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Risk Assessment Integrated with Cumulative Prospect Theory for Terrorist Attacks Against United States Critical Infrastructure

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WASHINGTON, D.C.

National Threat Advisory:
High Risk Of Terrorist Attacks

RISK ASSESSMENT INTEGRATED WITH *CUMULATIVE PROSPECT THEORY* FOR TERRORIST ATTACKS AGAINST UNITED STATES' CRITICAL INFRASTRACTURE

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TERRORISTS DON'T NEED BOMBS & HIJACKING TO ULTIMATELY ACHIEVE CATASTROPHIC DESTRUCTION AGAINST UNITED STATES AND ACQUIRE MASS MEDIA ATTENTION...

TERRORISTS ATTACK TO THE NATION'S GROUNDWATER RESOURCES & URBAN WATER SUPPLY SYSTEM... IS COMPARABLE OR WORSE THAN 9/11 TERRORIST ATTACKS & SUICIDE BOMBINGS IN IRAQ, AFGANISTAN & PAKISTAN,

...WHEN TERRORISTS USED THE PERFECT WEAPON OF DESTRUCTION ON THE RIGHT TIMING.

Protection of Critical Infrastructure has been the primary concern for governing agencies, environmental stakeholders, and the general populous worldwide.

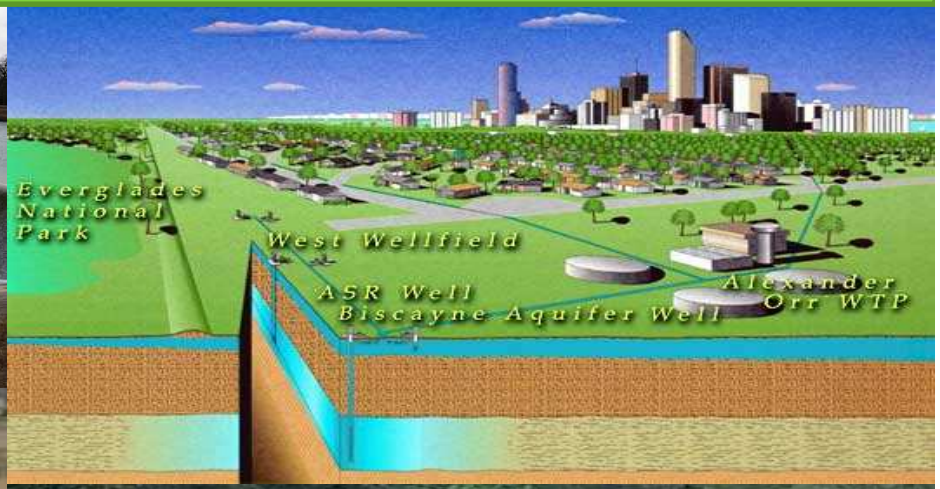
In the recent years, National Security has been a primary concern, initially regarding human health, and eventually including protection of sensitive infrastructure, the environment, and commerce from *threats of terrorism*.

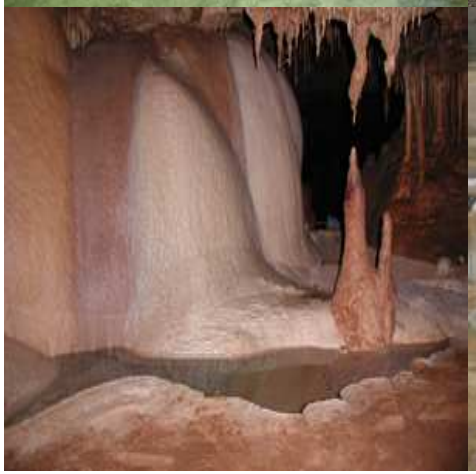
Methodological Approaches to Risk Assessment **embedded with cumulative prospect theory is providing an engineering profession with the necessary tools to address this public concern.**

OBJECTIVE

To develop & illustrate a Methodological Approaches to Risk Assessment, embedded with cumulative prospect theory for analysis of acts of terrorism against US Critical Infrastructure:

"GROUNDWATER AND WATER SUPPLY SYSTEM TERRORISM USING CYANIDE & ARSENIC", AS AN ILLUSTRATIVE EXAMPLE





CONCERNS OVER IMPACT OF TERRORIST ATTACKS USING CYANIDE & ARSENIC TO WATER SUPPLY SYSTEM

1.) Cause Catastrophic Health Effects (illness, diseases, or death)

2.) Cause Mass Casualties

3.) Create Chaos on Regional or National Security.

4.) Contaminate the Water Supply System and cause Long-term Damage to Safe- Drinking Water.

5.) Disrupt the downstream industry and commercial infrastructure, that depend on safe and clean water supplies.

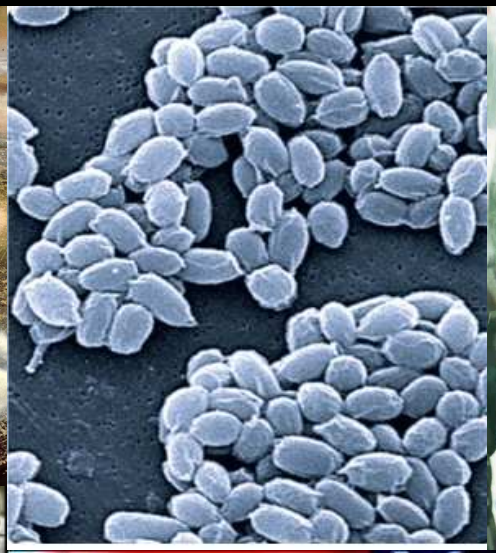
6.) Likely create irreversible damage to groundwater resources

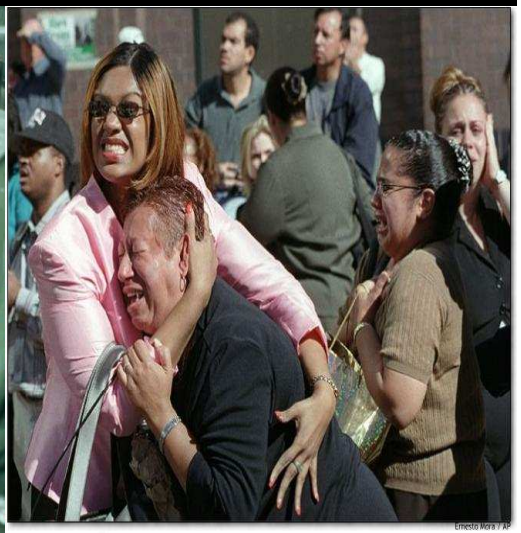
7.) Create a need to remediate and replace portions of the water system to make it safe, which could in turn create water shortages or outages.

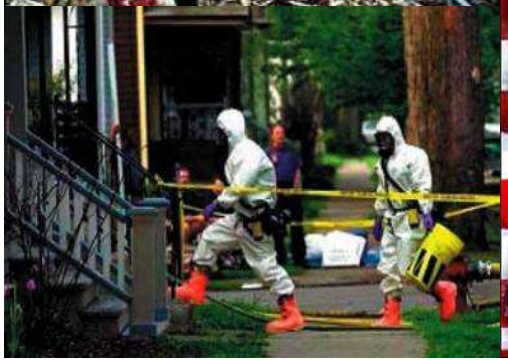
BACKGROUND

TERRORISM

Threat of unlawful violence to inculcate fear and intimidation.
Also Terrorists would like to acquire mass media attention and create chaos.




BACKGROUND

THE PRINCIPAL TERRORISTS AGAINST UNITED STATES

Osama Bin Laden & Al Qaeda-his followers, supporters and believers.

1.) Bin Laden - Very Wealthy
with approximately known assets of $300M

2.) Multi-Millionaire or Billionaire Supporters all over The world.

"The Islamic World Front for the struggle against the Jews and the Crusaders"

Bin Laden argued that Muslims everywhere in the world were suffering at the hands of the United States and Israel.

According to US Central Intelligence & Federal Bureau of Investigation :

Al Qaeda release a message calling for the use of weapons of mass destruction (WMD) against United States for supporting Israel.

BACKGROUND

WEAPONS OF MASS DESTRUCTION (WMD)

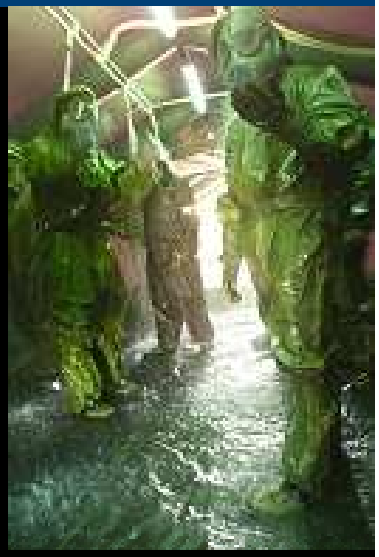
"Severely Contamination of Groundwater & Water Supply System" Using….

ARSENIC & CYANIDE

BACKGROUND

WEAPONS OF MASS DESTRUCTION (WMD)

ARSENIC



Major uses of Arsenic in the United States have been:

a.) Rodent poisons, insecticides, biocides and weed killer containing arsenic in both organic and inorganic forms.

In pure form arsenic:

It is a tasteless, odorless white powder or clear crystals Ingestion of two grams or more may be lethal in a very short time.

(trivalent forms) have a higher acute toxicity than arsenates (pentavalent forms).

The acute minimal lethal dose of arsenic in adults is estimated to be 70 to 200 mg or 1 mg/kg/day (Dart RC, 2004).

USEPA and International Agency for Research on Cancer (IARC)→ "Group I or class-A" human carcinogens

Also, it cannot be destroyed easily.

BACKGROUND

WEAPONS OF MASS DESTRUCTION (WMD)

ARSENIC

Chlorination is not effective to treat Arsenic in the water supply system, advance and costly treatment system shall be employed to reduce or remove Arsenic.

Meanwhile, the reaction of chlorine with organic present in the water may produce Trihalomethanes (THMs) which are known carcinogens.

Treatment Technology Maximum Achievable Removal Percentage

Treatment Technology	Maximum Percent Removal
Coagulation/Filtration	95
Enhanced Coagulation/Filtration[1]	95
Coagulation Assisted Microfiltration	90
Lime Softening (pH > 10.5)	90
Enhanced Lime Softening[1] (pH > 10.5)	90
Ion Exchange (sulfate < 50 mg/L)	95
Activated Alumina	95
Reverse Osmosis	>95
Greensand Filtration (20:1 iron:arsenic)	80
POU Activated Alumina	90
POU Ion Exchange	90

1 - Enhanced processes assume the existing plant can achieve 50 percent removal without modification. Process enhancements result in the balance to achieve the maximum removal. For example, an existing coagulation/filtration facility can achieve 50 percent removal. Process enhancements result in an additional 45 percent removal, for a total removal of 95 percent.

BACKGROUND

WEAPONS OF MASS DESTRUCTION (WMD)

CYANIDE

Sodium or Potassium Cyanides are suitable weapon for terrorist attacks on Groundwater because it is easy to acquire.

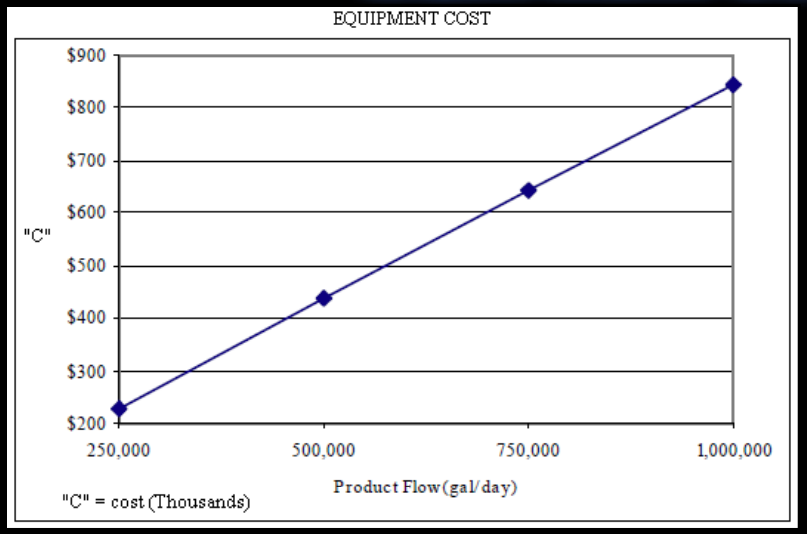
According to International Program on Chemical Safety (IPCS):

Sodium Cyanide is a highly toxic chemical compound and deadly human poison by ingestion and probable oral lethal dose in human is less than 5 mg/kg or a taste (less than 7 drops) for a 70 kg (150 lbs) person - super toxic.

