Drinking Water Supplies: Identifying, Assessing, and Mitigating Vulnerabilities

Steven C. Richards, PhD, PE
Colonel, US Army (Ret)
Environmental Engineer
US Army Center for Health Promotion
and Preventive Medicine
Aberdeen Proving Ground, MD

Presented at the

Professional Conference on Industrial Hygiene
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TERRORISM

- The calculated use of violence or threat of violence
  - To inculcate fear;
  - intended to coerce or to intimidate governments or societies,
- in the pursuit of goals that are generally political, religious, or ideological.

-DODI 2000.16, June 14, 2001

Vulnerability Assessment

The process the commander uses to determine the susceptibility to attack from the full range of threats to the security of personnel, family members, and facilities, which provide a basis for determining antiterrorism measures that can protect personnel and assets from terrorist attacks.

-DODI 2000.16, June 14, 2001

Newsweek
6:14 p.m. ET July 23, 2004

"The reduction in fragmentation and lack of information sharing [among the agencies] is still not adequate," Kean told a group of reporters. "All these agencies have got to change ... Time is not our side. We believe unless we implement these recommendations we are going to make ourselves more vulnerable to a terrorist attack."

- 9/11 Commission members, led by chairman Thomas Kean and vice chair Lee Hamilton

Agenda

- Introduction

I. Examples of water supply terrorism

II. Drinking water system vulnerabilities

III. US Federal and DoD requirements

IV. WSVA Overview

V. Application/Importance of risk assessment procedures

VI. Early warning systems

Water Supply Threat Composition

Terrorist
Vandal
Prankster
Employee

WHO?

WHAT?

Biological
Chemical
Physical
Cyber

RESULTS?

GOALS?

Ingestion/Sickness
Refusal to Drink
Deny Access

Disruption of way of life
Fear
Use of resources
Illness
Death

Canada and the U.S. Have United Against Fighting Terrorism

"...we are a country awakened to danger and called to defend freedom. Our grief has turned to anger, our anger to resolution, and whether we bring our enemies to justice, or justice to our enemies, justice will be done."

- President George Bush

"Given the responsibility to address new threats, such as non-state terrorism...the Government will develop... Canada's first national security policy...[and]...will engage with the United States to further strengthen North American security."

- Prime Minister Paul Martin

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Job losses lose to security
Terrorism dubbed top economic threat

WASHINGTON - Terrorism has replaced weak employment growth and the ballooning budget deficit as the biggest immediate threat to the economy, the National Association for Business Economics said.

- MARTIN CRUTSINGER THE ASSOCIATED PRESS

DRINKING WATER SUPPLY: Terrorists had eyes on water
Security bulletin reveals treatment facility plot details

By J.M. KALIL and DAVE BERNS
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Recent government intelligence suggests terrorists have discussed recruiting employees of water treatment facilities to poison drinking supplies in hopes of causing mass casualties, according to a federal bulletin obtained by the Review-Journal.

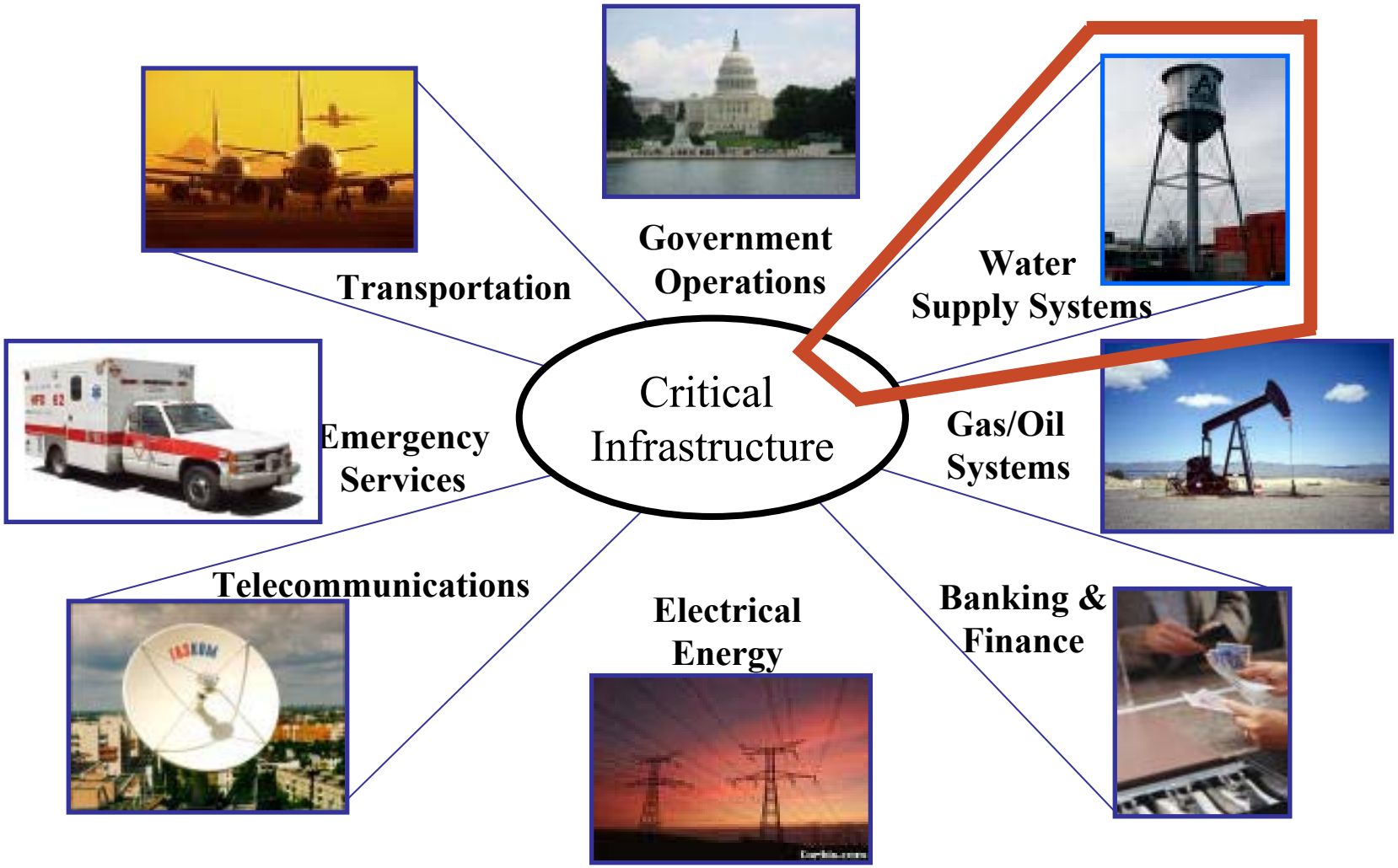
AUSTRALIA

- A co who worked on the control system was not off the utility
- He sa trol system to cause of sewage reek water turned unbearable for resi lice pulled him the computer a nt
- It was later discovered he accessed t es in a one month period.

