is designed to identify and confirm all reported cases of selected birth defects and childhood cancers in children exposed in utero to VOC-contaminated drinking water.

- **2003 – Telephone Survey Results**

ATSDR's 2002 telephone survey finds 106 children with specific birth defects and some types of childhood cancer. ATSDR begins confirming cases with medical records.

- **2004-2005 – Water Contamination Reconstruction**

Past Camp Lejeune water-quality sampling data are very limited. ATSDR begins historical reconstruction of Tarawa Terrace and Hadnot Point water treatment plant service areas to determine where and when certain areas at Camp Lejeune received VOC-contaminated drinking water.

- **2005 – Panels review health studies, water modeling**

In February, ATSDR convenes an expert panel to explore the need for and feasibility of conducting additional health studies of people exposed to contaminated drinking water at Camp Lejeune. In March, an expert panel evaluates the agency's field data gathering activities at Camp Lejeune and water modeling approach. ATSDR technical staff considers the panel recommendations and implements them as appropriate.

- **2005 – Birth Defects/Childhood Cancer Parent Interviews**

ATSDR begins Exposure to Volatile Organic Compounds in Drinking Water and Specific Birth Defects and Childhood Cancers study, which evaluates groups of children with and without health effects. Telephone interviews gather information about residence, other health factors, and amount of water mothers drank during pregnancy. Study includes use of water modeling data to determine which mothers received contaminated water.

- **2006 – Camp Lejeune Community Assistance Panel (CAP)**

ATSDR holds the first CAP meeting with community members and non-government scientific experts. The CAP will help identify feasible studies for the future and prioritize them.

- **2007 – Tarawa Terrace Water Analysis**

ATSDR's analysis of Tarawa Terrace water treatment plant service area reveals that from November 1957 through February 1987, residents of Tarawa Terrace family housing and other facilities received PCE-contaminated drinking water above EPA's maximum contaminant level.

- **2007-2008 – Feasibility of Conducting Further Camp Lejeune Studies**

ATSDR determines that additional studies of mortality and cancer incidence among persons living and working at Camp Lejeune are feasible and would be scientifically useful and helpful to people exposed to contaminated water.

- **2008 – National Defense Authorization Act**

In January, President George W. Bush signs the 2008 National Defense Authorization Act. This act includes a requirement that the Department of the Navy, working with ATSDR, conduct a health survey of persons possibly exposed to contaminated drinking water at Camp Lejeune.

- **2009 – Expert panel reviews water modeling**

ATSDR convenes an expert panel to assess water-modeling and data analyses for Hadnot Point-Holcomb Boulevard study area. ATSDR agrees to evaluate the applicability of simplified approaches for determining historical concentrations at water-supply wells. The panel also encourages the Department of the Navy to ensure that ATSDR has all data and documentation necessary to complete water-modeling activities.

- **2009 – Reevaluation of VOC Exposure**

ATSDR discovers additional information about VOCs in finished water at Camp Lejeune. ATSDR learns that people serviced by the Holcomb Boulevard water-distribution system occasionally have been exposed to contaminated water. ATSDR also recognizes that benzene present in the water-supply wells before 1985 should be moved from the appendix to the body of its public health assessment. Consequently, ATSDR removes the 1997 Public Health Assessment from its web site.

- **2010-2012 – DON/ATSDR work together to complete data gathering**

From 2010-2012, the DON/ATSDR Camp Lejeune Data Mining Technical Workgroup (DON, USMC, and ATSDR) conducted nine meetings to complete data gathering for water modeling and the epidemiologic studies.

- **2010 – ATSDR begins mortality study**

ATSDR begins a mortality study looking at all causes of death for military and civilian personnel who lived/worked at Camp Lejeune between specific dates in the 1970s and 1980s. The study seeks to determine if these deaths are linked to exposure to contaminated water at Camp Lejeune. The study includes an unexposed sample from Camp Pendleton.

- **2010 – ATSDR releases Hadnot Point-Holcomb Boulevard Chapter C Report**

The report describes the occurrence of PCE, TCE, benzene, and vinyl chloride in groundwater at Navy Installation Restoration Program (CERCLA) sites. The sites are located within the Hadnot Point and Holcomb Boulevard water treatment plants service areas and vicinities at Camp Lejeune.

- **2011 – ATSDR expert panel considers health survey issues**

ATSDR expert panel reviews process of confirming self-reported disease and survey evaluation bias and agrees to move forward with confirmation.