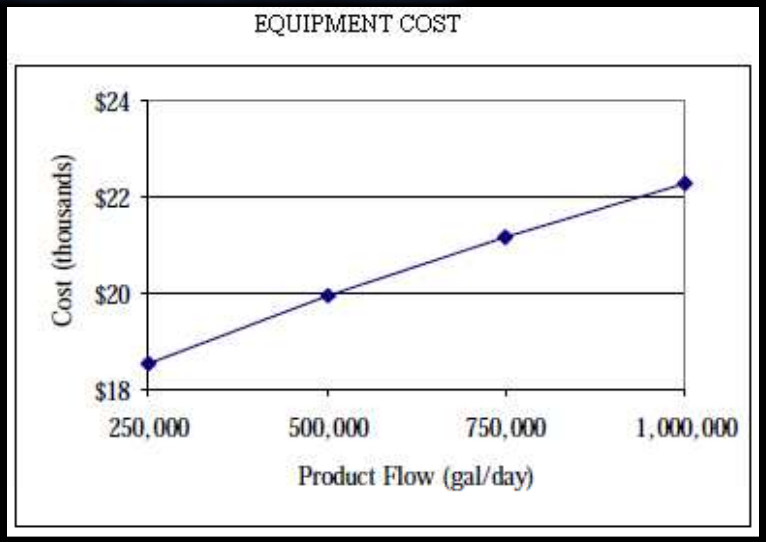
WATER TREATMENT

CYANIDE

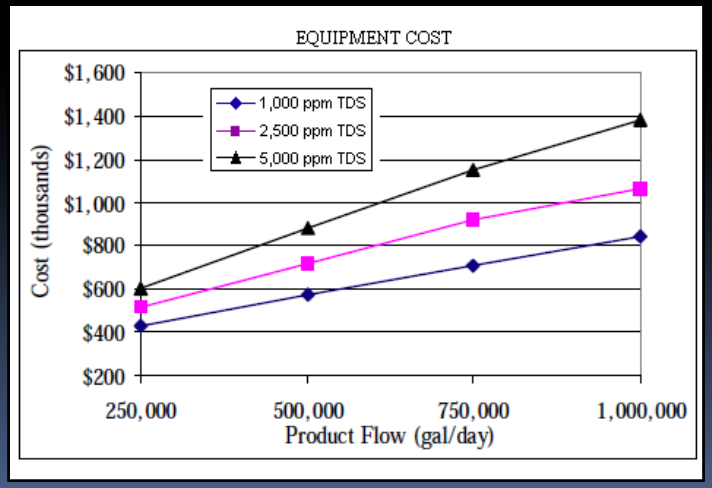
EQUIPMENT COST PER USEPA 1998



ION EXCHANGE



CHLORINATION



REVERSE OSMOSIS

GROUNDWATER RESOURCES IN THE UNITED STATES

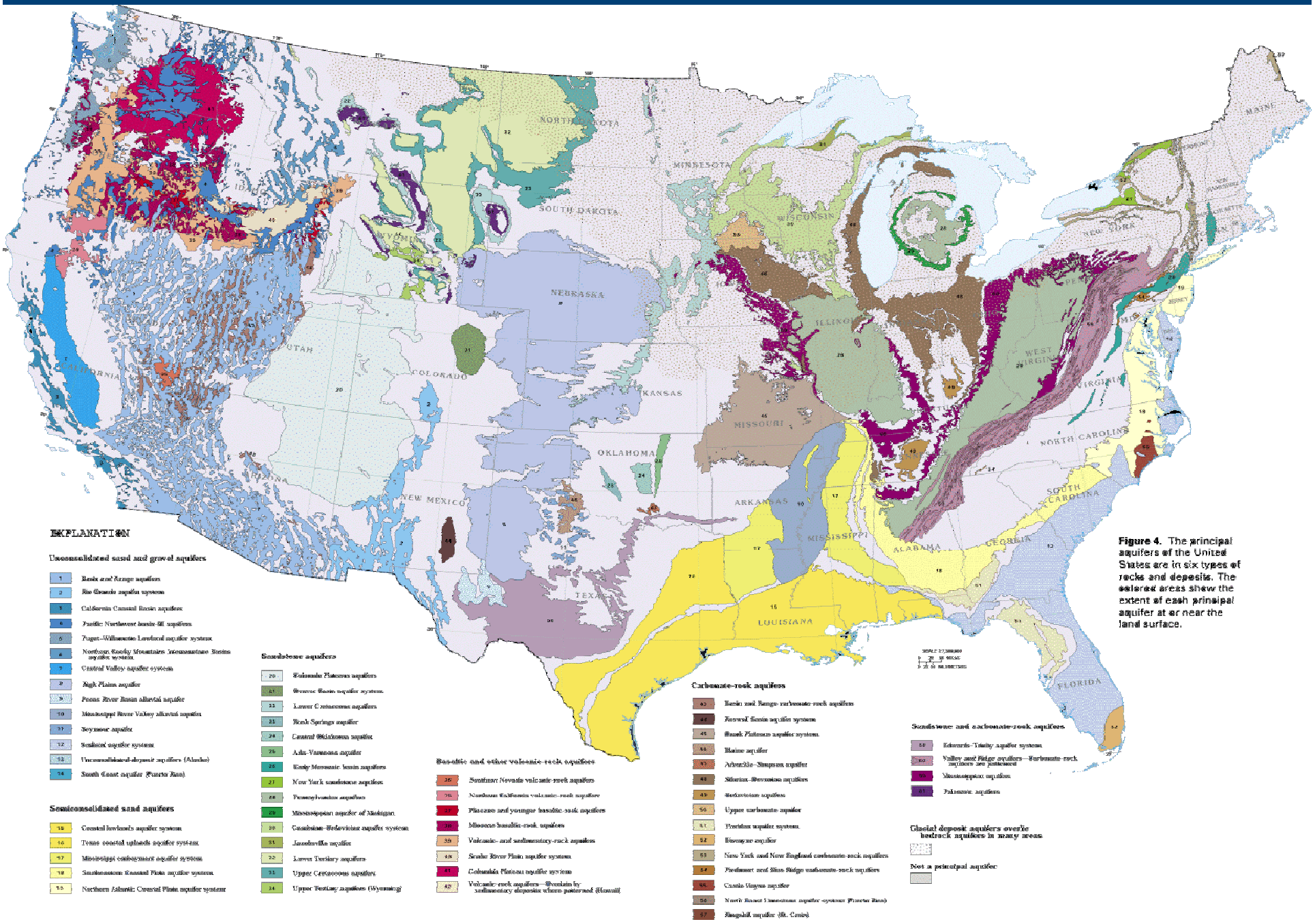
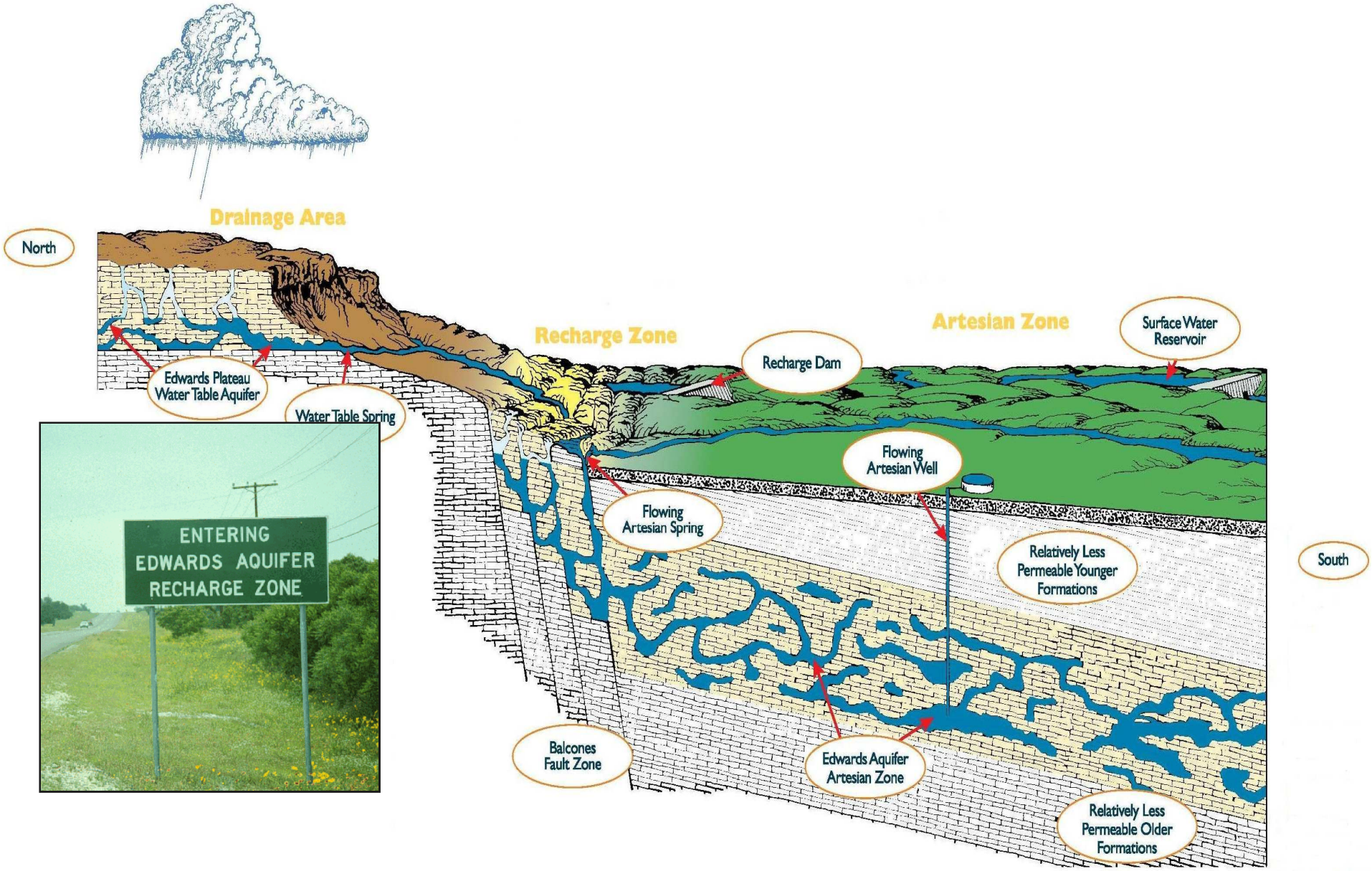


Figure 4. The principal aquifers of the United States are in six types of rocks and deposits. The colored areas show the extent of each principal aquifer at or near the land surface.