"Marine life black, and the s

He had accessed the system 46 times in a one month period.

President's Commission on Critical Infrastructure Protection



II
EXAMPLES OF WATER TERORISM

There Have Been Many Reported Water System Threats & Attacks

Date	Headline Title	Affected Area(s)
Feb 99	"Angolan agents/rebels blamed for 16 bomb attacks in Zambia"	Angola
Feb 02	"4 Terror Suspects Arrested in Italy"	Italy
Apr 02	"Water-poisoning plot uncovered, Iraqis arrested"	Jordan
Jan 03	"British army defuses firebomb at North Irish waterworks"	Ireland
Jan 03	"Security breech shuts down water plant"	Florida USA
Feb 03	"Man sentenced for polluting wells"	Ohio USA
Mar 03	"Philippine rebels bomb water reservoir"	Philippines
Mar 03	[illegible]	Tennessee USA
M[illegible]	[illegible]	New Zealand
Apr 03	[illegible]	Pennsylvania USA
May 03	"Officials call water safe from anthrax"	Maryland USA
Sept 03	"Las Cruces dumps 2 million gallons after break-in"	Texas USA
Nov 03	"Discolored water OK to drink, Carpentersville officials say"	Illinois USA
Nov 03	"Lax security at Montreal water plant revealed"	Canada
Nov 03	"Chemical facilities still vulnerable"	CA, PA, MD, NJ, TX

"Water terrorism threatened in New Zealand"

Headline News, 12 Feb 02…

force. "Italian authorities have

Italy disrupts plot against U.S. Embassy

4 arrested after a raid found cyanide, water-supply maps

By Eric J. Lyman
Special for USA TODAY

ROME — Italian police arrested four Moroccan men Wednesday who are suspected of planning to poison the water supply that feeds the U.S. Embassy in Rome.

The arrests increased concern that Italy may be a base for terror-related activities.

State Department spokesman Richard Boucher, echoing a statement released by the Embassy, praised Italy's police force. "Italian authorities have repeatedly thwarted planned terrorist attacks against American and other targets inside Italy," he said. "The latest incident shows the continuing danger posed by terrorists and the need to remain at a high level of vigilance."

Embassy security, already heightened since a threat 13 months ago and the attacks Sept. 11 in the United States, was increased further after the arrests Wednesday.

Italian law enforcement officials differed on whether the suspects had 9 pounds of pure cyanide, which can be lethal, or potassium ferrocyanide, a relatively benign compound that contains traces of cyanide. The men, ages 30 to 40, also had about 100 counterfeit residency permits and detailed maps of Rome that highlighted the water-supply network near the U.S. Embassy, officials said.

> "Italian officials are certainly acting as if these (recent arrests) are not isolated."
> — Giuseppe Melandri, a former officer in the Italian army

A member of the special *carabiniere* paramilitary police unit that raided the Moroccans' apartment on the outskirts of Rome told USA TODAY it was clear the men were working on a criminal plan. Pending further investigations, the men had been charged with possession of an illegal compound and false documents, he said.

The arrests came a week after three other Moroccans were apprehended on terror-related charges. Seven Tunisians arrested last year for alleged activities linked to the funding of Osama bin Laden's al-Qaeda terrorist network went on trial this week in Milan. There were reports that at least one of the Moroccans arrested Wednesday was linked to the Tunisians.

Chief Prosecutor Salvatore Vecchione reportedly was outraged that news of the raid had leaked, saying it may damage an ongoing investigation.

Earlier Wednesday, Interior Ministry Undersecretary Alfredo Mantovano used state-controlled media to urge residents to report activities that could indicate terror-related plans.

"Italian officials are certainly acting as if these (recent arrests) are not isolated," said Giuseppe Melandri, a security consultant and former Italian army officer. "But even if they gear up for a long-term battle, these sorts of activities are very hard to detect."

If the powdered compound found at the suspects' apartment proves to be high-grade cyanide, the quantity would have been enough to infect the water supply in a 2-square-mile area, say chemical weapons experts. An analysis of the compound should yield results today or Friday.

"Water plant sabotage the work of radical group"

MARTINY TOWNSHIP, MI — 24 Sep 03 – Four incendiary devices were found inside a water-bottling plant's pumping station, and a radical environmental group said it was responsible, The Associated Press (AP) reported in an article published by *The Kansas City Star*.

The Earth Liberation Front (ELF) claimed responsibility for the devices, accusing Ice Mountain Spring Water Co. of stealing well water for profit, the article said. ELF has claimed responsibility for many arson fires at housing construction sites in the West and Midwest.