- **2011 – ATSDR mails health surveys**

ATSDR mails ATSDR Health Survey of Former Marine Corps Personnel and Civilians to persons who lived or worked at Camp Lejeune when drinking water was contaminated and to persons living or working at Camp Pendleton during the same time period. The survey asks about more than 20 different cancers and diseases and provides opportunity to report diseases not mentioned.

- **2011 – ATSDR Public Information Forum**

ATSDR holds a public information forum for Camp Lejeune at the University of North Carolina Wilmington. The forum includes an update on ATSDR's health survey and other activities, an open house, one-on-one question and answer sessions, and an update from the CAP.

- **2012 – Geohydrologic Framework Report**

ATSDR releases Hadnot Point-Holcomb Boulevard Chapter B. The report includes information and data on the layers of sediment and groundwater beneath Camp Lejeune. This information provides a foundation for understanding groundwater flow and conducting water modeling.

- **2012 – ATSDR/DON Data Mining Workgroup Final Report**

The Data Mining Workgroup, established in 2010, assures that ATSDR has a complete accounting of DON document locations that contain potentially relevant data and information for water modeling. The documents identified by the workgroup provide more information on how the Camp Lejeune Drinking Water Systems were operated.

- **2012 – Contamination at RCRA Areas Report**

ATSDR releases Hadnot Point-Holcomb Boulevard Chapter D. This report summarizes investigations at 64 Resource Conservation and Recovery Act (RCRA) study areas. The report emphasizes the occurrence and distribution of refined petroleum products such as benzene, toluene, ethylbenzene, xylene, and chlorinated solvents of PCE and TCE within areas served by the Hadnot Point and Holcomb Boulevard water treatment plants.

- **2012-2014 – DON/ATSDR work together to complete data gathering**

From 2012-2014, the DON, USMC Camp Lejeune, and ATSDR conducted and completed data gathering for the soil vapor intrusion project.

- **2013 – Hadnot Point-Holcomb Boulevard Reconstruction Report**

ATSDR releases Hadnot Point-Holcomb Boulevard Chapter A and supplements. This report summarizes previous analyses and investigations—Chapters B, C, and D—and results of detailed *water modeling analyses*.

- **2013 – Birth Defects and Childhood Cancers Study**

The purpose of this study was to determine if maternal exposures to the drinking water contaminants at Camp Lejeune increased the risk of neural tube defects, oral clefts, and childhood hematopoietic cancers. This study also examined whether children exposed to contaminated drinking water during the first year of life had an increased risk of childhood cancers.

- **2014 – Mortality Study of Marine and Naval Personnel**

The purpose of this study was to determine whether residential exposures of Marines and Navy personnel to contaminated drinking water at Camp Lejeune increased risk of mortality from cancers and other chronic diseases.

- **2014 – Mortality Study of Civilian Employees**

The purpose of the study was to determine whether potential exposures to the drinking water contaminants at Camp Lejeune are associated with increased risk of death from specific cancers and other chronic diseases among those who were employed at the base.

- **2014 – Adverse Birth Outcomes Study**

ATSDR publishes study to determine if maternal exposures to contaminants in drinking water at Camp Lejeune were associated with preterm birth and fetal growth retardation. This study is a reanalysis of a previous study, which incorrectly categorized as “unexposed” some maternal exposures before June 1972 based on information available at the time.

- **2015 – Male Breast Cancer Study**

The purpose of this study was to determine if Marines who were exposed to contaminated drinking water at Camp Lejeune were more likely to have male breast cancer.

- **2016 – Cancer Incidence Study**

ATSDR begins the Cancer Incidence Study. The purpose of the study is to determine whether residential or workplace exposures to the drinking water contaminants at Camp Lejeune are associated with increased risks of specific cancers in Marines/Navy personnel and civilian employees.