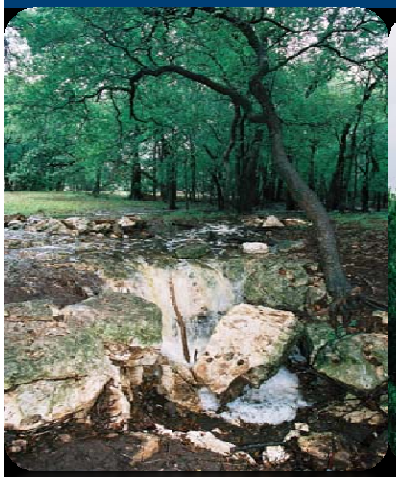
BACKGROUND

AQUIFER RECHARGE ZONE



BACKGROUND

EDWARDS AQUIFER CHARACTERISTICS



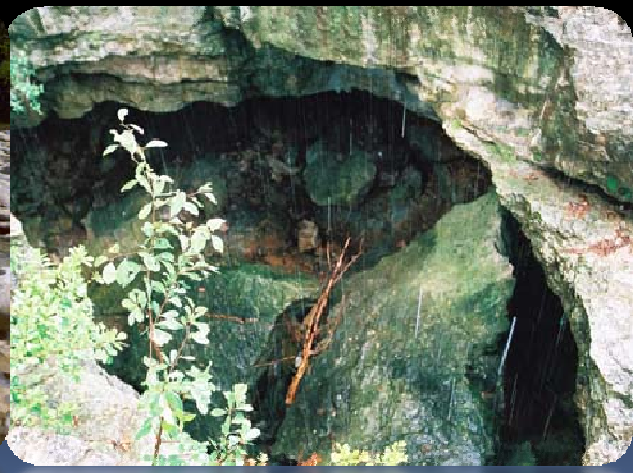
Water Entering Sink Hole

SARA Flood Control Dam

Creek Bed Fracture Showing Recharge

Hills and Dales Cave

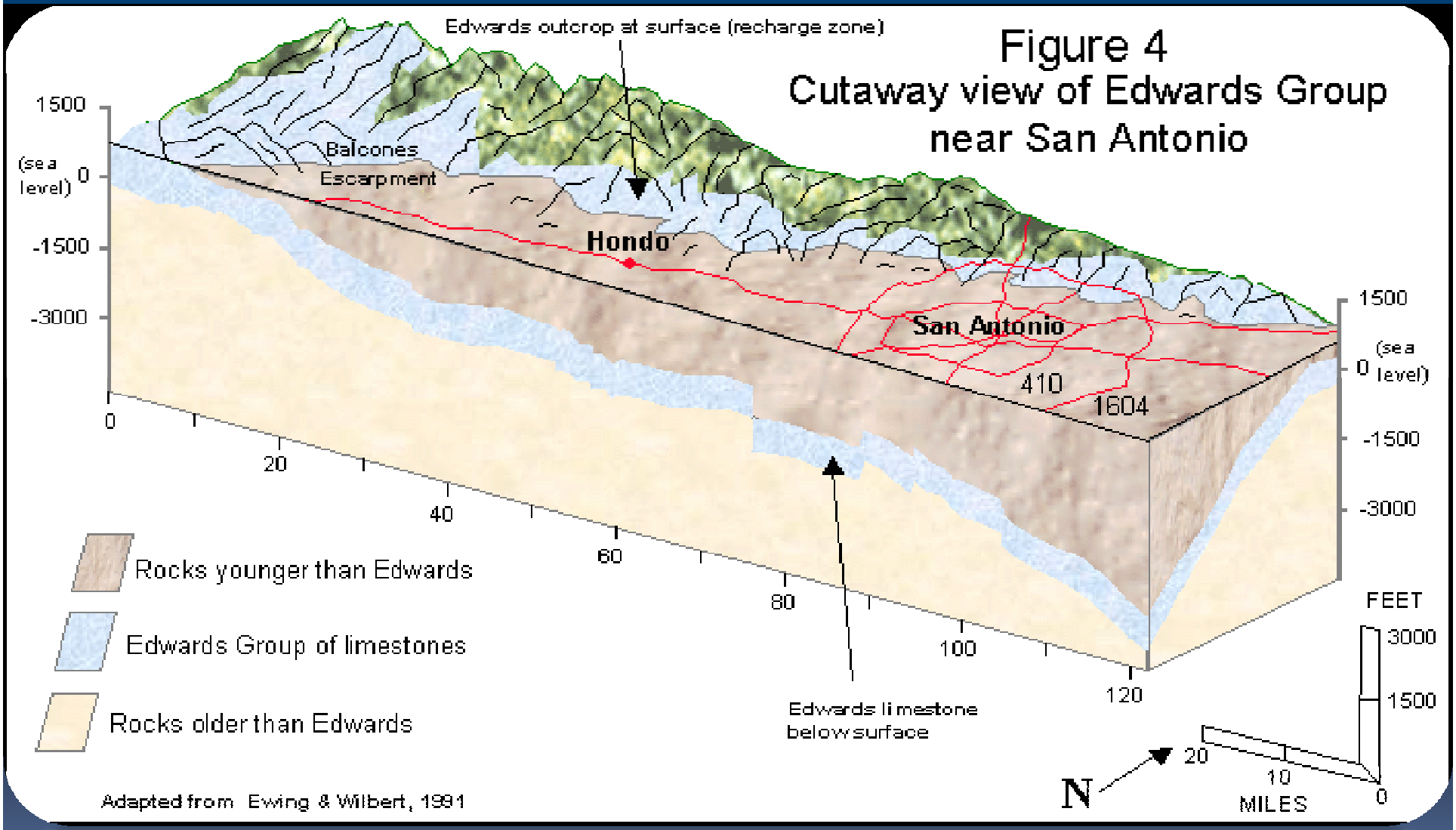
Fractures and Conduits



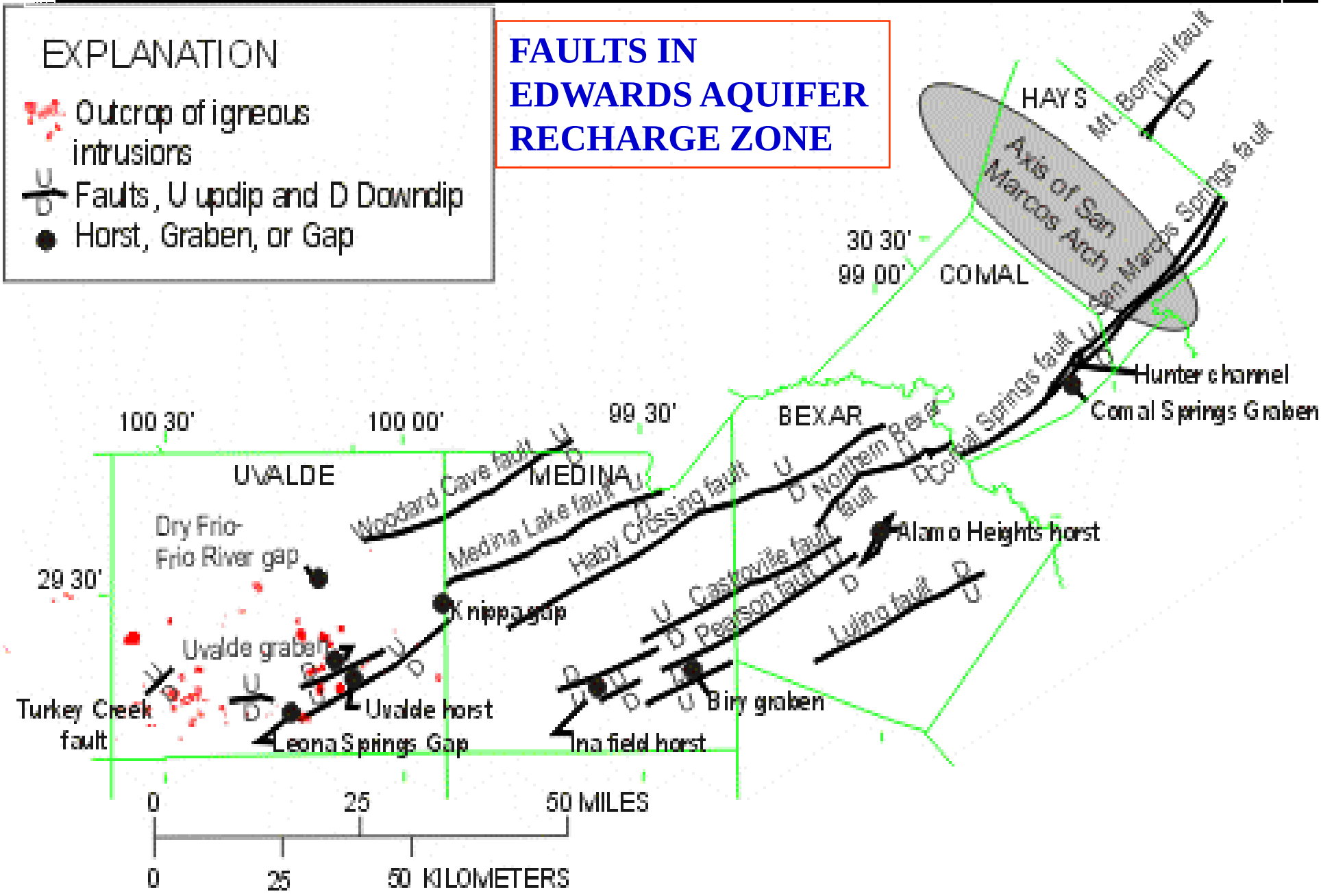
Recharge at Cub Cave

BACKGROUND

EDWARDS AQUIFER CHARACTERISTICS



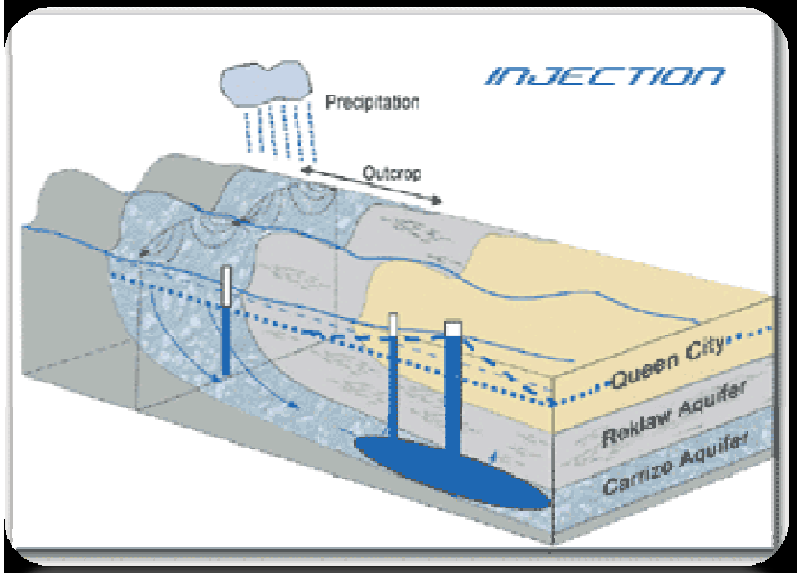
Structural Features That Affects Groundwater Flow