Water Tech ONLINE www.watertechonline.com

Army water systems have been targeted

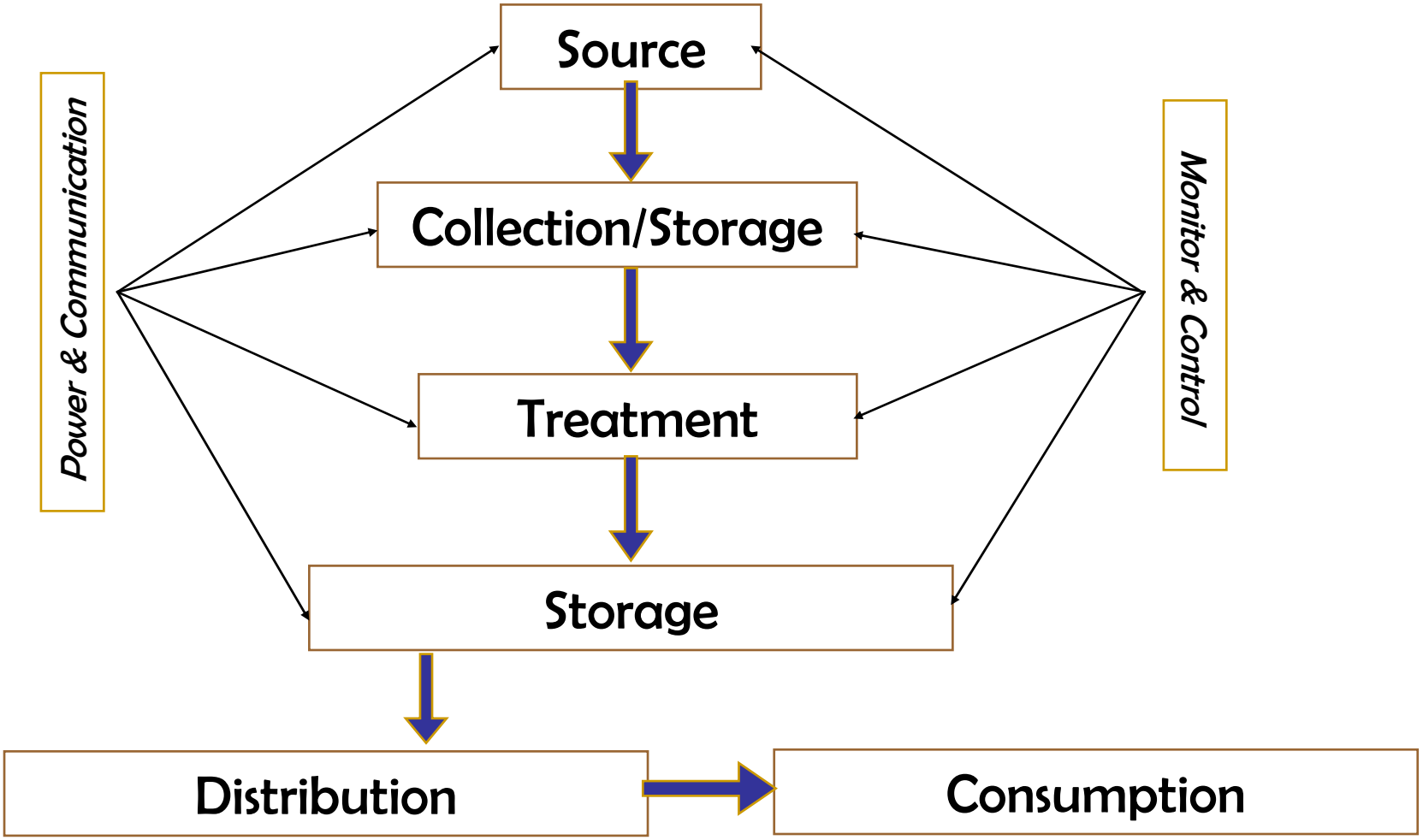
Jan 2004

Open tank discovered

Latex glove
found floating
on water surface

III
Drinking Water System Vulnerabilities

Basic Water Supply Principles



Water Sources

Sources

Surface: Lakes, rivers, streams, springs, catchments, shallow wells

Ground: Deep wells

Equipment

Intakes (floating or submerged), transmission lines, pumps, valves

Dependency

Dams, power supply

Inside a Water Treatment Facility

Source Water

Rapid Mixer

Flocculation Basins and Mixers

Sedimentation Basins

Filtration

Clearwells

Waste

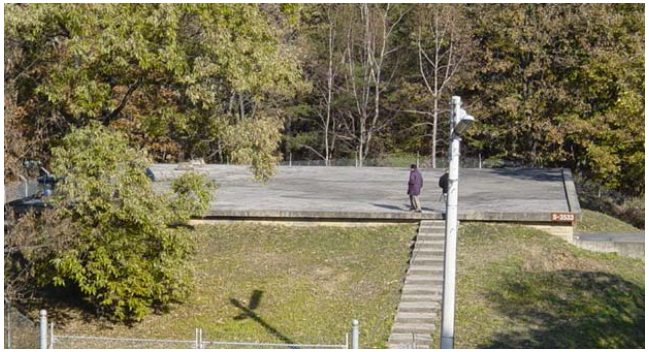
Storage & Distribution

Disinfection

Storage and Distribution

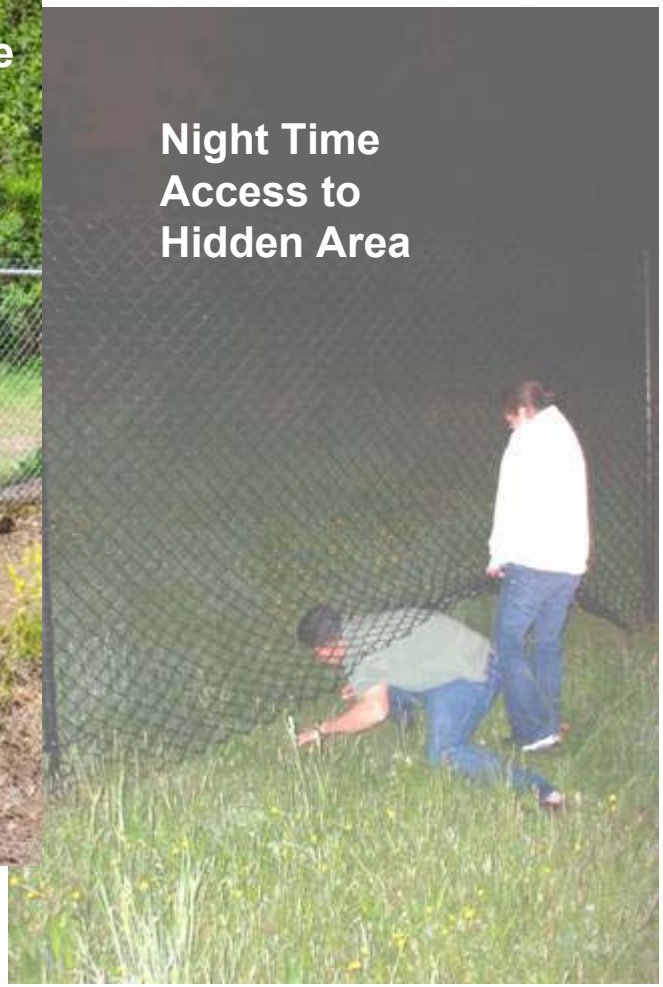
Fixed components

- Storage
  - Elevated tanks
  - Ground level tanks
  - Underground tanks
  - Uncovered tanks
- Distribution
  - Pumps, power, hydrants, valves, pipes, taps



