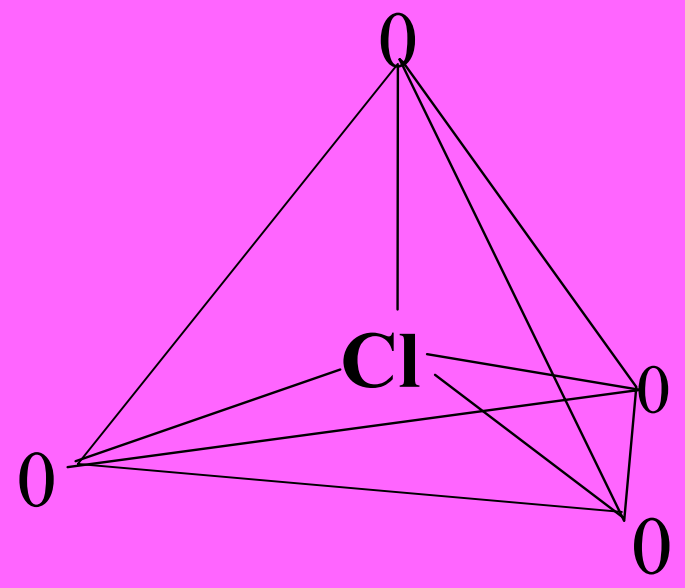
PERCHLORATE
ClO_4^-

Historical Perspective

Regulatory Authority

Risk

EPA, DoD, DoA Policy



Chemistry/Detection/Remediation

Information from:
K. Mayer, A. Jarabek,W. Parskins,D. Munch, D. Huber…USEPA
J. Breckenridge, D. Mattie, E. Becvar, B. Harre, M. Garb…USDOD

POTASSIUM NITRATE
CHAMPION
13.5-0-45
PRILLS
POTASSIUM NITRATE
OXIDIZER
5.1

OXIDIZER
5.1

DoD Systems That Use Perchlorate

- Space Shuttle SRBs
- TITAN II
- Minuteman
- Peacekeeper
- Polaris
- Poseidon
- TOW Missile (launch motor)
- Stinger Missile
- Sergeant Missile
- JATO Rockets
- Trident
- Mines

DoD Systems That Use Perchlorate

- Torpedos
- Smoke-generating
- Signal flares
- Parachute flares
- Timed fuses
- Star rounds for Very pistols
- Thermit-type incendiaries
- Rocket & small arms tracers
- Incendiary bombs

Not a complete list!

Specific Types of Materials

Tactical Missile System

AMRAAM AIM-120
ASROC (Rkt Mtr) MK37 Mod 0
ATACMS, Block 1
Falcon AIM-4
HARM AGM-88B
HARM AGM-88C
Hawk MIM-23
JSOW AGM-154B
Maverick AGM-65(A/B/D/H)

Cartridge 40MM Target Practice M918 LNKD	**DYES**
Marker Location Marine MK38 Modification1	**DYES**
Fuze Bomb Nose FMU-95/B	**FUZES**
Fuze FMU-94/B	**FUZES**
Pot M207A1	**FUZES**
Cartridge 60MM High Explosive M888	**HIGH EXPLOSIVE CARTRIDGES**
Cartridge 60MM Target Practice M50A3	**HIGH EXPLOSIVE CARTRIDGES**
Grenade Hand Fragmentation M26A1	**HIGH EXPLOSIVE GRENADES**
Grenade Hand Fragmentation M67	**HIGH EXPLOSIVE GRENADES**

At 1 ppb (ug/L)…

one thirtieth of an ounce of Perchlorate is dissolved in 264,172 gallons of water.

Perchlorate Regulatory Authority

SDWA- Federal

- **1974 Safe Drinking Water Act (SDWA)**
  - **1986 Amendments to the SDWA**
  - **1996 Amendments to the SDWA**
  - National Drinking Water Advisory Council
  - Science Advisory Board
  - Other Stakeholders

–Contaminant Candidate List

SDWA Criteria for Regulation

adversely affect health?

known or likely to occur PWSs?

Will regulation present an opportunity to reduce risk?

Regulate; publish MCLG and MCL

Historical Perspective on Perchlorate Occurrence

1980s - Aware of Perchlorate in CA and NV

1985-86 - San Gabriel Valley Superfund Site

ATSDR 1/21/86: "... the data do not prove that perchlorate ion has actually been found. If the presence of perchlorate ion is confirmed, the scientific database on this ion is insufficient to generate either an acute or longer-term health advisory for drinking water"

"... The minimal acute toxicity data available suggest that one or two ppm perchlorate ion would not represent an immediately acute and substantial threat to the public health.

The ATSDR does not consider this level to be "safe" in the absence of experimental data.."

1990s - Rancho Cordova (Aerojet) ppm

Historical Perspective-continued

- March 1997; Expert review of an "RfD" concluded data inadequate risk assessment
- Fall 1997; Congress mandated state-of-the-science determination
- January 1998; Interagency Perchlorate Steering Committee
- DOD and Perchlorate Study Group partnered with EPA to develop testing strategy
- Development of health and eco database with DOD/PSG dollars in 2 years

Perchlorate Releases

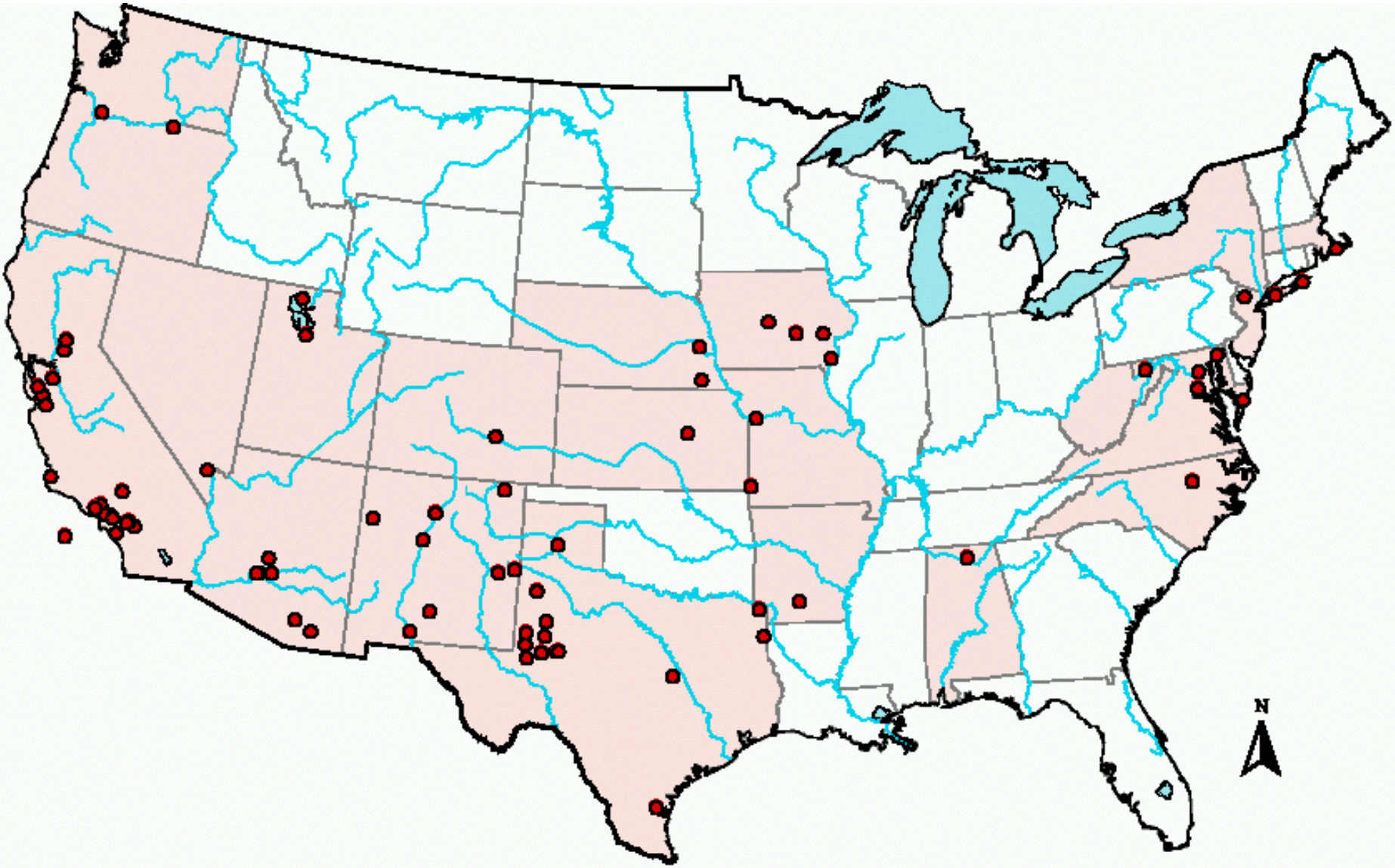
- Open-Burn/Open-Detonation
- Facilities for Rocket Motors
- Explosives Manufacturing and Disposal
- Fireworks Manufacturing