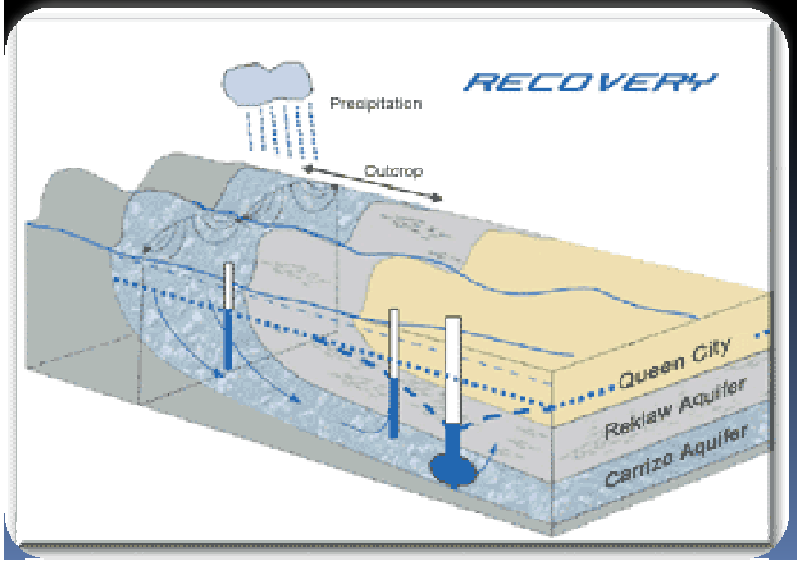


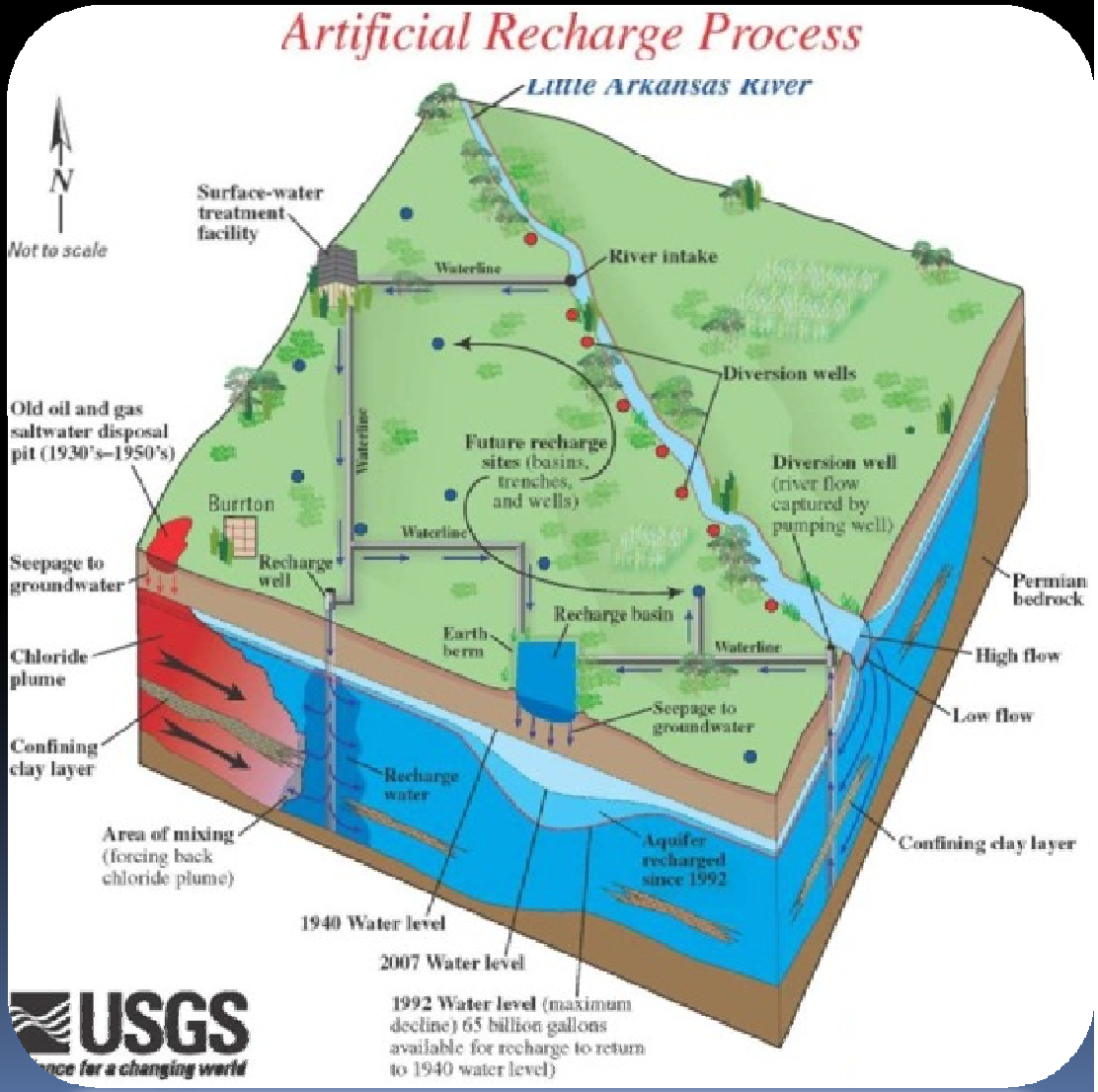
BACKGROUND

WATER SUPPLY SYSTEM

Aquifer Storage & Recovery



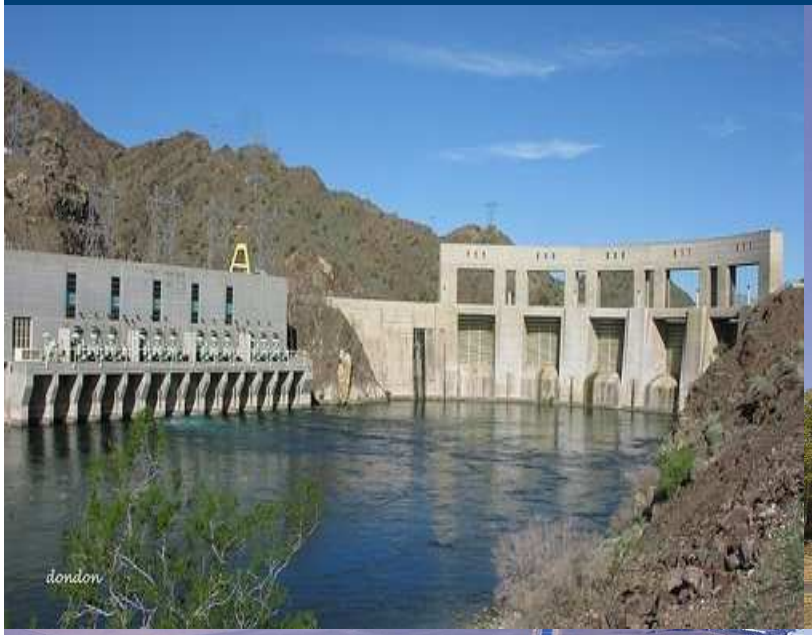


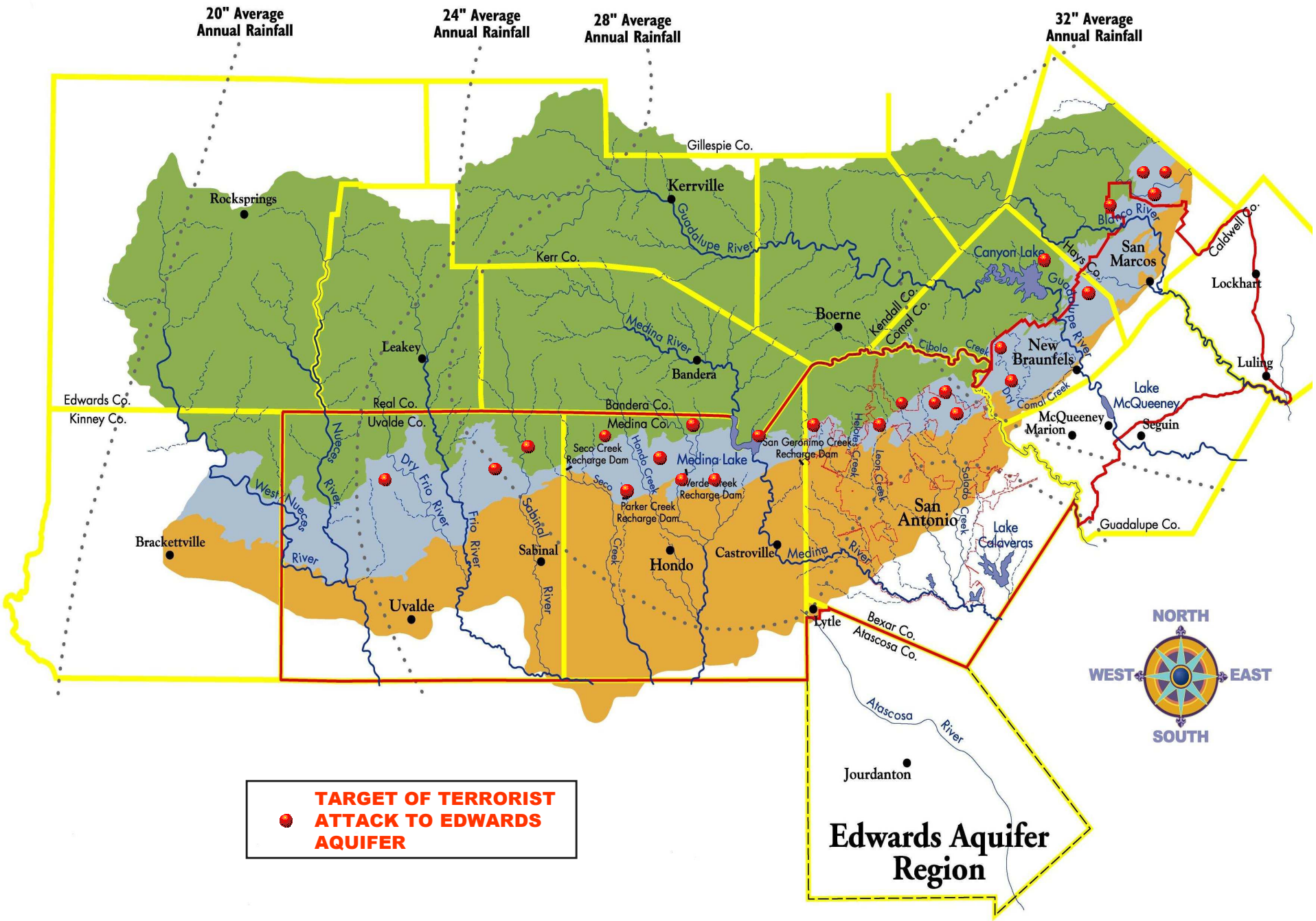


SURFACE WATER IN THE UNITED STATES

BACKGROUND

WATER SUPPLY SYSTEM




20" Average Annual Rainfall
24" Average Annual Rainfall
28" Average Annual Rainfall
32" Average Annual Rainfall
Gillespie Co.
Kerrville
Guadalupe River
Rocksprings
Kerr Co.
Boerne
Kendall Co.
Comal Co.
Canyon Lake
Blanco River
Hays Co.
San Marcos
Caldwell Co.
Lockhart
Guadalupe River
Cibolo Creek
New Braunfels
Luling
Medina River
Leakey
Bandera
Dry Comal Creek
Lake McQueeney
McQueeney
Seguin
Marion
Edwards Co.
Kinney Co.
Real Co.
Uvalde Co.
Bandera Co.
Medina Co.
Nueces River
West Nueces River
Dry Frio River
Frio River
Sabinal River
Seco Creek
Seco Creek Recharge Dam
Hondo Creek
Medina Lake
Verde Creek Recharge Dam
Parker Creek Recharge Dam
San Geronimo Creek Recharge Dam
Helotes Creek
Leon Creek
Salado Creek
San Antonio
Lake Calaveras
Guadalupe Co.
Brackettville
Sabinal
Hondo
Castroville
Medina River
Uvalde
Lytle
Bexar Co.
Atascosa Co.
Atascosa River
Jourdanton
NORTH
WEST
EAST
SOUTH
TARGET OF TERRORIST ATTACK TO EDWARDS AQUIFER
Edwards Aquifer Region

CURRENT SECURITY COMPONENTS ON US BORDERS

ILLEGAL INFLOW OF ALIEN (NON US-CITIZEN/NON- US RESIDENT)

Every year, about 500 million people cross these borders, and over two-thirds of them are non-U.S.citizens.

There is one border agent for every five miles of border, and for each person who crosses *legally*, officials only have about 12 seconds to determine their legitimate identity, whether they should be admitted, under what conditions, and for how long (O'Connor, T., 2008).