Poor Fence
Installation

Washed out Area of Fence


Night Time
Access to
Hidden Area

Unsecure Chlorine Cylinders

Unsecure Hatches

Lack of Tank
Climb Guards
Major
Component
of WTP
No Illumination

Chelmsford (A 414)
Chipping Ongar A 128
Brentwood
Kelvedon Hatch A 128
Industrial Estates
Secret Nuclear Bunker

IV
Federal and US DoD Requirements

2002: PL 107-188

Public Health Security and Bioterrorism Preparedness and Response Act of 2002

Section 401 establishes WVA and Emergency Response Plan (ERP) requirements

- WSVA & ERP Deadlines -

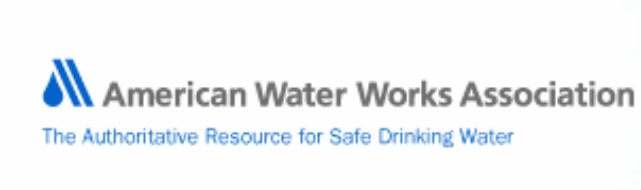
Systems serving population of:	Submit VA and VA Certification prior to:	ERP Certification within 6 months of VA but no later than:
>/= 100,000 persons	March 31,2003	September 30,2003
50,000 to 99,999 persons	December 31,2003	June 30,2004
3,300 to 49,999 persons	June 30,2004	December 31,2004

The U.S. DoD Also Requires Very Small Water Systems to Conduct Water VAs

- **All systems serving > 25 people required to conduct a water system VA** to include
  - CONUS & OCONUS
  - Purchasing and consecutive systems
  - Unregulated systems
  - Small CWS and Non-CWS

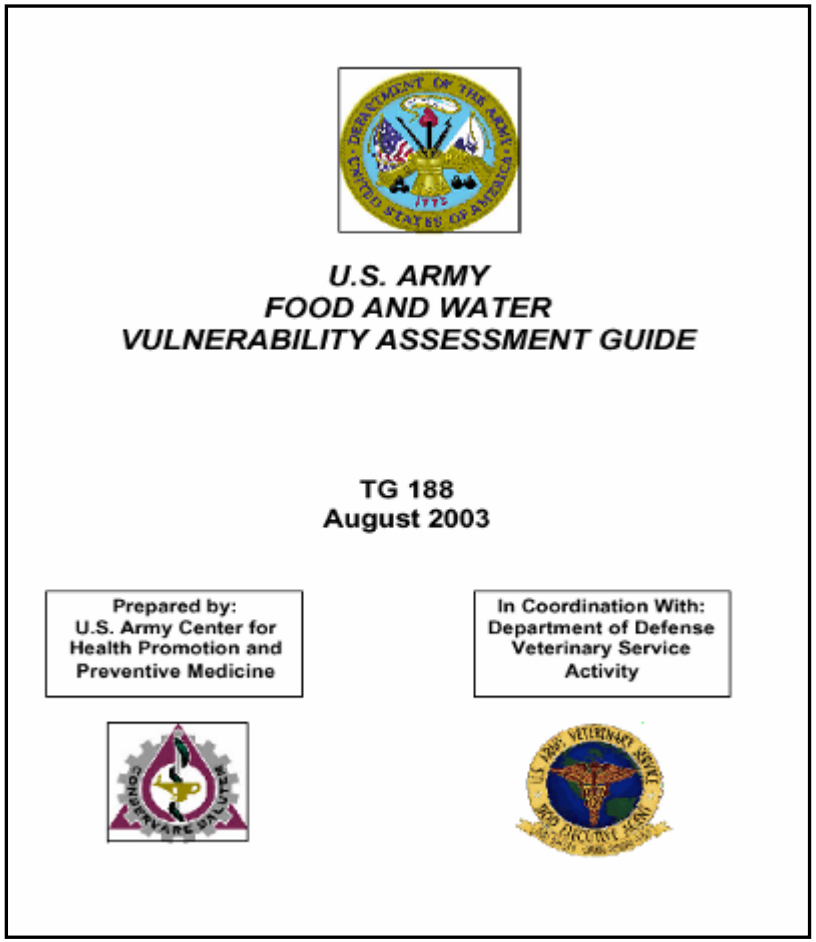
V
Water System Vulnerability Assessment Overview

WSVA Information and Assistanace



USACHPPM Guidance

- USACHPPM Support
  - Developed US Army Food and Water Vulnerability Assessment Guide (TG 188)
  - "How-to" guide written for the project officer
  - Uses Army Risk Management Process