Photo courtesy James Hurley USAF

Perchlorate Releases

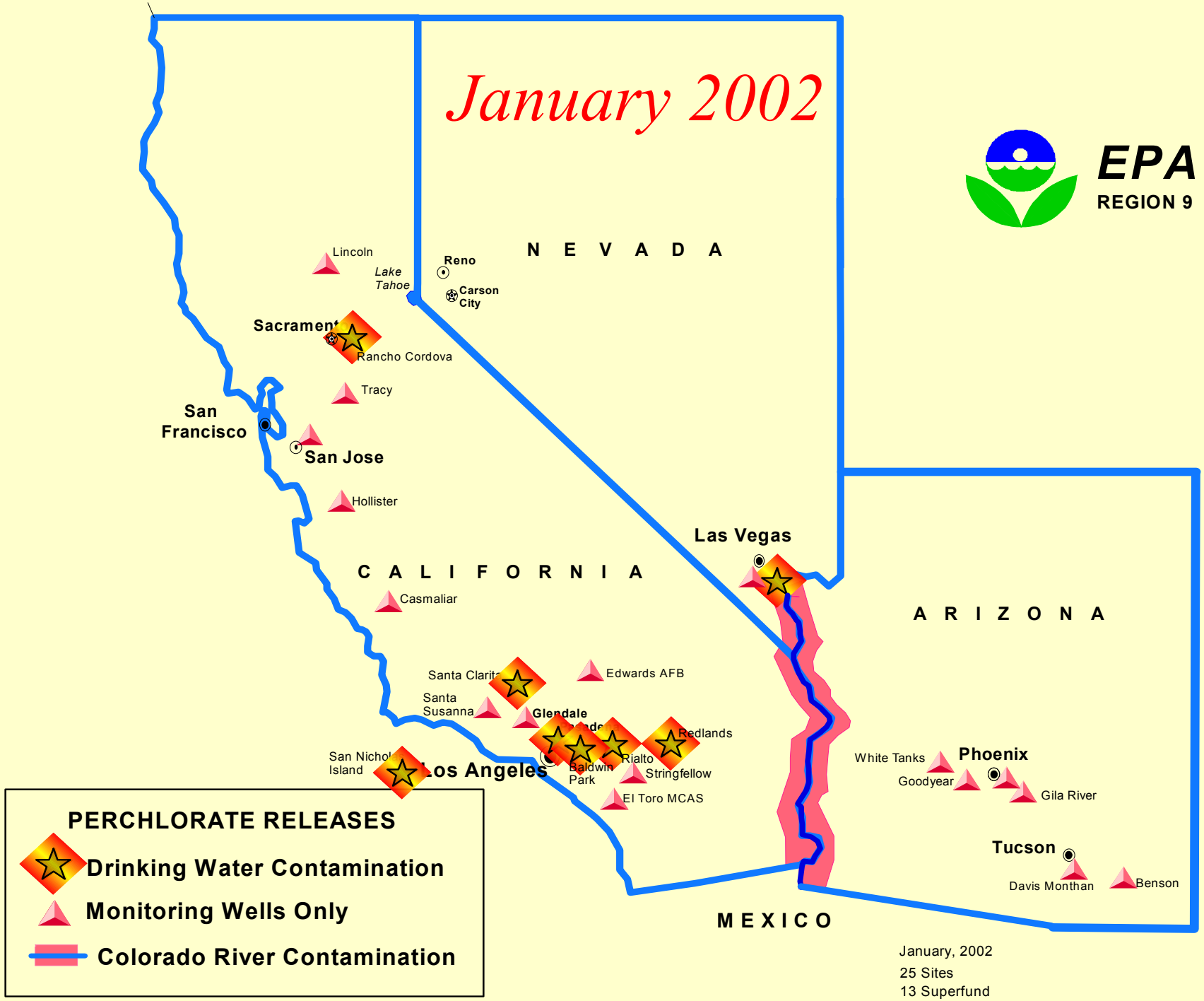
- High-pressure washout of solid propellant from rocket motors

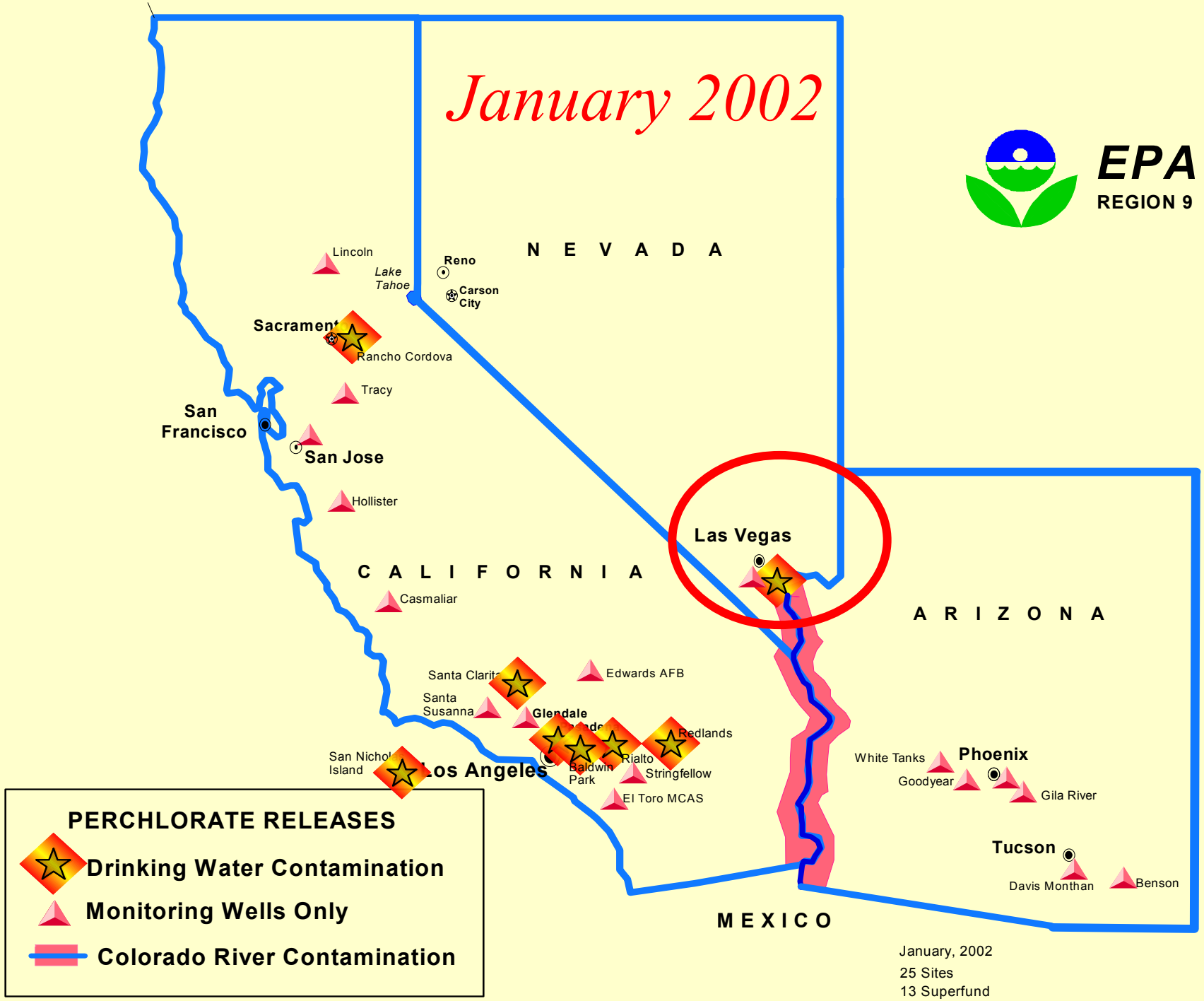
Photo courtesy James Hurley USAF



Reported Releases of Perchlorate into the Environment, as of December 2002

EPA
Region 9 GIS Center


January 2002
EPA
REGION 9
N E V A D A
Lincoln
Lake Tahoe
Reno
Carson City
Sacramento
Rancho Cordova
Tracy
San Francisco
San Jose
Hollister
C A L I F O R N I A
Casmaliar
Las Vegas
A R I Z O N A
Santa Clarita
Edwards AFB
Santa Susanna
Glendale
Redlands
San Nicholas Island
Los Angeles
Baldwin Park
Rialto
Stringfellow
El Toro MCAS
White Tanks
Phoenix
Goodyear
Gila River
Tucson
Davis Monthan
Benson
M E X I C O
PERCHLORATE RELEASES
Drinking Water Contamination
Monitoring Wells Only
Colorado River Contamination
January, 2002
25 Sites
13 Superfund


January 2002
EPA
REGION 9
N E V A D A
Lincoln
Lake Tahoe
Reno
Carson City
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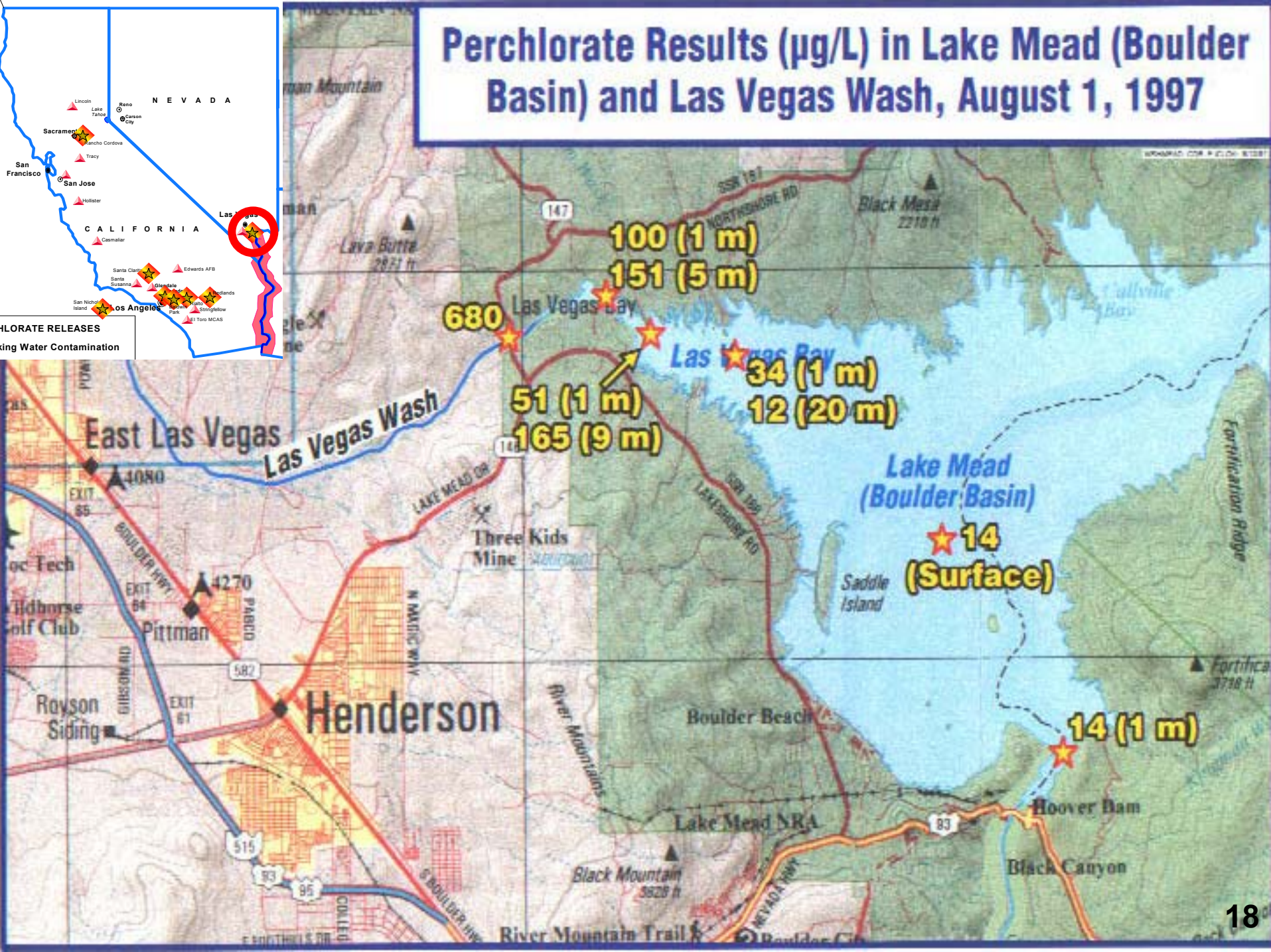
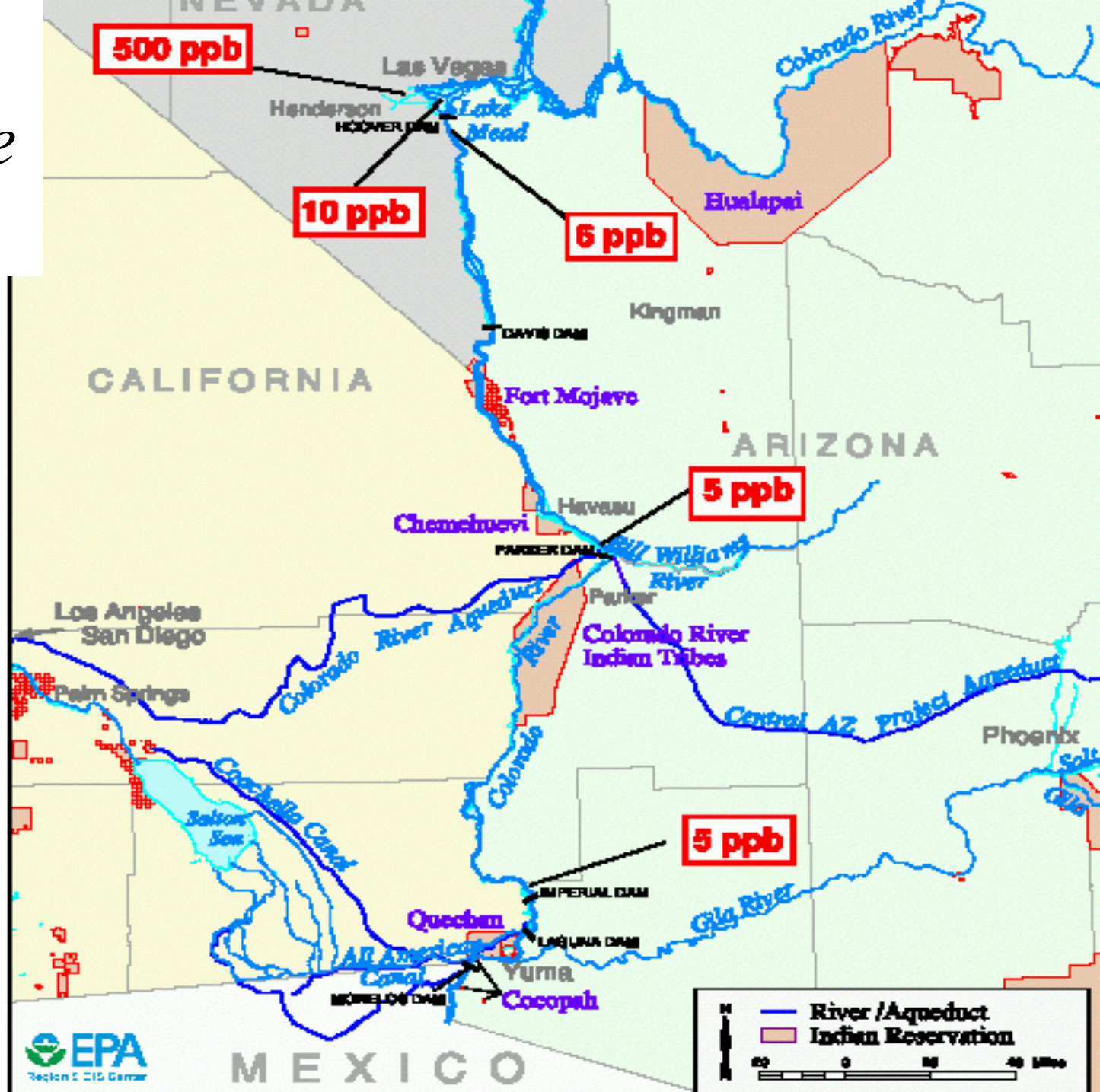
Drinking Water Contamination
Monitoring Wells Only
Colorado River Contamination
January, 2002
25 Sites
13 Superfund