US-VISIT Program

Electronic System for Travel Authorization (ESTA)

E- Passport

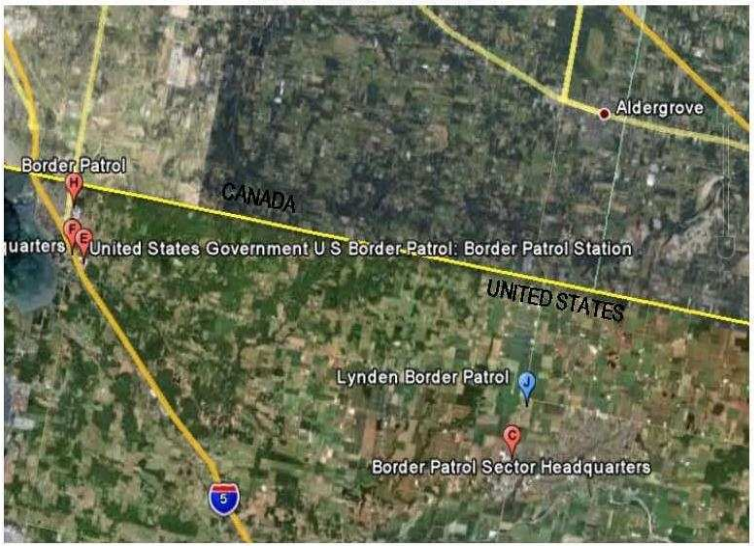
Custom & Border Protection (CBP)-

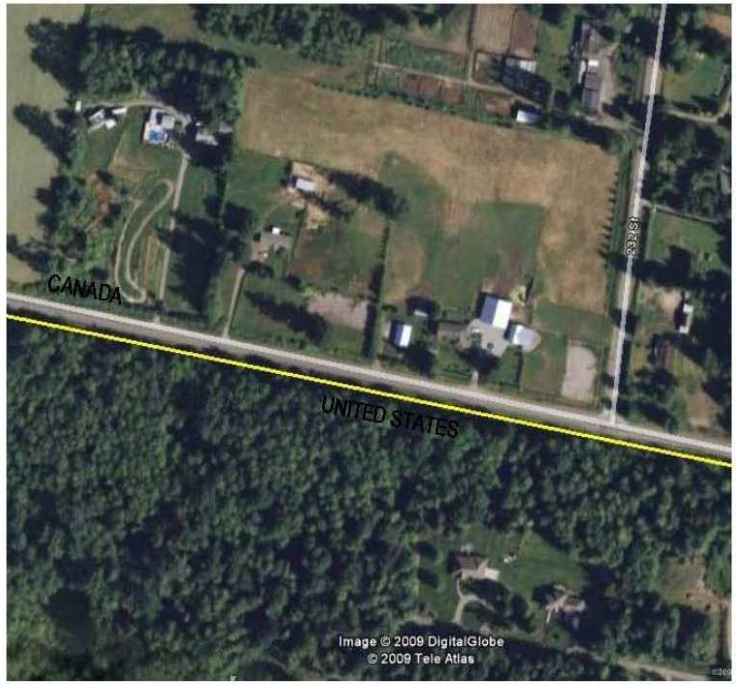
According to Giermanski of DHS, CBP suffer from seriously flawed decision-making", citing the "door only" policy, radio frequency identification technology, and lack of focus on exports which contain bombs.