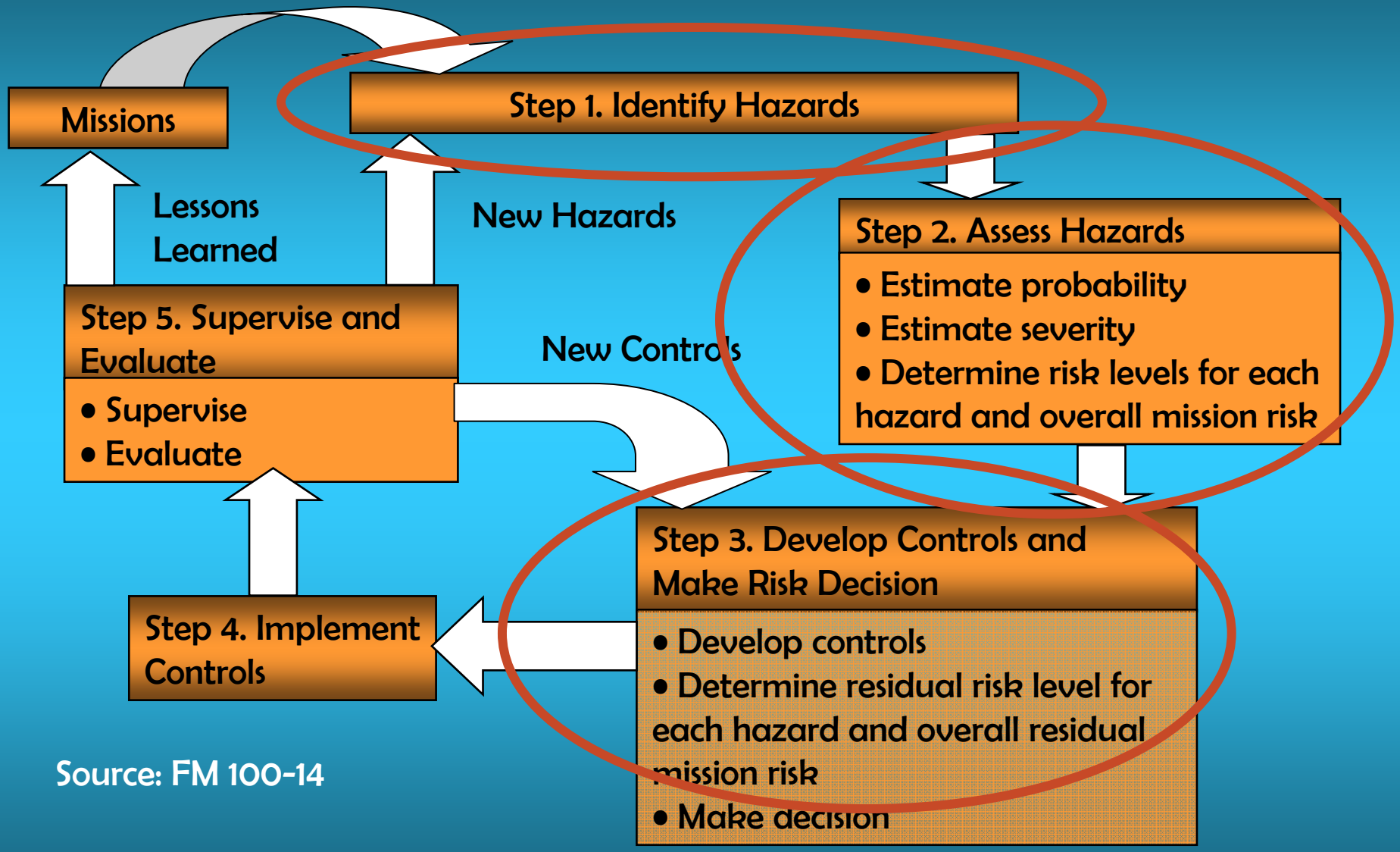
U.S. ARMY
FOOD AND WATER
VULNERABILITY ASSESSMENT GUIDE

TG 188
August 2003

Prepared by:
U.S. Army Center for Health Promotion and Preventive Medicine

In Coordination With:
Department of Defense Veterinary Service Activity

Army Operational Risk Management/WSVA



Source: FM 100-14

Necessary Components of a Water VA

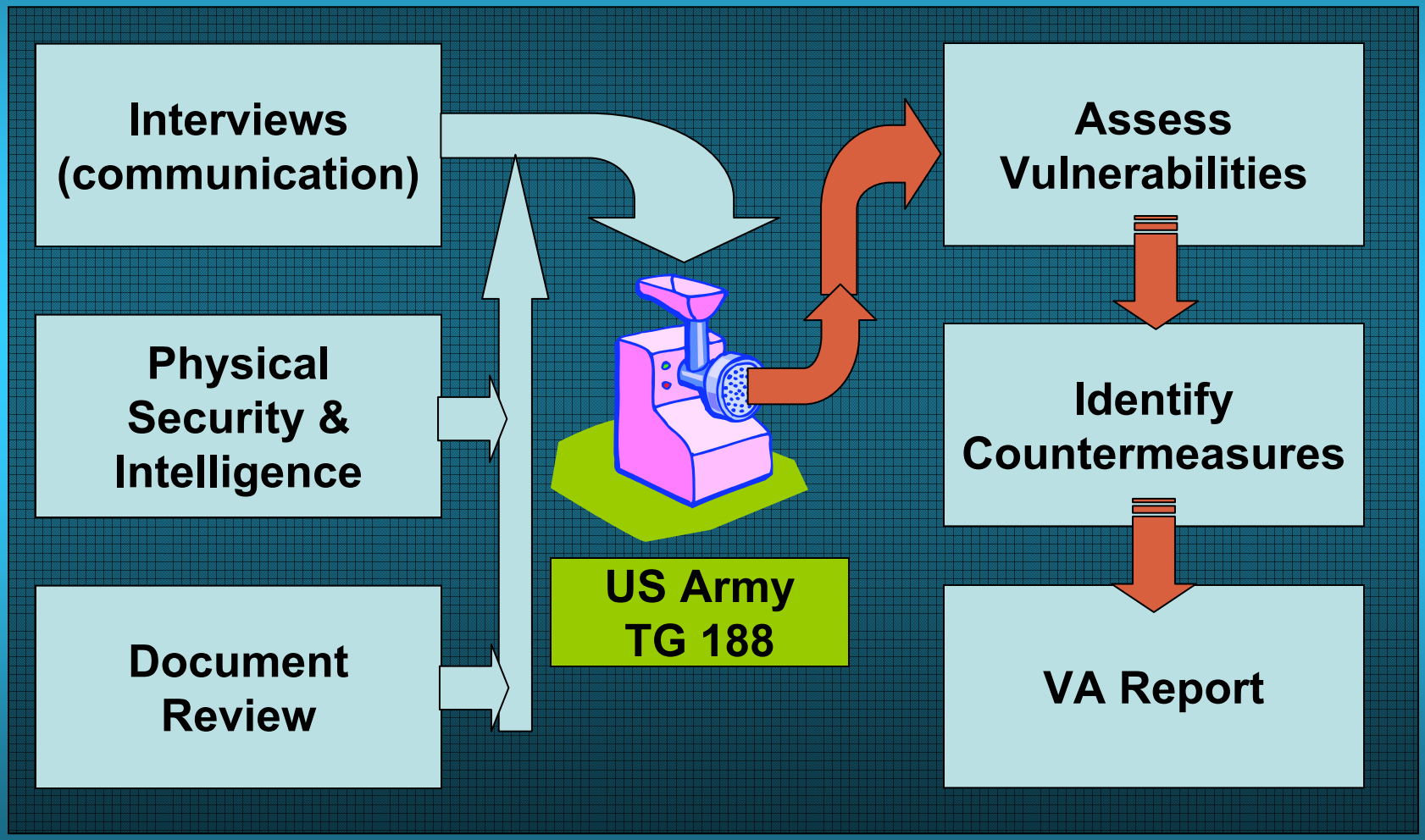
At minimum evaluate the following water system components