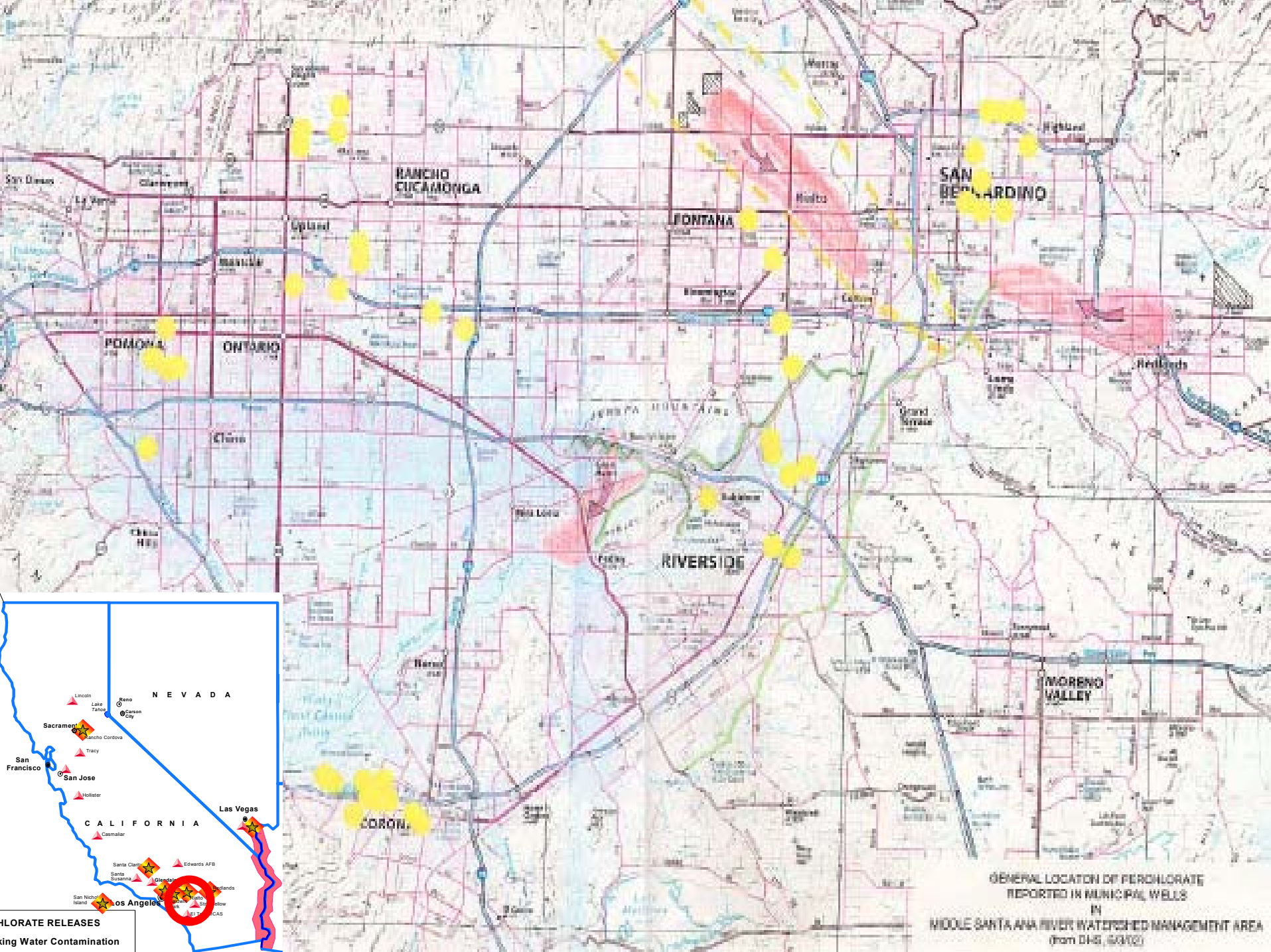
Perchlorate Results (µg/L) in Lake Mead (Boulder Basin) and Las Vegas Wash, August 1, 1997



u/L Perchlorate 2002



January
2002
EPA
REGION 9
N E V A D A
Lincoln
Lake Tahoe
Reno
Carson City
Sacramento
AEROJET
MATHER AFB
LLNL Site 300
San Francisco
United Technologies
San Jose
Hollister
C A L I F O R N I A
Casmalia
Las Vegas
BMI/ Kerr-McGee
A R I Z O N A
Santa Clarita
Edwards AFB
Santa Susanna
ROCKETDYNE
SAN FERNANDO
NASA-JPL
Redlands
Rialto
Baldwin Park OU
STRINGFELLOW
El Toro MCAS
Los Angeles
San Nicholas Island
White Tanks
Phoenix
Goodyear PGA
GILA RIVER BROWNFIELDS
Tucson
Davis Monthan
APACHE POWDER
M E X I C O
PERCHLORATE SITES
Response Lead
Superfund
Waste Management
State
January, 2002
25+ Sites
13 Superfund



GENERAL LOCATION OF PERCHLORATE
REPORTED IN MUNICIPAL WELLS
IN
MIDDLE SANTA ANA RIVER WATERSHED MANAGEMENT AREA
(from DHS, 6/3/02)

Formerly Used Defense Sites (FUDS) in the Middle Santa Ana River Watershed Management Area

September 2002

Legend

Formerly Used Defense Site (FUDS)

Non-Cold War (approx. 1/2mile)