US-CANADA BORDERS

UNITED STATES - CANADA BORDERS

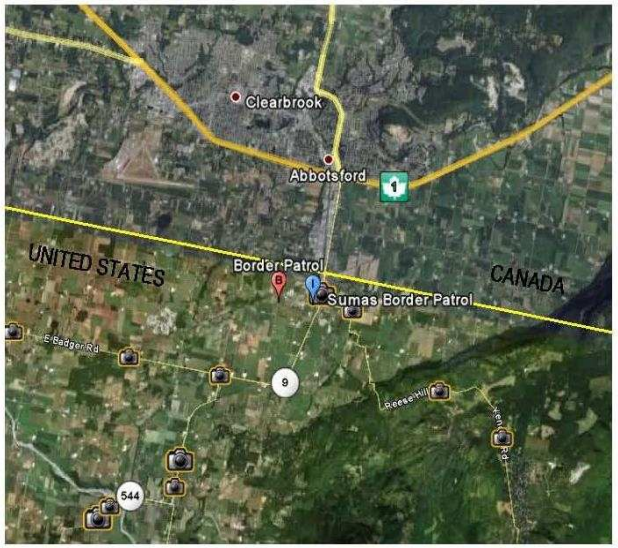
AERIAL PHOTOGRAPHIC MAP A2

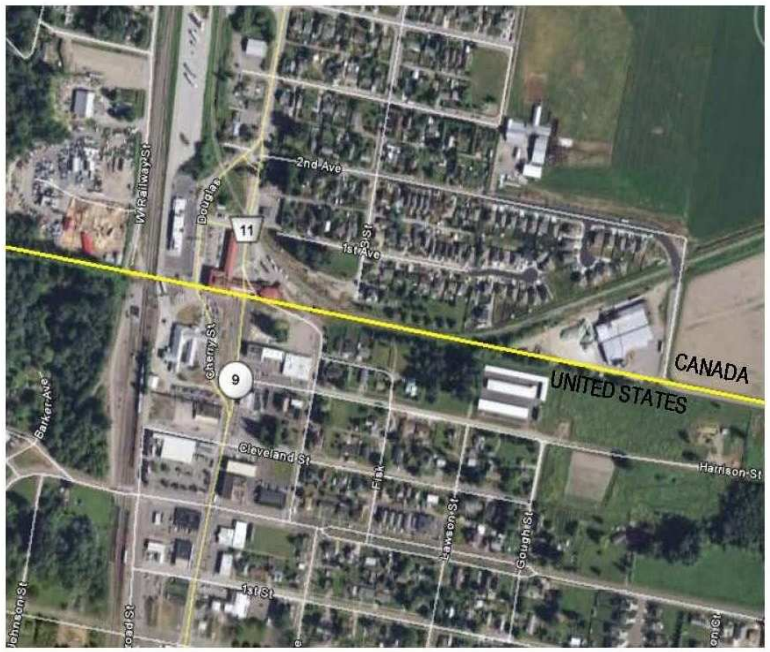




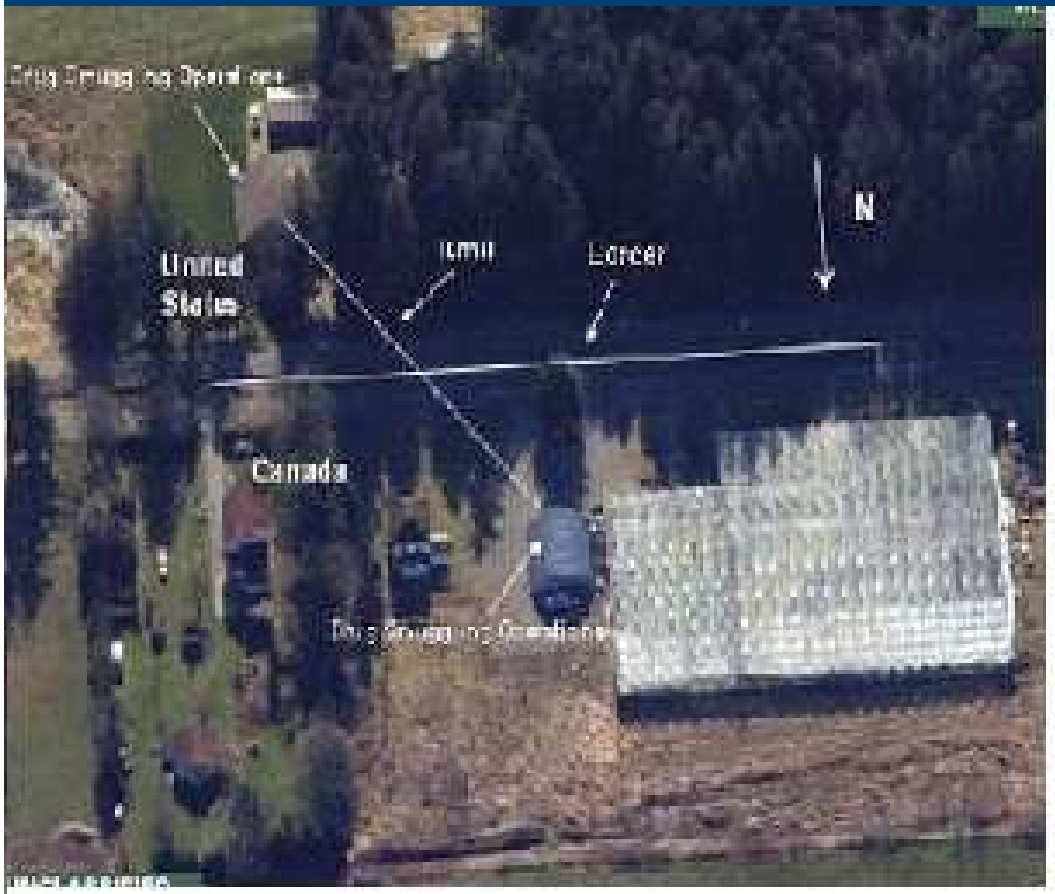
UNITED STATES - CANADA BORDERS

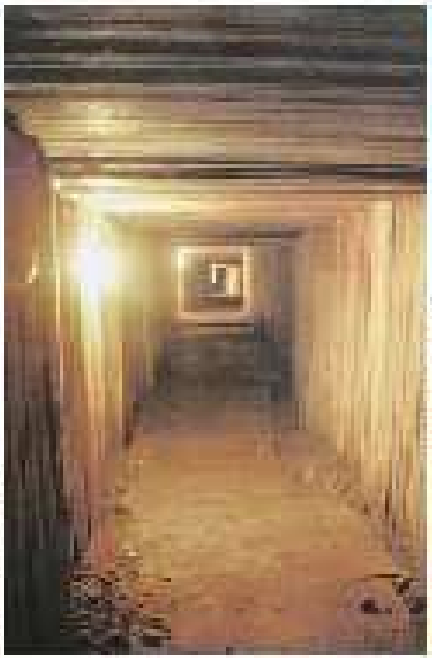
AERIAL PHOTOGRAPHIC MAP A4





US-CANADA BORDERS





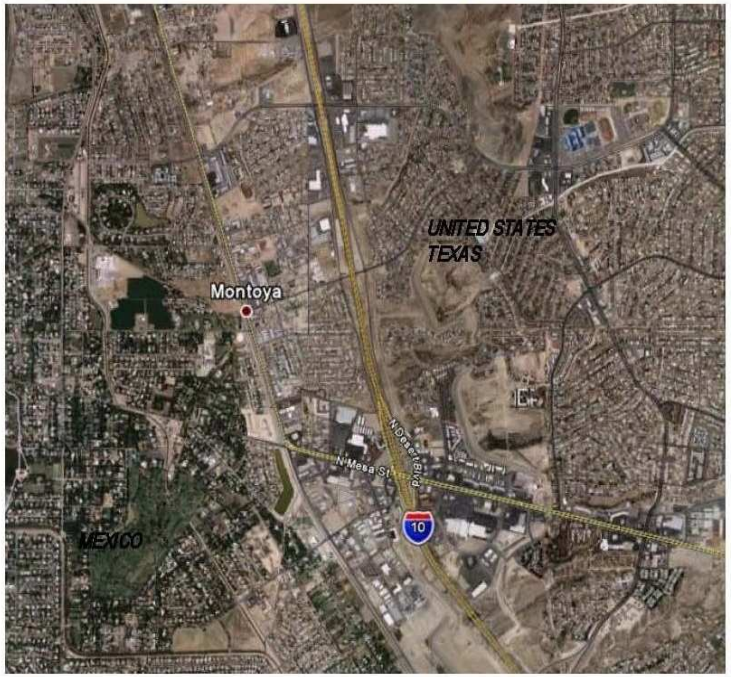
US-MEXICO BORDERS

UNITED STATES - MEXICO BORDERS

AERIAL PHOTOGRAPHIC MAP A6

UNITED STATES - MEXICO BORDERS

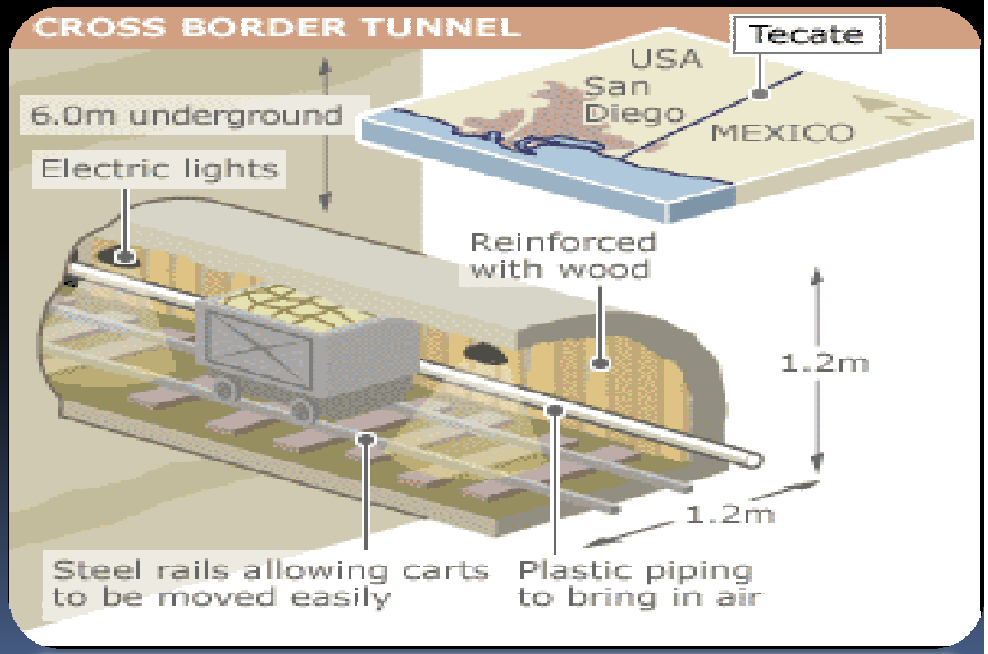
AERIAL PHOTOGRAPHIC MAP A8



US-MEXICO BORDERS

Tunnels in US –MEXICO Borders

- Traffickers continue to construct tunnels beneath U.S. borders to transport drugs, illegal aliens and other contraband, according to an internal briefing prepared by a U.S. Northern Command Task Force.
- Dozens of tunnels have been found in recent years,
- Overall, between 1990 and November 2008, **ninety four (94) cross-border tunnels** were discovered,
- 35 of those were in California,
- 58 in Arizona, and one in Washington State (FAS, 2009).



REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

- The United States' water supply was designated as one of eight national infrastructures vital to the security of the United States, through the issuance of Executive Order (EO) 13010.

- President Clinton issued Presidential Decision Directive 63 (PDD 63) in May 1998, which designated the U.S. Environmental Protection Agency (EPA) as the lead federal agency responsible for protecting the U.S. water supply from intentional physical, chemical, and biological attacks.

- **Title IV of the Bioterrorism Act of 2002** pertains to drinking water security and safety requiring vulnerability assessments and emergency and emergency response plans for large and medium size water systems.

- In 2006, EPA has evolved to be in charge of developing surveillance and monitoring systems to provide early detection and awareness of water contaminations events per Homeland Security Presidential Directive 9 (HSPD 9).

REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

SAFE DRINKING WATER ACT

- The Safe Drinking Water Act allows States to establish a Comprehensive State Groundwater Protection Program to protect underground sources of drinking water.

  The Act does not cover private wells based upon United States Code (*42 U.S.C. § 300f(4)(A)*). Likewise, Bottled water is regulated by the Food and Drug Administration (FDA) under the Federal Food, Drug, and Cosmetic Act.

Title 40 Of The Code Of Federal Regulations

Maximum Contaminant Levels (MCL), are standards that are set by EPA in Title 40 of the Code of Federal Regulations.

It is the legal threshold limit on the amount of a hazardous substance that is allowed in drinking water under the Safe Drinking Water Act. The MCL standards and Treatment Technique (TT)

Thus, National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects or aesthetic effects in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply

REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

Contaminant		MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
IOC	Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2
OC	2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.07
OC	Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	0.2
OC	1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	zero
OC	o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC	p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.075
OC	1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero

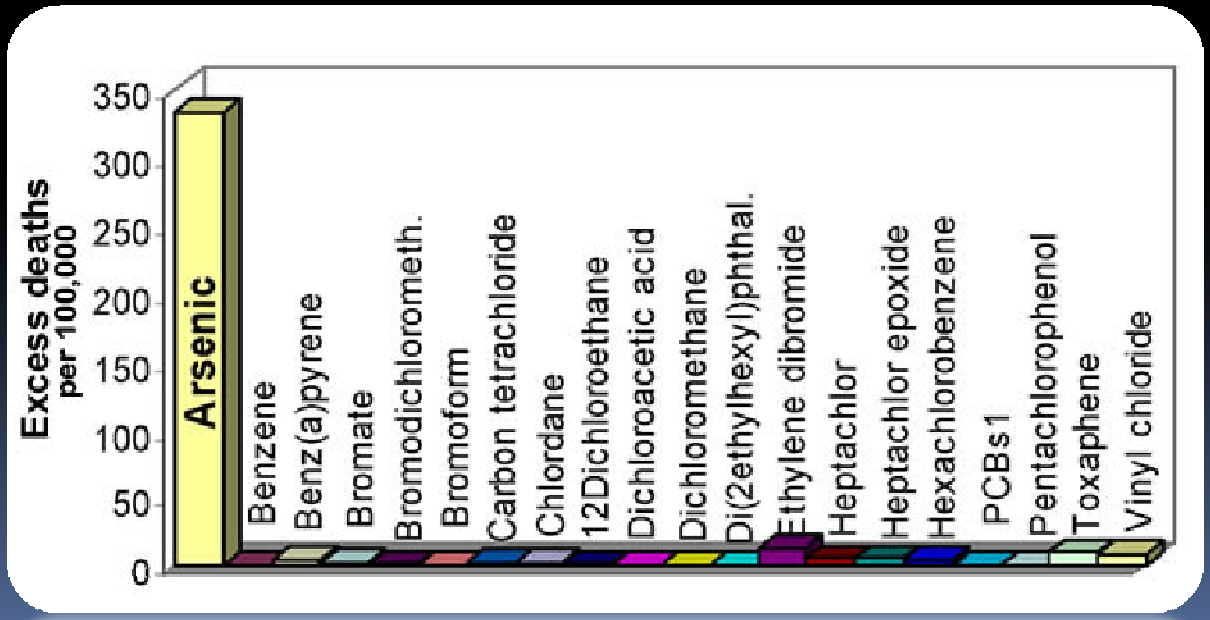
REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

Arsenic Being Not Part Of The National MCL Regulations…

EPA is establishing a health-based, non-enforceable Maximum Contaminant Level Goal (MCLG) for arsenic of zero and an enforceable Maximum Contaminant Level (MCL) for arsenic of 0.01 mg/L (10 µg/L).

The national cost of meeting an arsenic MCL of 2 µg/L was estimated at $2.1 billion annually. Ion exchange, reverse osmosis, and lime softening were the treatment technologies considered.

ESTIMATED CANCER RISK DEATHS PER 100,000 PEOPLE EXPOSED AT THE MCL FOR EACH DRINKING WATER CHEMICAL CARCINOGEN PER NRC & UC BERKLEY 2001



REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

Agencies Involved in Protection Policies

NOTE:EPA has evolved to be in charge of developing surveillance and monitoring systems to provide early detection and awareness of water contaminations events per Homeland Security Presidential Directive 9 (HSPD 9).

EPA works with other federal agencies such as:

1.) Centers for Disease Control and Prevention (CDCP),

2.) Federal Bureau of Investigation (FBI),

3.) Department of Defense (DOD)

4.) water organizations : e.g., Water Environment Research Foundation (WERF)

REGULATORY POLICIES FOR THE PROTECTION OF GROUNDWATER & WATER SUPPLY SYSTEM

Funding for Protection Research

Each state will receive a minimum of $50,000 and each territory will receive at least $16,700.

According to EPA, the current Federal Funding for Policy Making and Implementations is between $1,000, 000 to $10,000,000.

QUANTITAVE RISK ESTIMATION MODEL

Risk Has Two Major Components:

(1) the existence of a possible unwanted consequence or loss, and

(2) an uncertainty in the occurrence of that consequence which can be expressed in the form of a probability of occurrence.

Consequence implies a negative value to a risk taker.

TERRORIST SCENARIOS

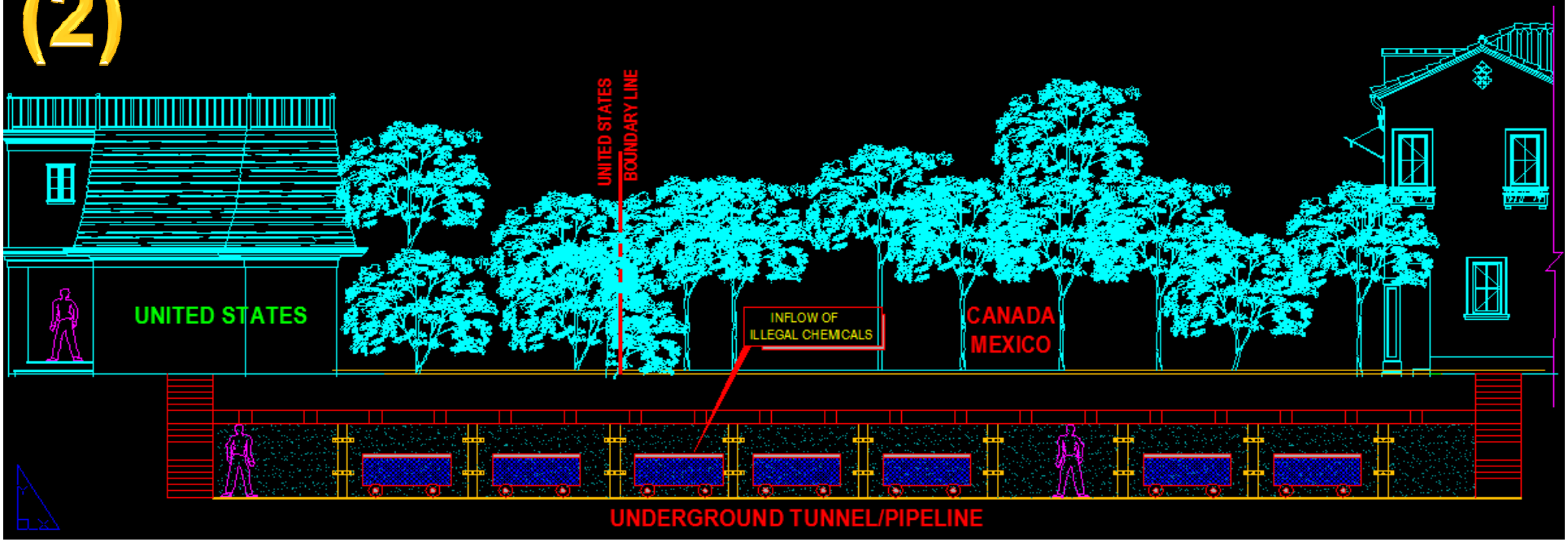
TERRORIST(S) BUY OR RENT REAL ESTATE PROPERTY ON OR ADJACENT TO…

- US-CANADA BORDER
- US-MEXICO BORDER
- ADJACENT TO CRITICAL INFRASTRUCTURE (E.G. WATER INFRASTRUCTURE)
- MAJOR GROUNDWATER RECHARGE ZONE
- ARTIFICIAL AQUIFER RECHARGE OR AN ASR
- ACQUEDUCTS/RESERVOIR
- MAJOR WATER SUPPLY STORAGE FACILITIES
- MAJOR WATER WELLS FOR COMMERCIAL USE