- Pipes and constructed conveyances
- Physical barriers
- Water collection, pretreatment, and treatment
- Storage and distribution facilities
- Electronic, computer, and other automated systems (SCADA)
- Use, storage, handling of chemicals
- Operation and maintenance of water system

WSVAs Look Closely at Many Details

- Characterize water system
- Identify & prioritize adverse consequences
- Determine acts that could result in undesired consequences
- Assess likelihood of those acts
- Evaluate existing countermeasures
- Analyze current risk & develop prioritized plan to reduce risk

Framework For Analyzing Information



VI
Application and Importance of Risk Assessment Procedures

Probability + Severity = Risk

TG 188 Uses Operational Risk Management (ORM)

- Probability: The likelihood that an aggressor could successfully exploit the vulnerability
  - Consider the effort required to man, train, equip, and supply a terrorist to carry out such an attack
- Severity: The extent of loss that would result if a successful attack were to occur
  - Takes into account death, widespread illness, ability of the plant to provide water, and number of days to repair damage
  - Also considers loss of public confidence

Probability is One Piece Used to Determine Risk

- **Highly Likely**
  - **Easy to execute. No existing safeguards. No specialized training and very little equipment required. (80-100% success rate)**
- **Likely**
  - **Does not require high level of training and supplies are easily obtained. Minimal protective measures in place. (60-80% success rate)**
- **Probable**
  - **Reasonable that capability exists and existing measures inadequate to deter. Collusion with an insider could provide a terrorist access and the necessary training and equipment. (40-60% success rate)**
- **Questionable**
  - **Remotely possible. Specialized knowledge, training, and equipment required. Information may be obtained by an outsider from generic sources. (20-40% success rate)**

Severity is the Other Piece

- **Catastrophic**
  - Causes deaths or widespread severe illness, complete loss of ability to provide safe drinking water to entire water system—will take > 2 days to restore service.
- **Critical**
  - Causes minor illness, severely damages ability to provide safe drinking water—service can be restored in 2 days, major property damage.
- **Marginal**
  - Degrades ability to provide safe drinking water, appreciable property damage, requiring a construction project to repair.
- **Negligible**
  - Little or no adverse impact on ability to provide safe drinking water, little property damage—does not affect normal equipment operation.

Risk Determination Matrix

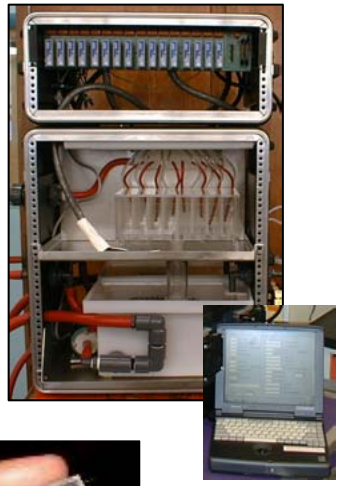
HAZARD SEVERITY	HAZARD PROBABILITY				
	Highly Likely	Likely	Probable	Questionable	Unlikely
Catastrophic	Extremely High	Extremely High	High	High	Moderate
Critical	Extremely High	High	High	Moderate	Low
Marginal	High	Moderate	Moderate	Low	Low
Negligible	Moderate	Low	Low	Low	Low

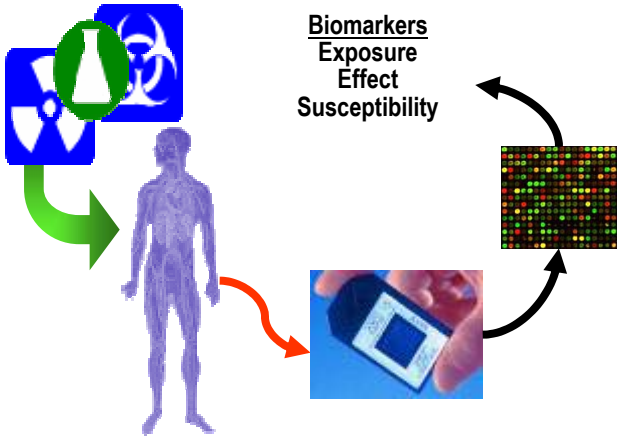
Prioritization and Execution

Commander's Responsibility

- The Threat Changes
- The Risk Changes
- Difficulty in Implementing Recommendations
- Time Frame Involved
- Resources (Personnel and $$$) Available
- Other Force (Health) Protection Demands

Army WSVAs Have Been Performed
at More than 150 US Army Systems Worldwide

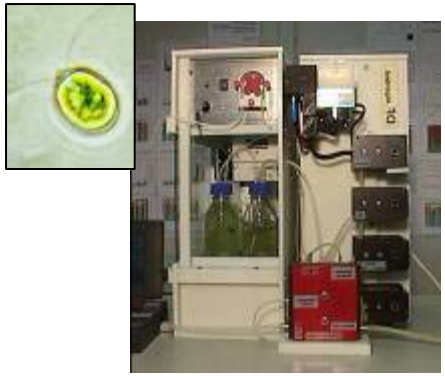




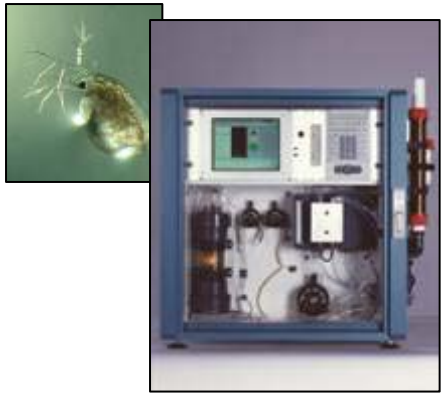
VII
Early Warning Systems

Integrated Biomonitoring Platform

- Funded by EPA source water protection program (EPA lead)
- Integration of fish biomonitor with other systems
- Includes development of an in-stream fish biomonitor chamber
- Also: mobile autonomous underwater vehicle with "biobay"