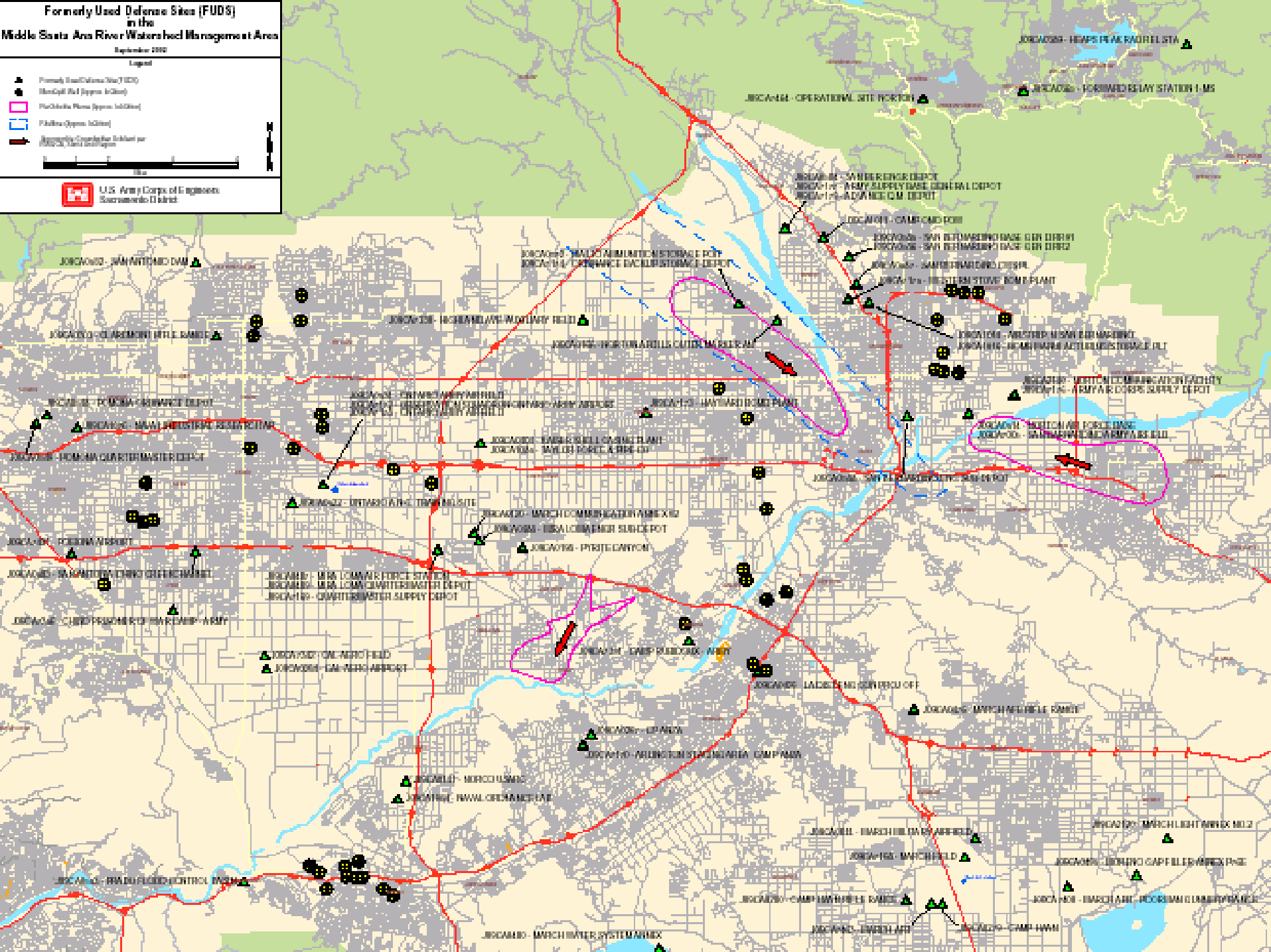
Non-Suitable Plume (approx. 1mile)

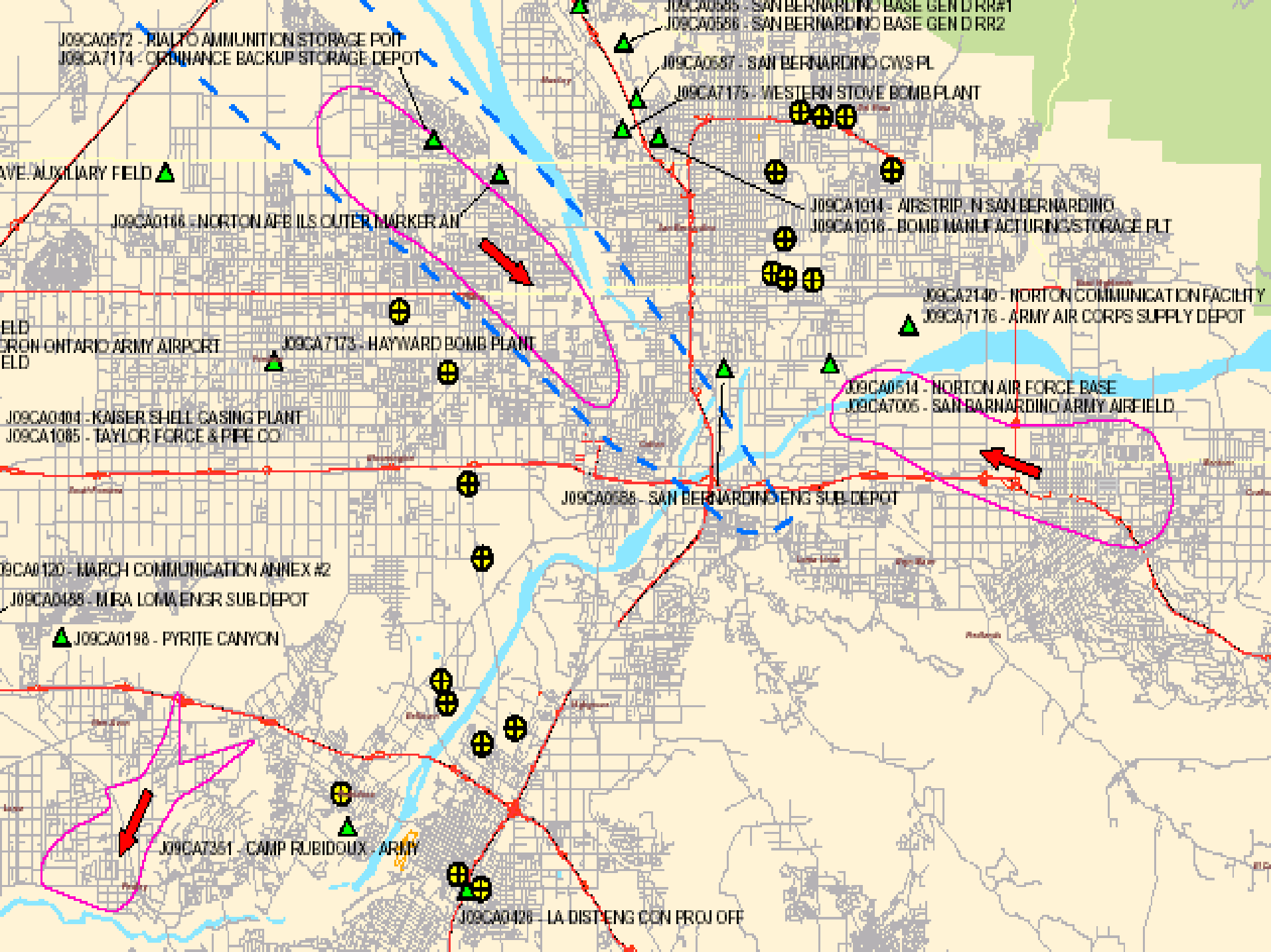
Plume (approx. 1/2mile)

Groundwater Contaminant Subset per Analytical Data Collection

Miles

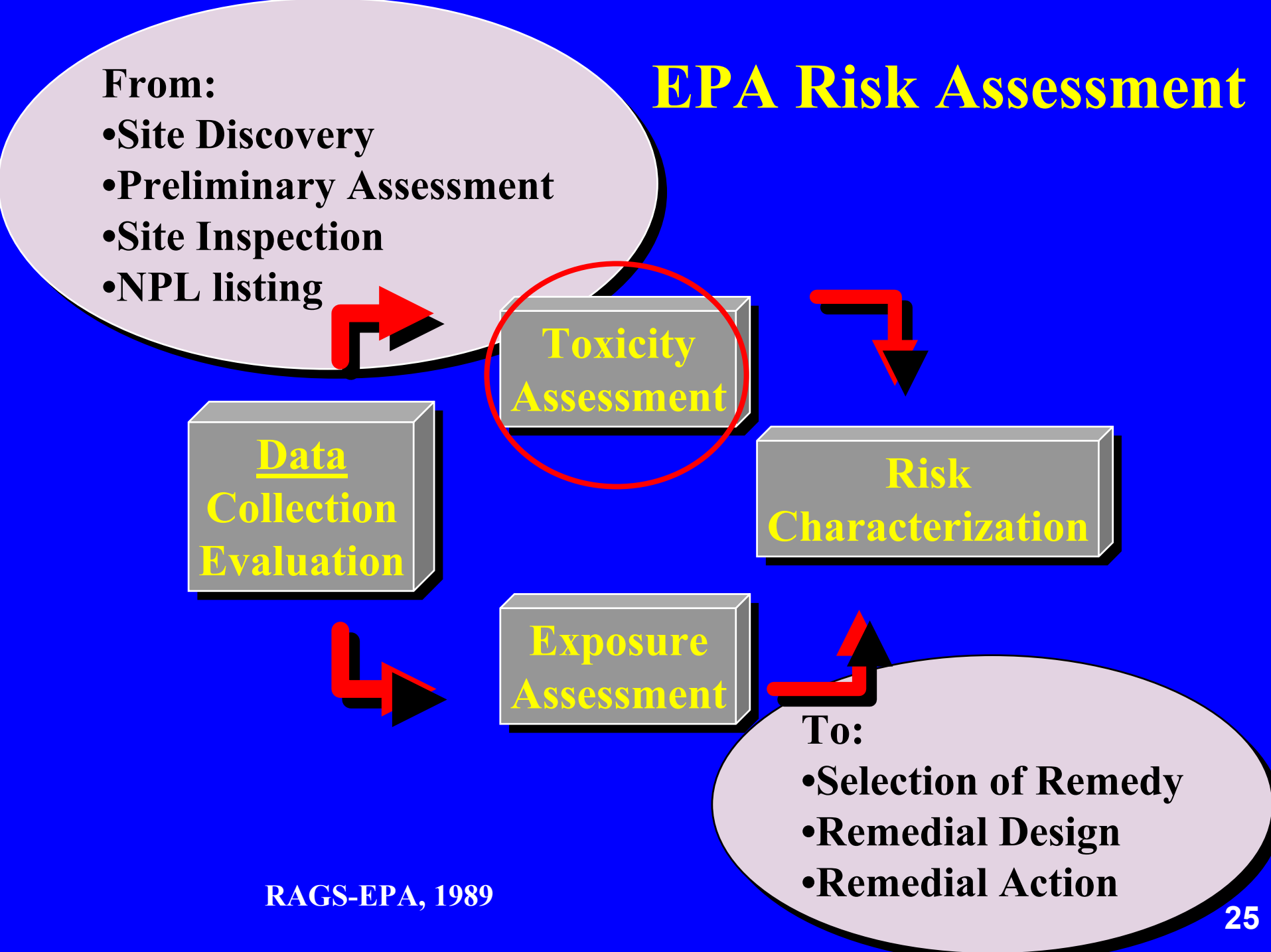
U.S. Army Corps of Engineers
Sacramento District




J09CA0585 - SAN BERNARDINO BASE GEN D RR#1
J09CA0586 - SAN BERNARDINO BASE GEN D RR2
J09CA0572 - RIALTO AMMUNITION STORAGE POIT
J09CA7174 - ORDNANCE BACKUP STORAGE DEPOT
J09CA0587 - SAN BERNARDINO CWS PL
J09CA7175 - WESTERN STOVE BOMB PLANT
AVE. AUXILIARY FIELD
J09CA1014 - AIRSTRIP, N SAN BERNARDINO
J09CA0166 - NORTON AFB ILS OUTER MARKER AN
J09CA1016 - BOMB MANUFACTURING/STORAGE PLT
J09CA2140 - NORTON COMMUNICATION FACILITY
J09CA7176 - ARMY AIR CORPS SUPPLY DEPOT
ELD
CRON ONTARIO ARMY AIRPORT
ELD
J09CA7173 - HAYWARD BOMB PLANT
J09CA0514 - NORTON AIR FORCE BASE
J09CA7005 - SAN BARNARDINO ARMY AIRFIELD
J09CA0404 - KAISER SHELL CASING PLANT
J09CA1085 - TAYLOR FORCE & PIPE CO
J09CA0588 - SAN BERNARDINO ENG SUB DEPOT
9CA0120 - MARCH COMMUNICATION ANNEX #2
J09CA0488 - MIRA LOMA ENGR SUB DEPOT
J09CA0198 - PYRITE CANYON
J09CA7351 - CAMP RUBIDOUX - ARMY
J09CA0428 - LA DIST ENG CON PROJ OFF