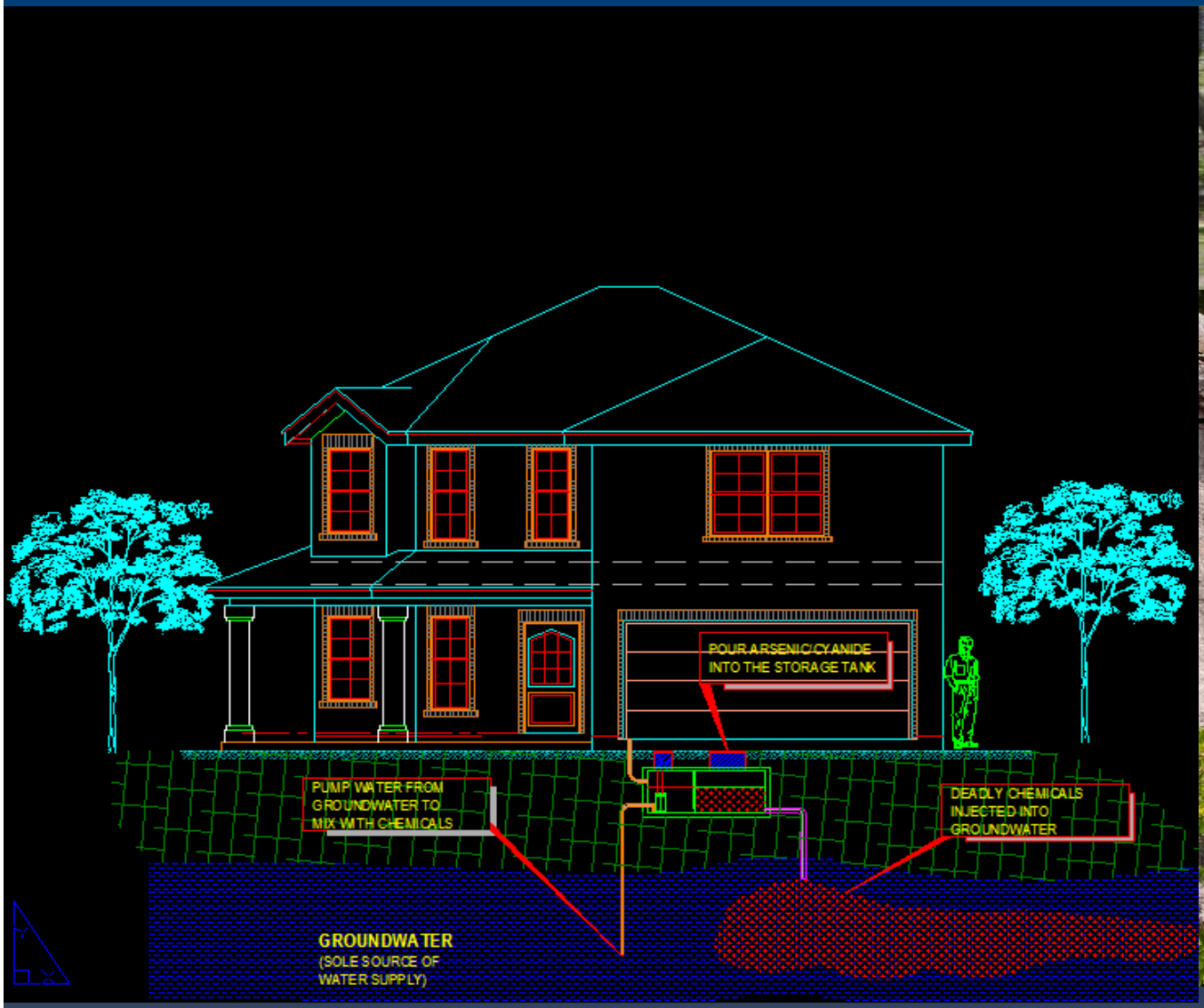
TERRORIST SCENARIOS : *ACQUIRING DEADLY CHEMICALS*

(1)

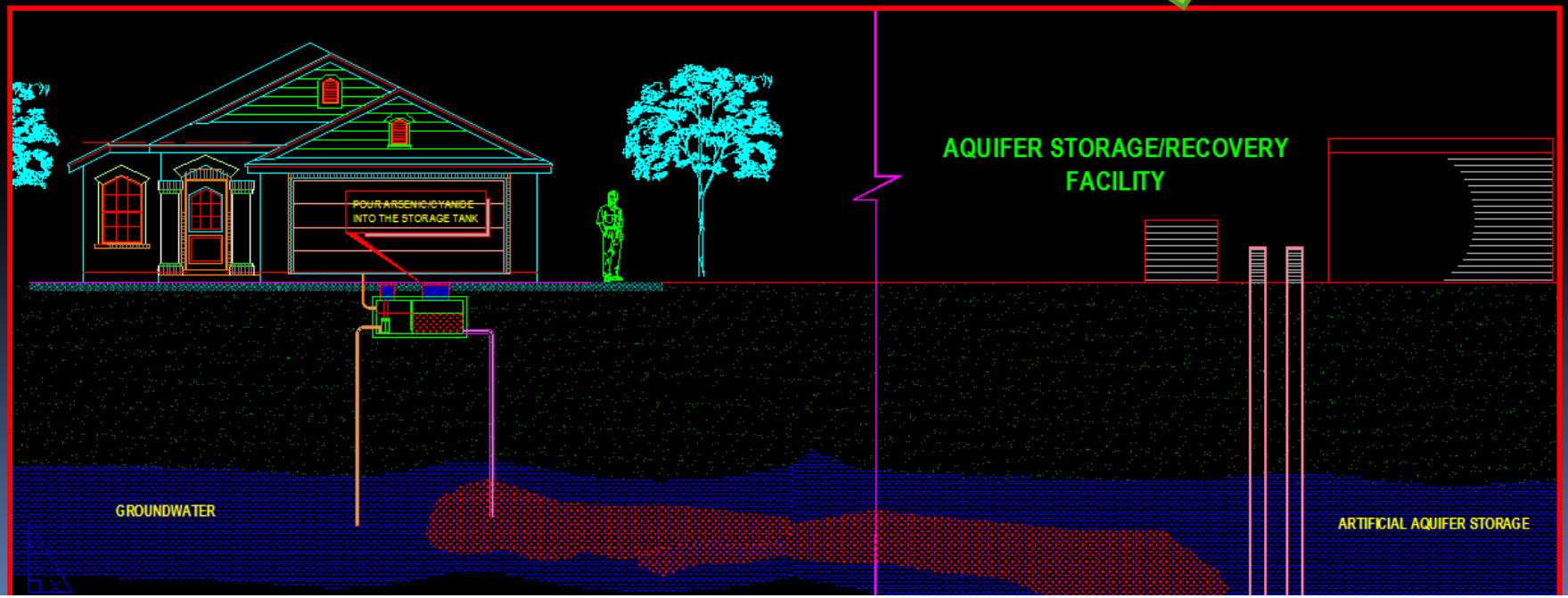
(2)



TERRORIST SCENARIOS



TERRORIST SCENARIOS



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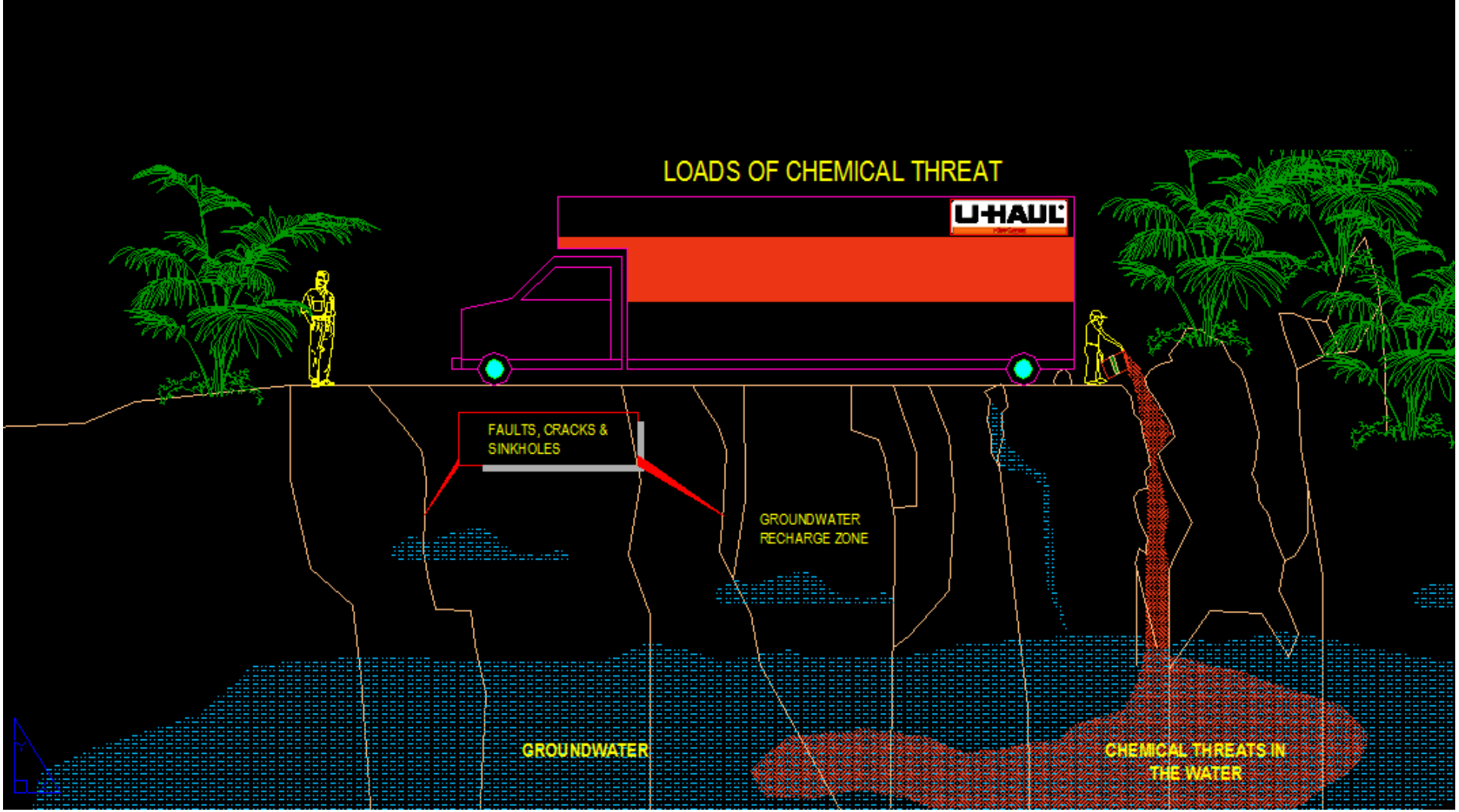

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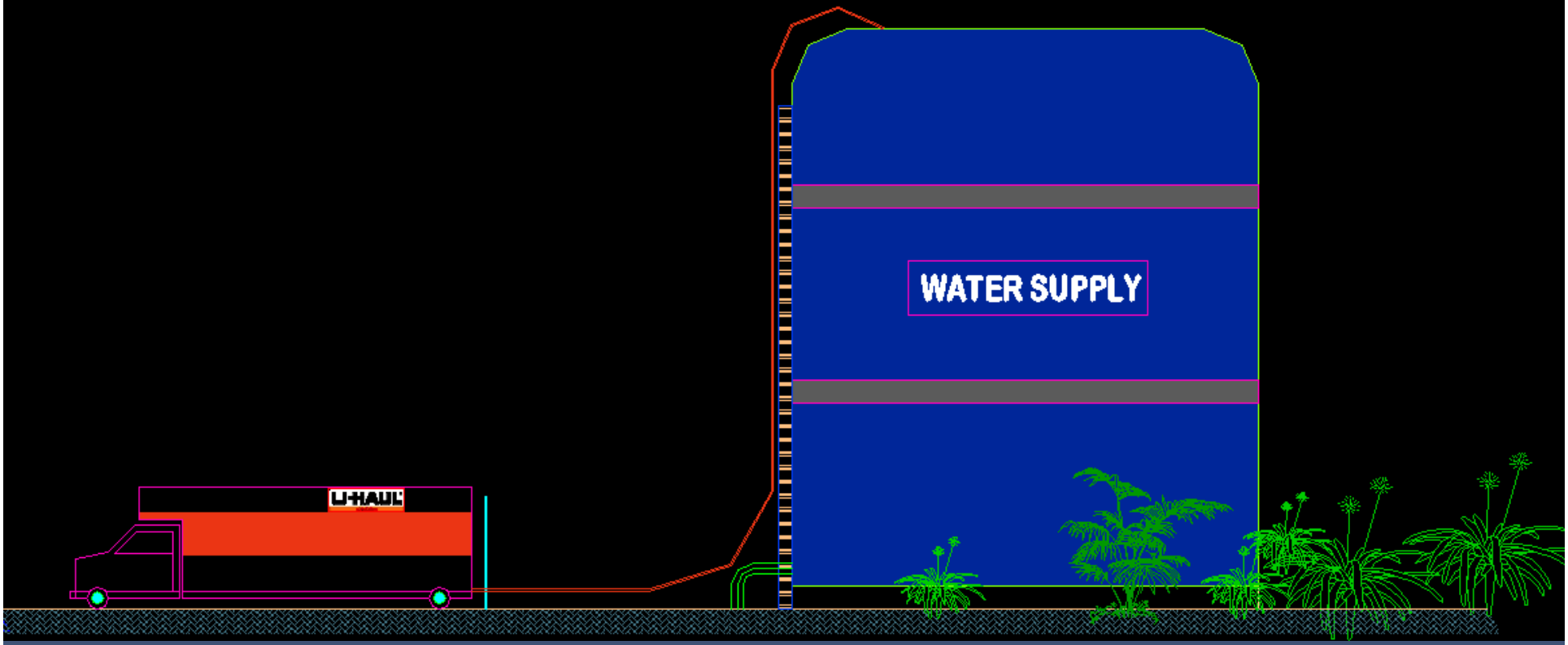