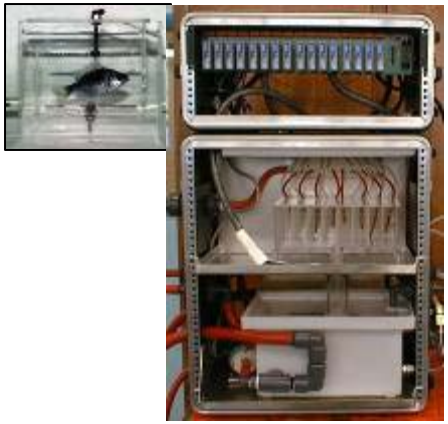


Algae



Daphnids

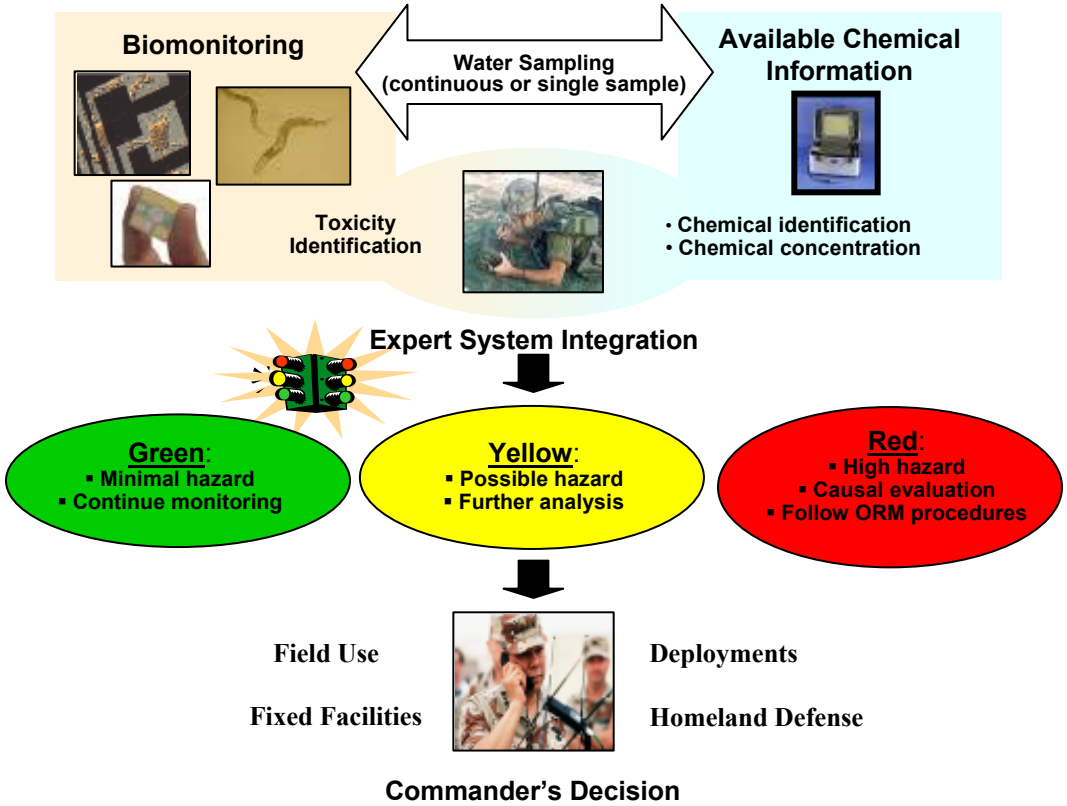
Clams



Fish

The Envrionmental Sentinel Biomonitor Concept

- Builds on aquatic biomonitor experience
- To use cell- or tissue-based toxicity sensors
- Modular design for "plug and play" operation
- Reduced logistical footprint