Toxicology & Risk

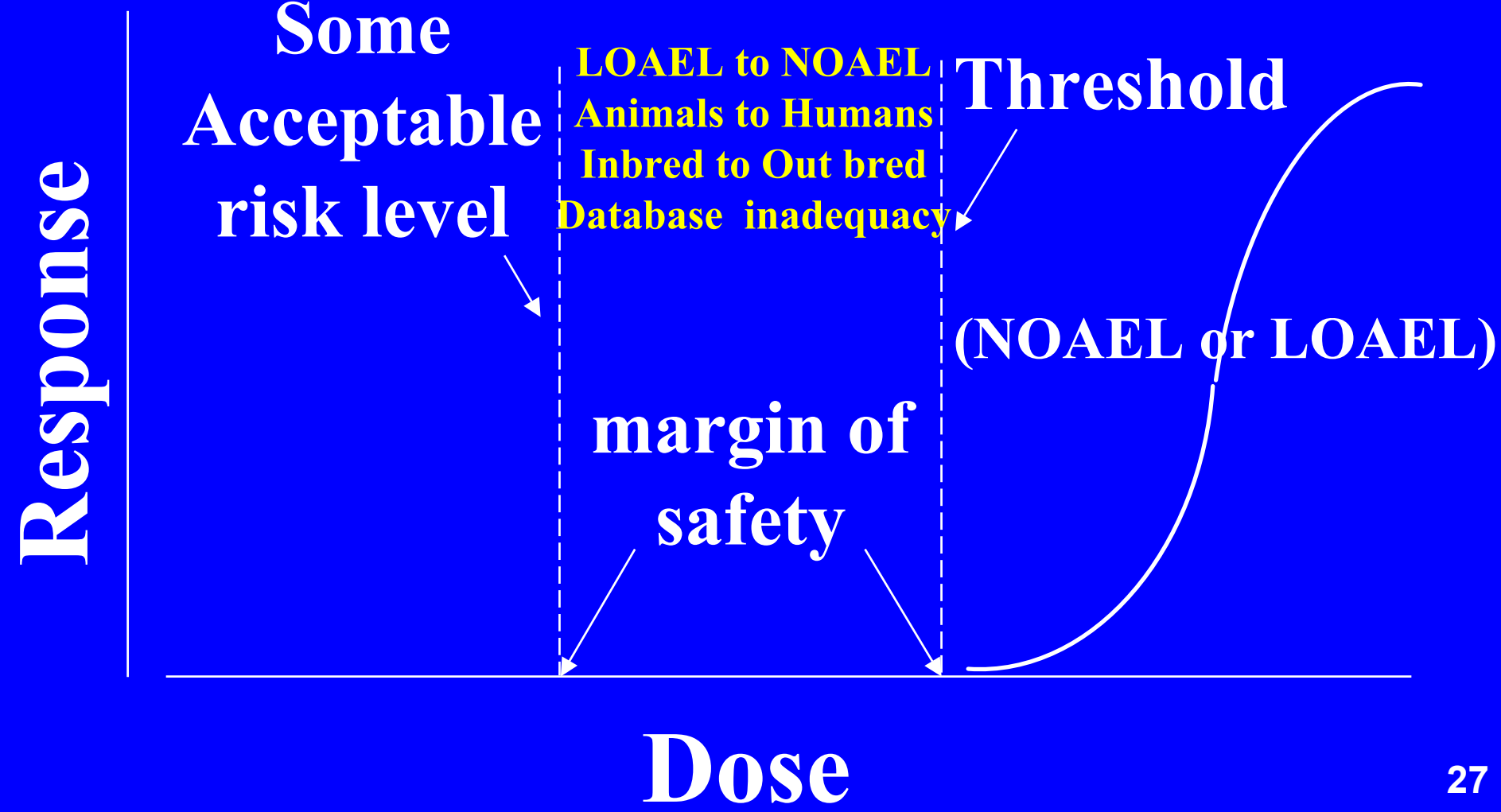
EPA Risk Assessment



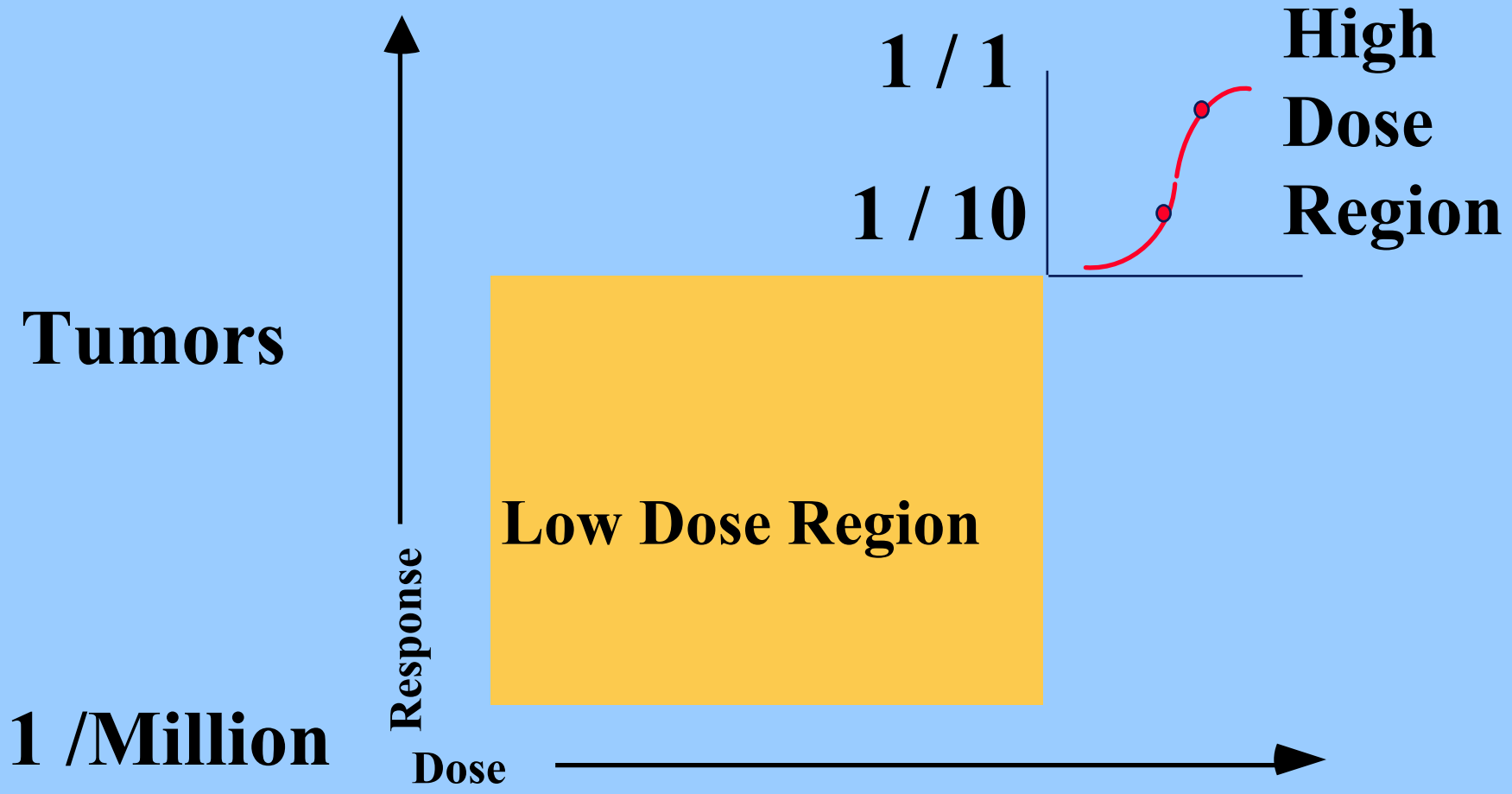
RAGS-EPA, 1989

The EPA has taken a Unique Approach to Toxicity Assessment For Perchlorate

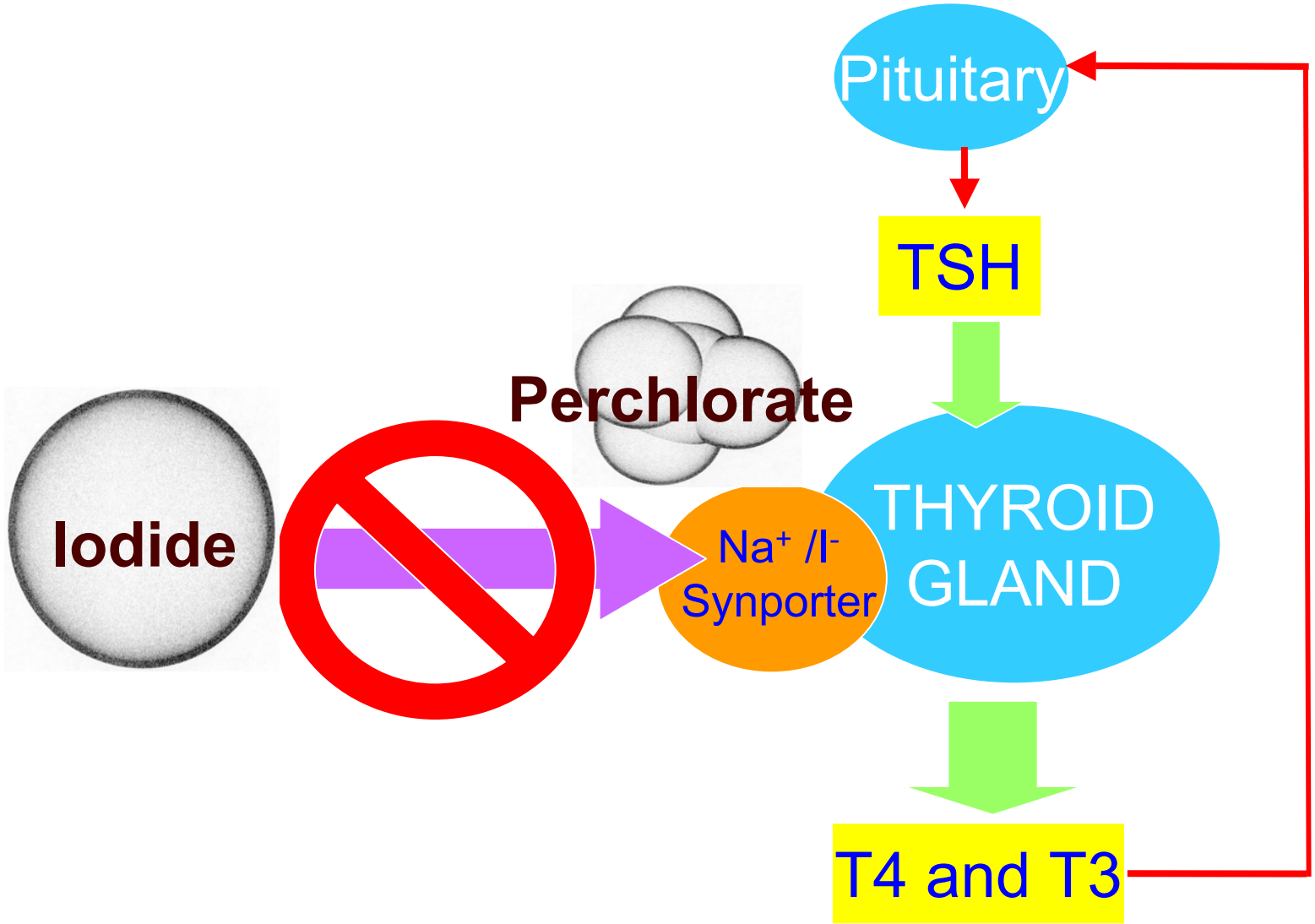
Historical Evaluation of Non-Carcinogens