- **2016 – Camp Lejeune Drinking Water Public Health Assessment**

ATSDR released preliminary findings from the revised public health assessment (PHA) of the health effects of exposure to volatile organic compounds (VOCs) found in the drinking water at CL

* 01/13/17 ATSDR Assessment of the Evidence for the Drinking Water Contaminants at Camp Lejeune and Specific Cancers and Other Diseases

* 01/13/17 – Camp Lejeune Final Rule Published 38 CFR 3

* **01/20/17-Camp Lejeune Drinking Water Public Health Assessment**

http://www.atsdr.cdc.gov/sites/lejeune/docs/camp_lejeune_timeline.pdf

Camp Lejeune Presumptions

- VA created a presumption of service connection for Veterans who were assigned to Camp Lejeune during the period of contamination from 08/01/1953-12/31/1987 for ≥ 30 days and have developed the following conditions:
 - Liver cancer
 - Kidney cancer
 - Bladder Cancer
 - Adult leukemia
 - Non-Hodgkin's lymphoma
 - Multiple myeloma
 - Parkinson's disease
 - Aplastic anemia and other myelodysplastic syndromes
- Final rule was published in January 2017
- Took effect-March 13, 2017

Honoring America's Veterans and Caring for Camp Lejeune (CLA) Families Act of 2012

- Provides health care at VA facilities for 15 conditions to Veterans who were stationed or resided at CL for > 30 days between 1957 to 1987.
- Do not need to be SC to enroll
- VA serves as “last payer” for medical bills for 15 conditions to family members who resided at CL \geq 30 days between 1957 to 1987.
- Law does not allow for care or payment for conditions found to have another cause.

The 15 Conditions in the Health Care Law

- (i) Esophageal cancer
- (ii) Lung cancer
- (iii) Breast cancer
- (iv) Bladder cancer
- (v) Kidney cancer
- (vi) Leukemia
- (vii) Multiple myeloma
- (viii) Myelodysplastic syndromes
- (ix) Renal toxicity*
- (x) Hepatic steatosis
- (xi) Female infertility
- (xii) Miscarriage
- (xiii) Scleroderma
- (xiv) Neurobehavioral effects*
- (xv) Non-Hodgkin's lymphoma

USMC - Q and A Booklet



**CAMP
LEJEUNE** HISTORIC
DRINKING
WATER

CAMP LEJEUNE HISTORIC DRINKING WATER
Questions and Answers
SECOND EDITION | MARCH 2012

https://clnr.hqi.usmc.mil/clwater/documents/CLHDW_Booklet.pdf

VA - OPH Website

UNITED STATES
DEPARTMENT OF VETERANS AFFAIRS



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You are here: Home » Military Exposures

 **Military Exposures**
Veterans may have been exposed to a range of chemical, physical, and environmental hazards during military service.

New Camp Lejeune Health Care Law
Veterans and family members who served on active duty or resided at Camp Lejeune between 1957 and 1987 for 30 days or more may be eligible for medical care for 15 health conditions. [Learn More](#) ▶ 

4 Ways to Find Exposures

Related Health Concerns Wars & Operations

Search Public Heal

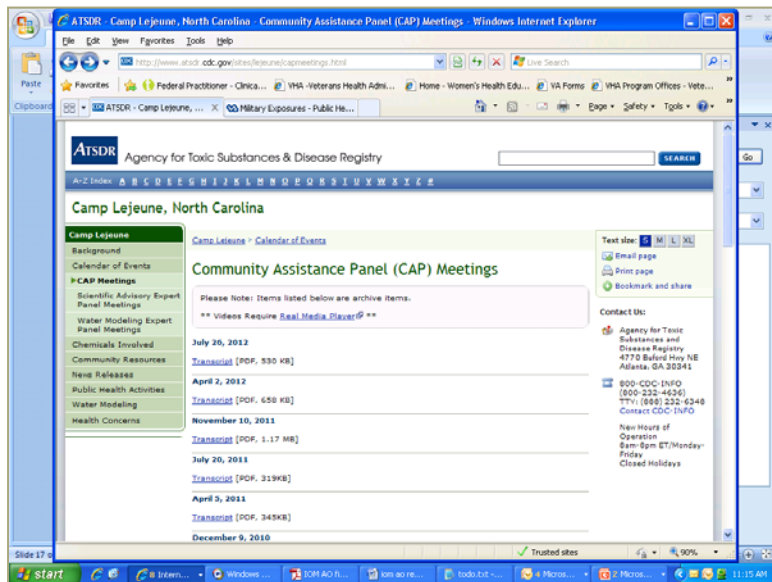
Connect with Veterans H
f t

Subscrib
Exposures Up
Enter your email :
S

Contact V

ATSDR –Website

<http://www.atsdr.cdc.gov/sites/lejeune/index.html>



CAP established by ATSDR in 2006
Community members provide input
to ATSDR on proposed studies, etc.
Meet quarterly (the public can call
in)