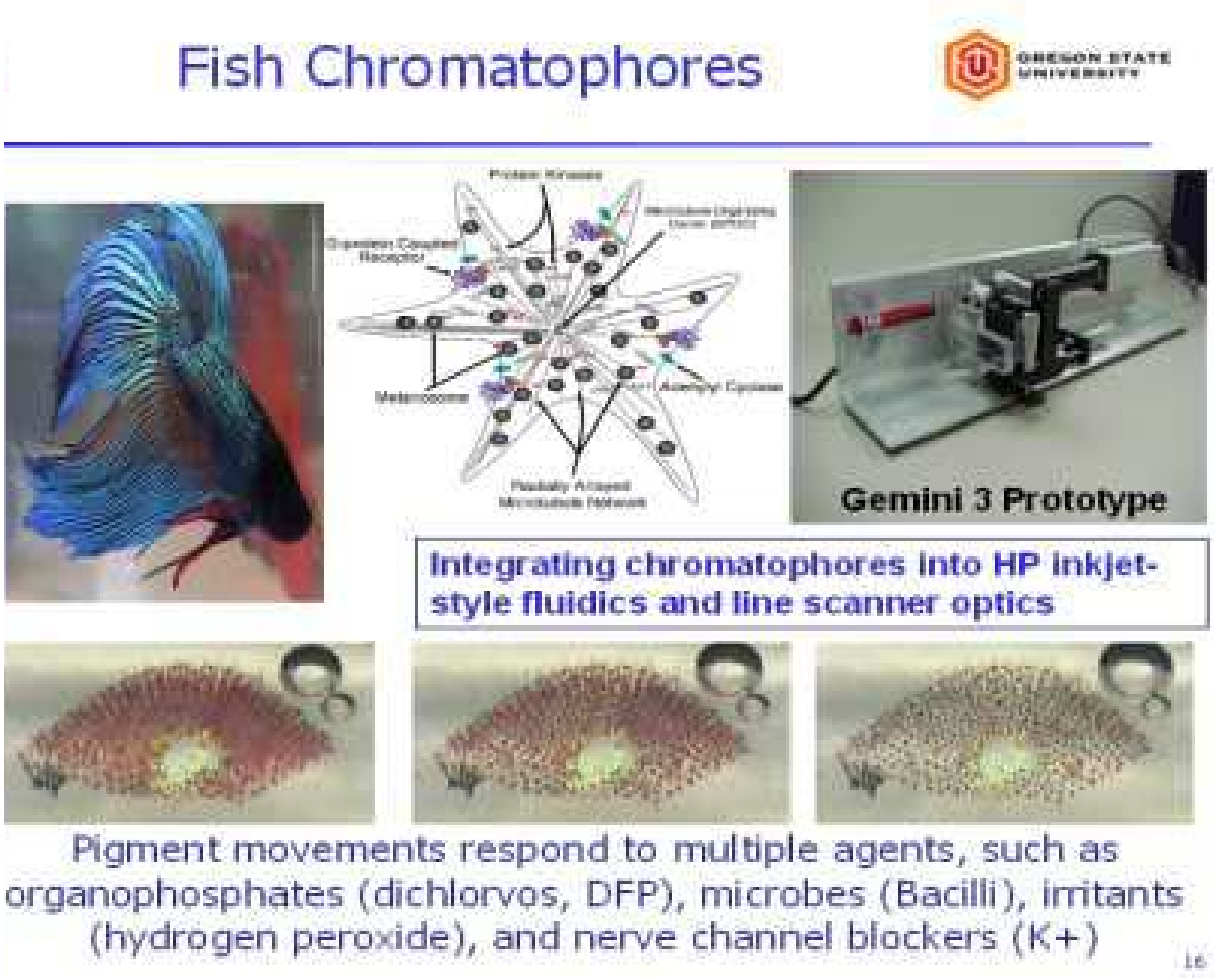


Bacterial Sensor Example:

- Toxicity causes decrease in light output by luminescent bacteria
- Uses freeze-dried bacteria
- Extensive data base
- Issues:
  - False negatives
  - Water matrix effects
  - Testing underway in EPA's Environmental Technology Verification (ETV) program

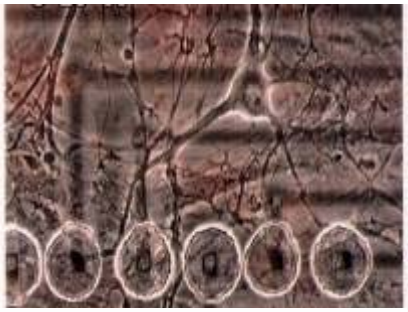
Vertebrate Cell Sensor Example: Fish Chromatophores

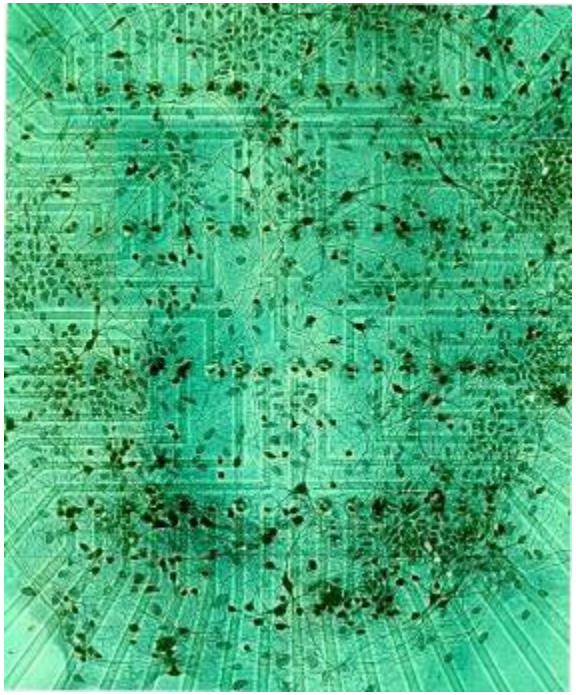
- Toxicity changes pigment patterns
- Cells in disposable cartridges
- Issues:
  - Cell viability, availability
  - Effects data
- Source: P. McFadden, Oregon State U.



Vertebrate Cell Sensor Example: Mammalian Neurons

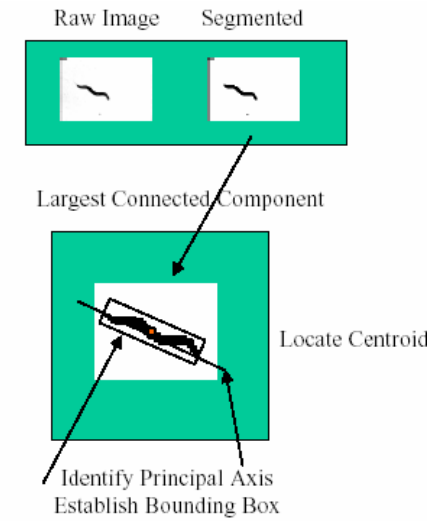
- Neuronal network on microelectrode array; measure mean spike rate
- Network viability up to 6 months; 1-2 days on test
- Issues:
  - Cell source, viability
  - Informatics
  - Sample preparation
- Source: J. Pancrazio, NRL

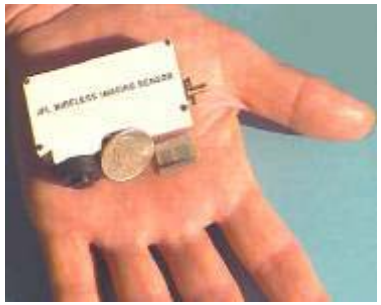


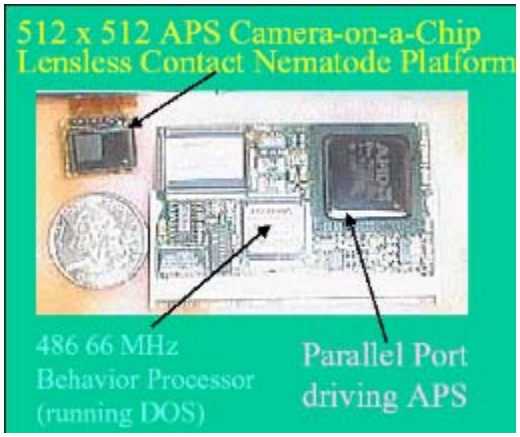


Whole Organism Sensor Example: *C. elegans* Movement

- Measure nematode movement with miniature wireless sensor
- Nematodes genetically engineered for agent sensitivity
- Issues:
  - *C. elegans* shelf life
  - Still at proof of concept stage
  - Tie-in with USACEHR biomarker development research
- Source: http://wormlab.caltech.edu/jpl.html







Reminder

Don't forget to mention non-bio chemical monitoring systems !

SUMMARY

- Examples of water supply terrorism
- Drinking water system vulnerabilities
- Federal and US DoD requirements
- WSVA Overview
- Application/Importance of risk assessment procedures
- Early warning systems

QUESTIONS?

Steven C. Richards
USACHPPM
(410) 436-8410
Steven.Richards@us.army.mil