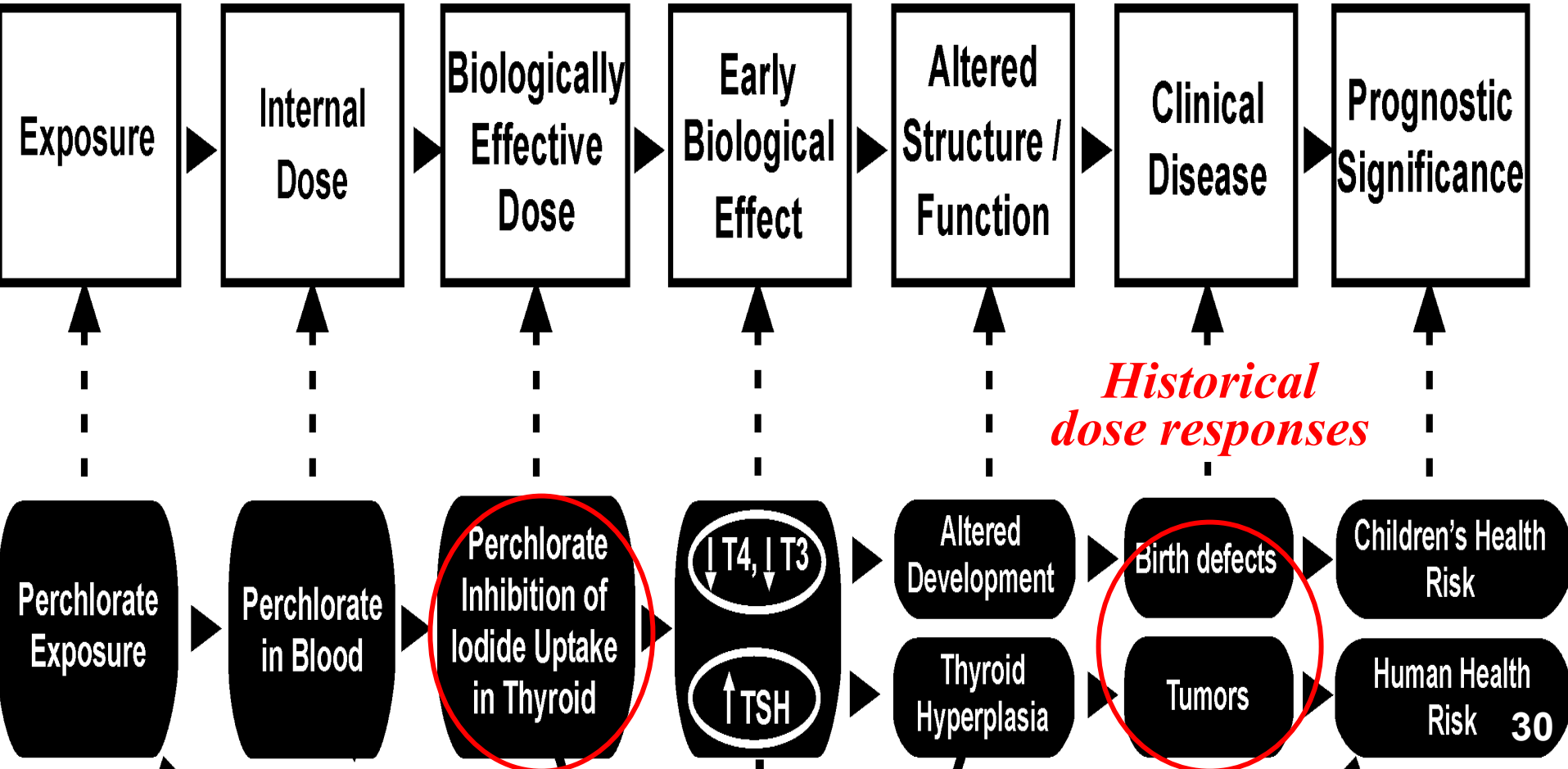
Historically Carcinogens have been treated as if there is No Safe Level



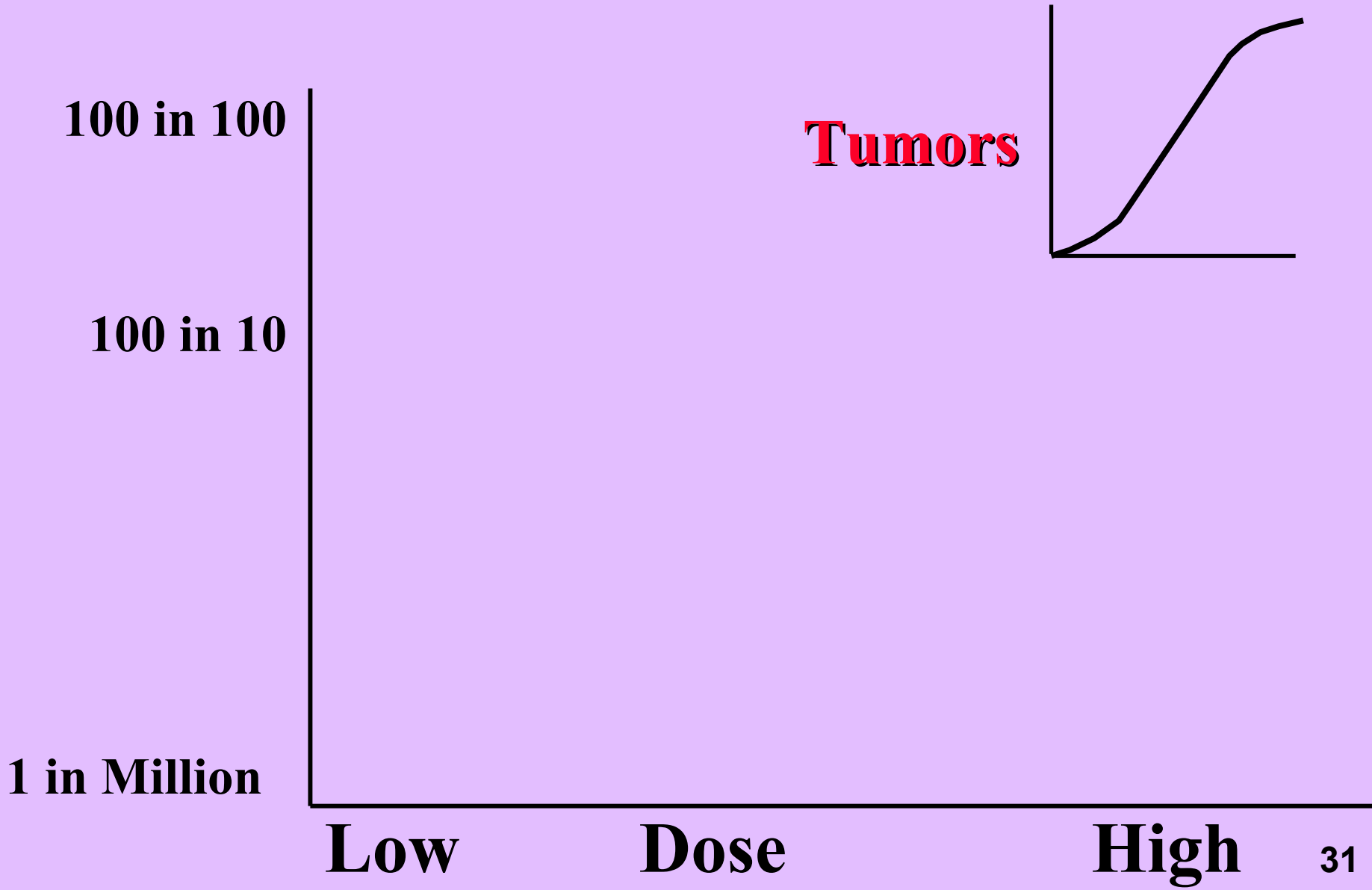
Molecular Mechanism of Perchlorate



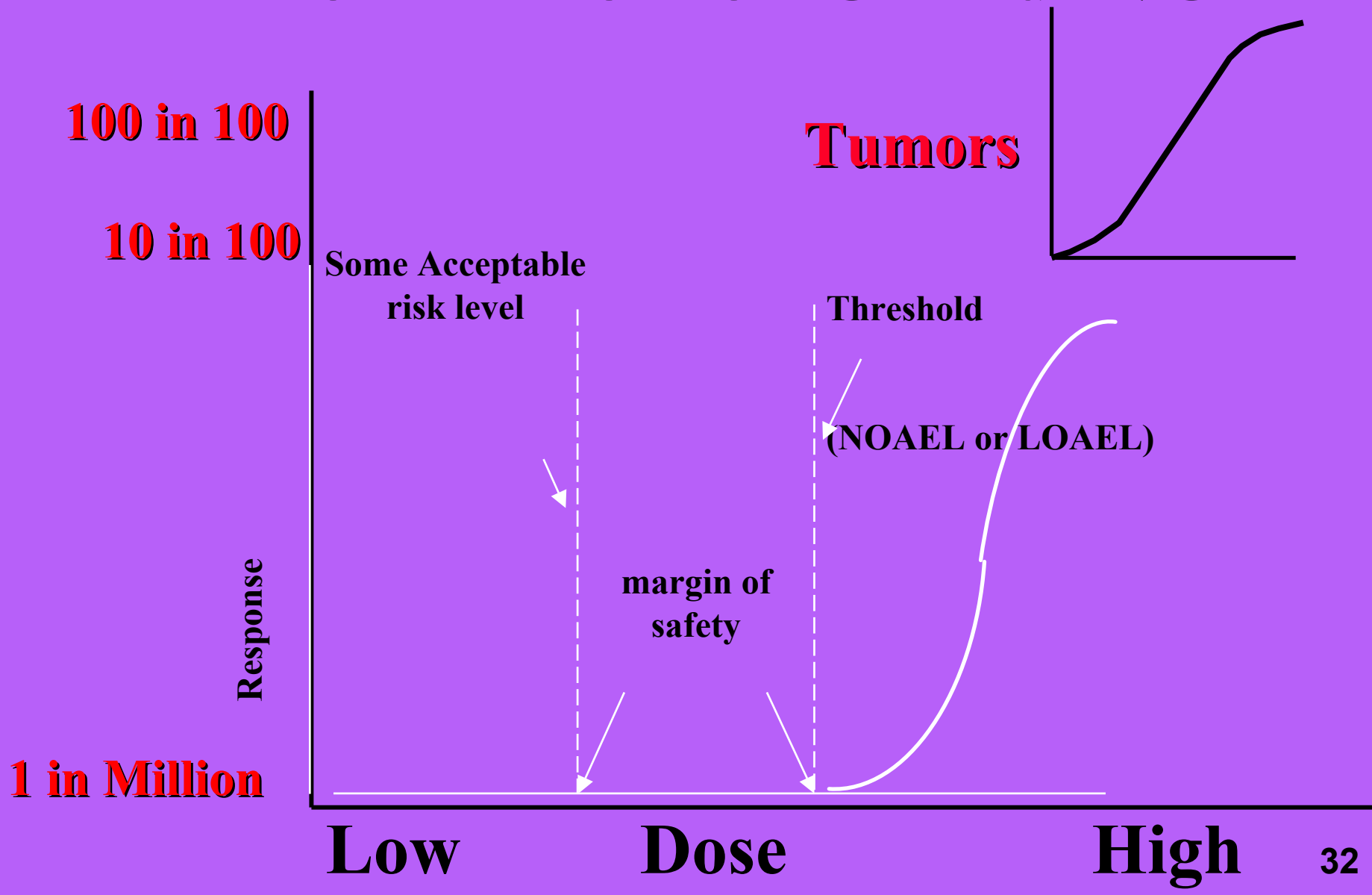
Unique Risk Assessment Approach: Molecular Mechanism of Action



Historical Approach



Emerging Approach: Harmonization of C and NC



Operational Derivation

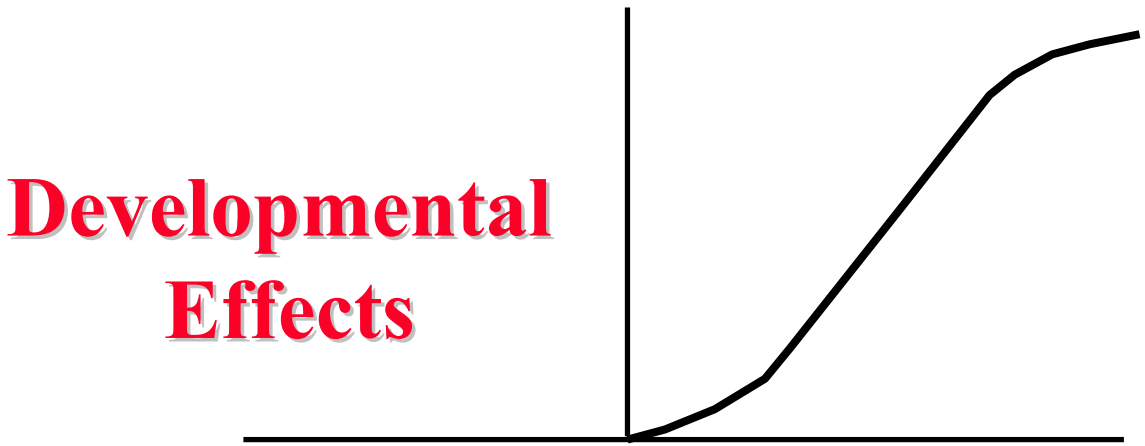
RfD (mg/kg-day) = 0.01 x 0.85 ÷ 300 = 0.00003

Operational Derivation

RfD (mg/kg-day) = 0.01 ÷ 300 x 0.85 = 0.00003

Where:

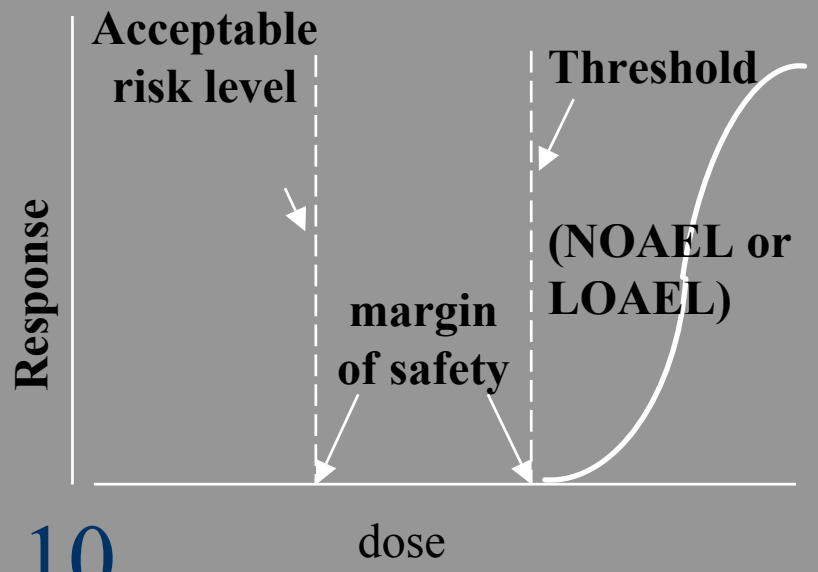
- 0.01 is the benchmark point of departure



- 0.85 adjusts to perchlorate anion alone
- 300 is the composite uncertainty factor

Uncertainty Factors

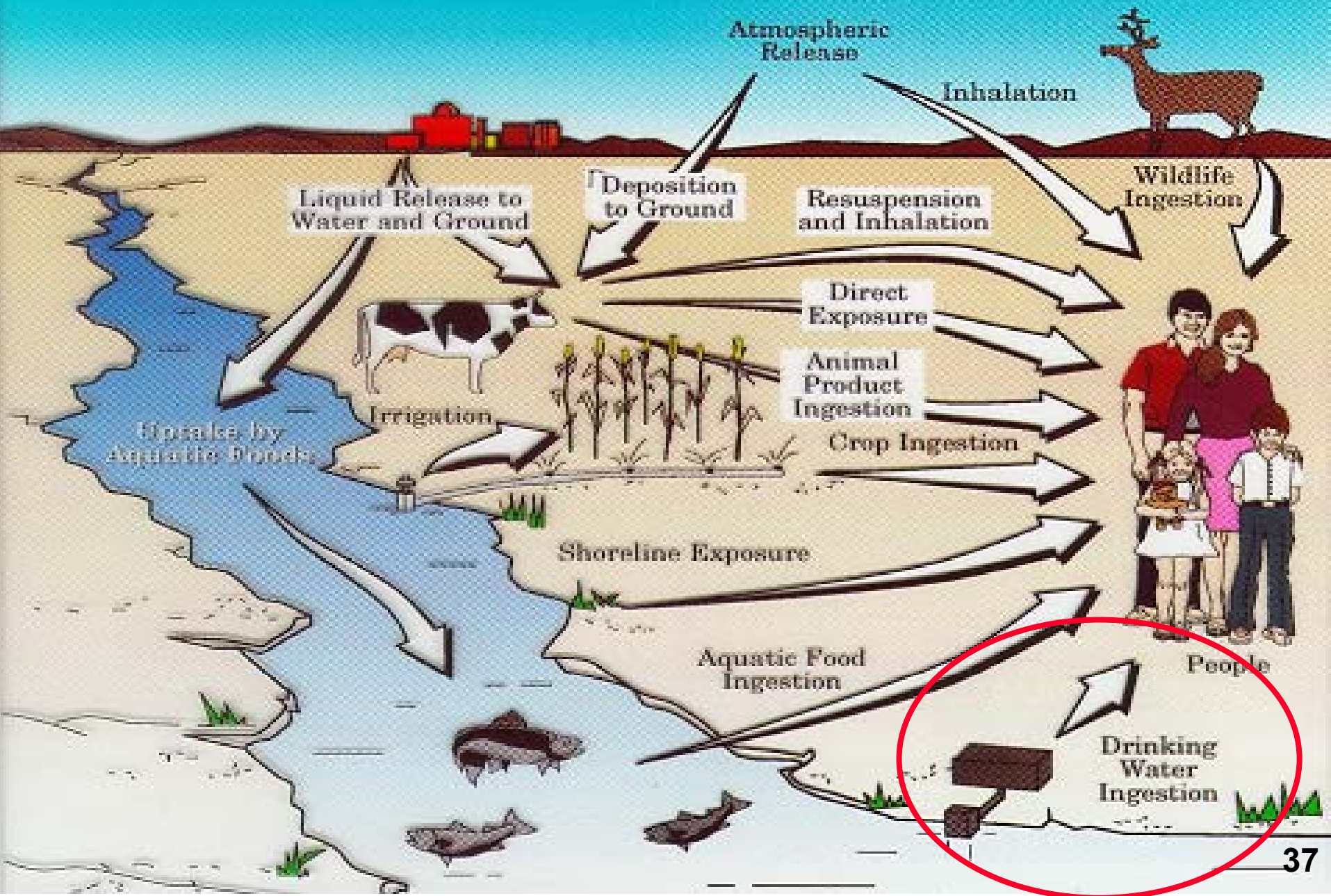
- Intrahuman: 3
- Interspecies: None
- LOAEL to NOAEL: 10
- Subchronic to chronic duration: 3
- Database Insufficiencies: 3



Distinguish the RfD from guidance value that may result

- Conversion to drinking water equivalent level
  - Adjustment by 70 kg and 2 L/day
    - DWEL = 1 ug/l (ppb)
- Derivation of maximum contaminant level goal (MCLG) typically involves the use of a relative source contribution factor
  - Range of 0.2 to 0.8
    - Result would be MCLG between 0.2 to 0.8 ug/l (ppb)

Relative Risk Contribution of 20% to 80%



Summary
EPA's Perchlorate Risk Assessment Approach is Unique

Na^+/I^- synporter inhibition & NOAEL response

Harmonization of non-cancer and cancer toxicity

Relative source contribution considered

Policy Issues

Department of Defense
AFRL
Perchlorate Study Group

PSG

ORD
OW
OSWER
Regions

Interagency
Perchlorate
Steering
Committee

DEPARTMENT OF THE AIR FORCE
WASHINGTON, DC

Office of the Assistant Secretary

SAF/IEE
1665 Air Force Pentagon
Washington, DC 20330-1665

19 FEB 2002

ERG, Inc.
110 Hartwell Avenue
Lexington, Massachusetts 02421

Dear Sir and Madam

The Department of Defense (DoD) preliminary comments to the Environmental Protection Agency (EPA) draft document, Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization. External Review Draft are attached. The Air Force, as the lead agent for DoD perchlorate assessment and policy, submits these comments in accordance with the Federal Register, January 2, 2002 (Volume 67, Number 1) Notice on Peer Review of EPA Draft Human Health and Ecological Risk Assessment of Perchlorate. DoD will be submitting additional comments during the thirty-day extension period.

DoD is concerned that the EPA overlooked relevant human studies especially the protocol that EPA helped develop. There are errors in the calculations for sensitivity analysis and human equivalent exposures in Sections 6 and 7. As a result of these points, along with the remainder of DoD's comments, it appears the potential human health risk is overestimated.

I have requested the DoD toxicologists meet with the EPA experts to gain a better understanding of the new EPA risk assessment methodology used in this report. If you have any questions, please call the DoD POC, Mr. David Carrillo, HQ USAF/ILEVR, Comm (703) 604-0561, e-mail: david.carrillo@pentagon.af.mil or Lt Col Barbara Larcom in my office at (703) 697-1019.

Sincerely

Maureen T. Koetz

MAUREEN T. KOETZ
Deputy Assistant Secretary
of the Air Force
(Environment, Safety, and
Occupational Health)

EPA Interim Human Study Policy

- Federal agencies adhere to "common rule" guidance that includes informed consent
- Agency has long-standing concern for "third-party" human data
  - Intentional dosing with toxicant
  - IRB information often unavailable
  - how to ensure adherence on *post hoc* basis
- Moratorium issued on December 14, 2001 re: use of this type of data **in the future** until the NAS determines criteria for acceptability

Recent History

- Spring 2002-Scientific Review of EPA's perchlorate Draft Risk Assessment- Sacramento
- 3/2002- CA-EPA Draft Health Assessment
- 8/2002- Proposition 65 Listing Requested
- 11/2002- DoD Assessment policy
- Spring 2003- AFCEE generated a list
- 1/2003- Col. Thompson testifies - Sacramento
- 1/2003- USEPA restates 1999 guidance
- 3/2003- Sen. Finstein introduces legislation
- Today- DoA Draft Guidance

States' Status

California - 4 ppb 2002 Action Level
-6 ppb Draft Public Health Goal

New York- 5 ppb and 18 ppb Planning & Action levels

Texas- 4 ppb Action Level & Residential Cleanup Level

Arizona- 14 ppb 1998 Health Based Guidance Level Based on Child Exposure.. to review after EPA final RfD

Massachusetts- 1 ppb Advisory for children and other at-risk subpopulations in 2002

New Mexico- 1 ppb Recent Drinking Water Screening

Nevada- 18 ppb Public Notice Standard

FEDERAL REGULATOR

The 1999 EPA interim guidance will stand until a new assessment is finalized.

Region IX PRGs

~~39~~ mg/ kg Residential soil (7.8)

~~1000~~ mg/kg Industrial soil (100)

~~18~~ ug/L Tap water (3.6)

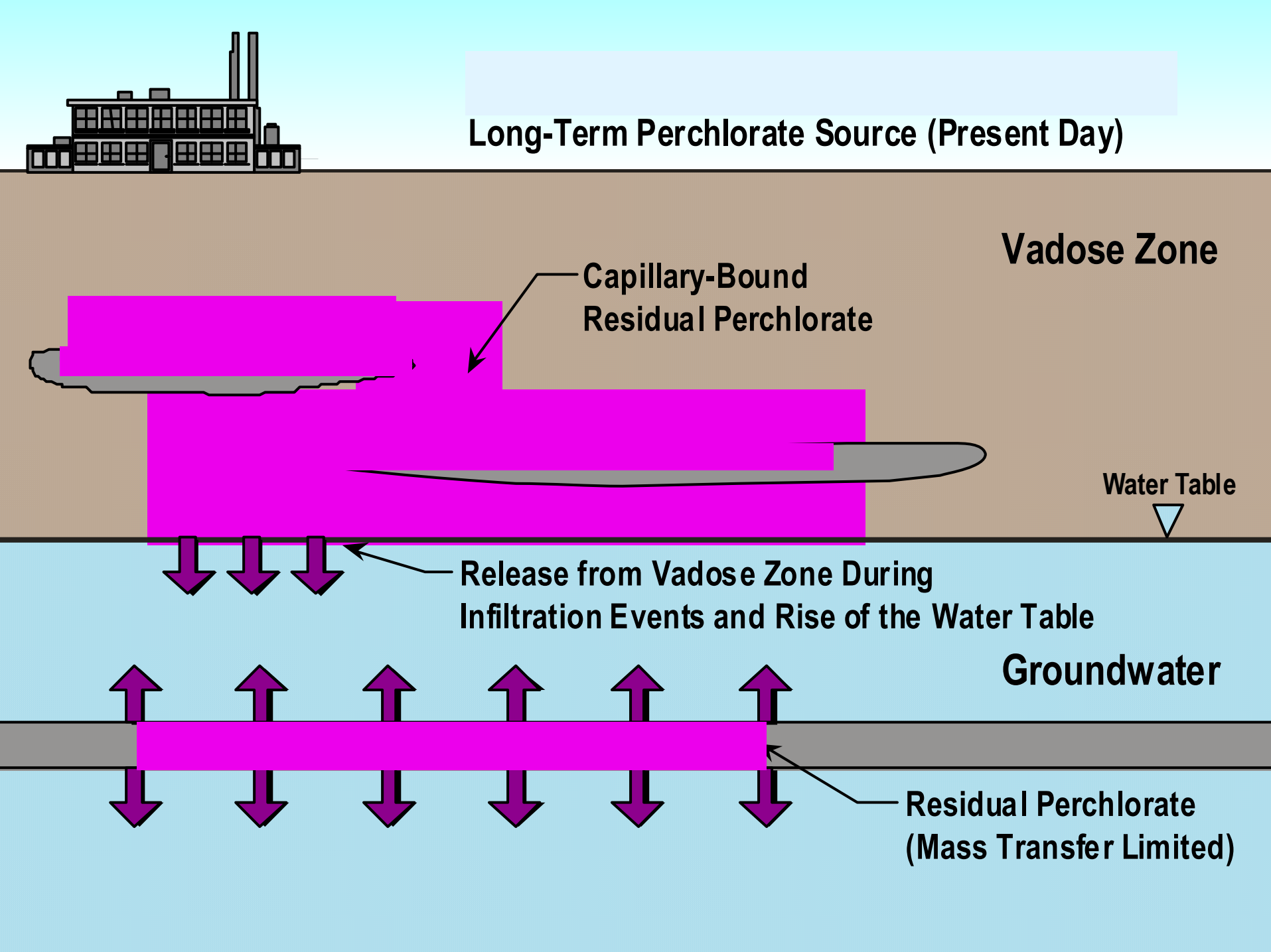
Chemistry

Chemical Properties

Detection Methodology

Perchlorate Properties

- **Highly Soluble**
- ***Concentrated solutions are more dense than water***
- **Non-volatile**
- **Kinetically stable**
- **Minimal sorption to most soils**


Long-Term Perchlorate Source (Present Day)
Vadose Zone
Capillary-Bound
Residual Perchlorate
Water Table
Release from Vadose Zone During
Infiltration Events and Rise of the Water Table
Groundwater
Residual Perchlorate
(Mass Transfer Limited)

Perchlorate Detection Methods

- EPA Method 314.0, November 1999
  - Widely adopted as std. Method
  - 4 ppb

Remedial Alternatives

Full-Scale Ion Exchange Operations

- La Puente Valley County Water District
- Kerr-McGee facility (Henderson, NV)

La Puente Valley County Water District System

San Gabriel Valley/ Baldwin Park Superfund

- Ion Exchange Resin: Regenerated onsite
- Capacity: 2,500 gpm, (1st phase of 26,000 gpm in treatment capacity)
- Treated Water Used: drinking water supply
- Operational: 2000 to present
- Vendor: Calgon Carbon Corp

La Puente Valley County Water District

- Perchlorate Influent: ~ 100 ug/L
- Perchlorate in Treated water: < 4 ug/L
- Capital Cost: ~$2 million
- Operating Cost: ~$145/acre-foot

Biological Treatment

- Microbes can chemically reduce undesirable chemical to less toxic or non-toxic chemicals

- Microbes of interest may require changes in physical/chemical environment to thrive

Full-Scale Biological Reactors Operating in California & Utah

- 3,600 gpm system operated by Aerojet-General Corporation (Northern CA)
- Continuously stirred tank reactors at Thiokol facility (Utah)

Aerojet-General Bioreactor System

Part of Aerojet Superfund Site

- **Bioreactor Type**: fixed film on GAC
- **Total Capacity**: 3,600 gpm
- **End Products**: primarily chloride & oxygen
- **Use of Treated Water**: aquifer recharge
- **Carbon Source/Electron Donor:** ethanol
- **Operational**: 1998 to present
- **Vendor**: Envirogen Inc.

Aerojet-General Bioreactor System

- Perchlorate Influent: approx. 2,500 ug/L
- Perchlorate in Treated water: < 4 ug/L
- Capital Cost: approx. $5.5 million
- Reported Operating Cost: approx. $65/acre-foot

http://clu-in.org/perchlorate/

CLU-IN

What's Hot? What's New?

Remediation

Characterization and Monitoring

Initiatives and Partnerships

Publications and Studio

Databases

TechDirect and Newsletters

About the Technology Innovation Office

EPA United States Environmental Protection Agency

Technology Innovation Office

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Jump to a CLU-IN Section

Perchlorate
Remediation Resources

- Policy and Guidance
- Studies and Reports
  - > Summaries
  - > Bioremediation
  - > Chemical Reduction
  - > Ion Exchange
  - > Multiple Technologies
  - > Permeable Reactive Barriers
  - > Phytoremediation
  - > Thermal Decomposition
- Presentations
- Web Sites

DoD's Interim guidance- take a handout

five areas related to sampling for perchlorate, including basis for sampling, funding for sampling and follow-on actions, analysis method, conducting sampling, follow-on actions and regulatory agency access for sampling.

"While Ammonium Perchlorate is on track for future regulatory action at both the national and state levels, it is important to note that a RfD or enforceable regulatory standards have not been established, and questions about Ammonium Perchlorate health effects remain…To maintain a proactive DoD stance in absence of a Federal or state promulgated regulatory driver, and to assist installations in responding to regulatory requests to sample soil, ground water and surface waters, Components should follow the following guidelines . ."