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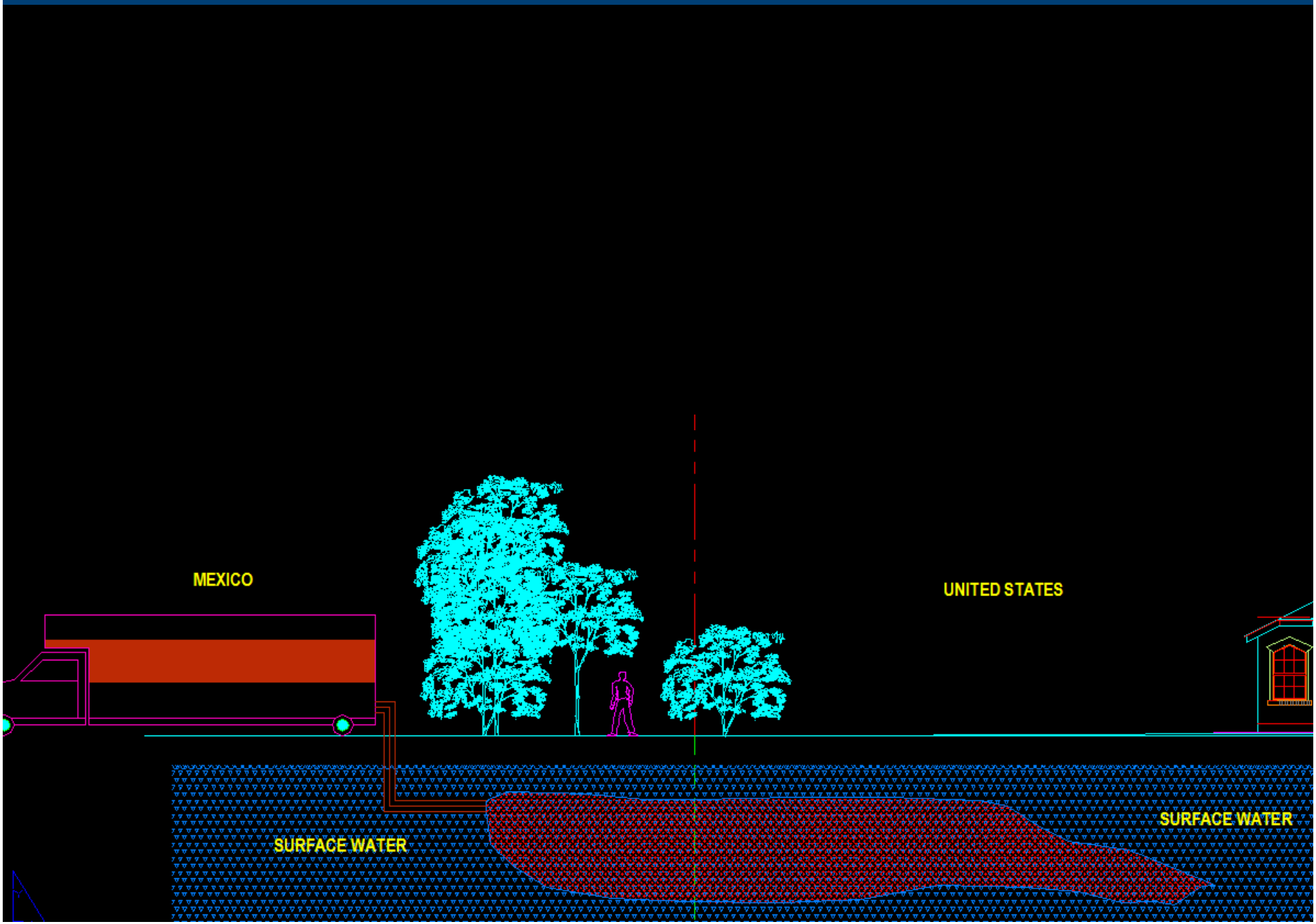


FIVE STEPS OF RISK ESTIMATION

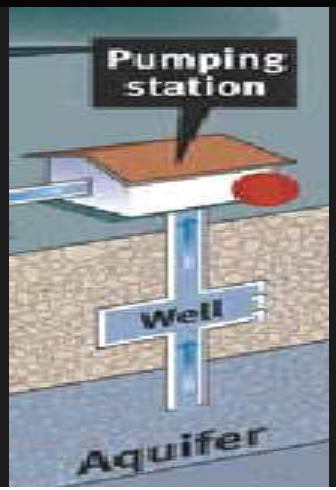
1.) **C**ausative event,
2.) **O**utcome,
3.) **E**xposure,
4.) **C**onsequence and
5.) **V**alue of consequence

PROCESS OF RISK ESTIMATION		
1	Causative Events	a. Terrorist intrusion to Aquifer Recharge Area b. Terrorist intrusion to water supply system/facilities c. Terrorist purchased and rented homes on top of Recharge Zone d. Terrorist rented/purchased agricultural properties adjacent or on top of "Artificial Aquifer Recharge/Recovery" (ASR) Area (e.g. Twin Oak ASR Facility- *According to San Antonio Water System (SAWS) Most land directly above the underground reservoir can continue its prior use and land can be leased.)* e. Terrorist (intrusion) purchased and rented properties near Future Water Supply Projects (e.g. Carizo Aquifer, Brackish Groundwater, LCRA: Highland Lakes)
2	Outcome	a. Dumping or Injection of Large Quantity of Chemical Threats (Cyanide & Arsenic) in Aquifer Recharge area. b. Injection of Chemical Threats (Cyanide & Arsenic) in water storage system/water facilities (e.g. ASR, Winwood Tank Station, Oliver/Bulverde Sneckner Ranch)
3	Exposure (s)	a. Chemical in Aquifer Recharge area: *i. Chemical mixed in water supply system* *ii. Chemical mixed with chlorine in the treated water then formed another poisonous compound* *iii. Chemical will not be oxidized by chlorine* iv. *Chemical mixed with other chemical compounds in the water* v. *Chemical diluted in some areas* b. Chemical in Water Supply System/Storage Facilities : *i. Chemical mixed in water supply* *ii. Chemical mixed with chlorine in the treated water then formed another poisonous compound* *iii. Chemical will not be oxidized by chlorine* c. Chemical in Alternative/Future Water Supply *i. Chemical mixed in water system* *ii. Chemical mixed with other chemical compounds present in the water* *iii. Chemical will not be oxidized by chlorine*
4	Consequence (s)	a. Catastrophic Health Effects to Human *i. Cyanide: (Short Term Effect) Damage Nervous System and Other disease. Immediately cause death.* *ii. Arsenic: (Long Term Effect) slowly cause death and Cancer.* b. Disrupt downstream commercial, agriculture and industry infrastructure: *i. Contaminate Livestock in Bexar County* *ii. Contaminate agricultural products* *iii. Contaminate and destruction of food supply* *iv. Contaminate water for commercial use: Restaurants, Fast Food, supermarkets and other businesses.* c. Injury to animals and aquatic organisms dependent to water systems in the recharge area (including endangered species). d. May create irreversible damage to Edwards Aquifer and other water supply system (e.g. ASR Twin Oaks, Storage Tanks, and future water
5	Consequence Value(s)	a. Revision or change in policy b. Provide intrusion detection technology c. Increase Surveillance d. Improve Intelligence e. Provide funding for research on improving technology and policy

AN EXAMPLE OF EVENTS IN A RISK PATHWAY

HAZARD → **OUTCOME** → **EXPOSURE** → **CONSEQUENCE**

HAZARD	OUTCOME	EXPOSURE	CONSEQUENCE
TERRORISM INSIDE RECHARGE ZONE	INJECTION OF TOXIC CHEMICAL (e.g. CYANIDE) INTO THE GROUNDWATER & WATER SUPPLY SYSTEM	POLLUTION TO DRINKING WATER RESERVES	INJURY TO PUBLIC



EVALUATION OF RISK RATES/FACTORS

1.) Fatal Motor Vehicle Accidents Data-
from US Census Bureau & National Highway Traffic Safety Administration (NHTSA).
(These rates are also compared and based upon Department of Homeland Security).

2.) Engineering Judgment

3.) Engineering Judgment with Pareto Principle (80-20 Rule).

EVALUATION OF RATE/FACTOR BASED UPON DATA FROM USCB, NHTSA & DHS

For a particular class of events *i*, such as motor vehicle accidents or commercial passenger aircraft accidents, a number of such accidents or event Ni will occur is a given period of years t_i. The mean number of accidents per year N_i, is computer by the formula

$$\overline{N} = \frac{N_i}{t_i} = \quad \text{mean number of accidents or events per year}$$

a number of consequence measures for consequences of different nature:

F_{ij} = number of total fatalities for accidents *ij*

F_{ij1} = number of total fatalities under voluntary risk conditions

F_{ij2} = number of total fatalities under involuntary risk conditions

I_{ij} = number of total injuries

I_{ij1} = number of total injuries-voluntary risk

I_{ij2} = number of total injuries-involuntary risk

D_{ij} = cost of event in dollars

$$F_{ij1} + F_{ij2} = F_{ij}$$

$$I_{ij1} + I_{ij2} = I_{ij}$$

The mean number of fatalities, injuries, or costs is derived for each factor by taking the sum of the magnitude of each event and dividing it by the number of events in question. Thus,

$$\overline{F} = \frac{1}{N_i}\sum_j F_{ij} = \text{mean number of fatalities, per accident of type } i$$

$$\overline{F} = \frac{1}{N_i}\sum_j F_{ij1} = \text{mean number of fatalities, voluntary risk}$$

$$\overline{F} = \frac{1}{N_i}\sum_j F_{ij2} = \text{mean number of fatalities, involuntary risk}$$

EVALUATION OF RATE/FACTOR BASED UPON DATA FROM USCB, NHTSA & DHS

The populations at risk are denoted as follows:

P_i = total population at risk

P_{i1} = population subject to voluntary risks

P_{i2} = population subject to involuntary risks

Then the number of fatalities, injuries, and costs per year for each class of accident or event is of the form,

$\overline{N}_i \times \overline{F}_i$ = mean number of fatalities per year

$\overline{N}_i \times \overline{I}_i$ = mean number of injuries per year

$\overline{N}_i \times \overline{D}_i$ = mean year costs

The risk to an individual is

$$\overline{f}_i = \frac{\overline{N}_i \times \overline{F}_i}{P_i} = \text{mean probability of death to an individual at risk per year}$$

$$\overline{k}_i = \frac{\overline{N}_i \times \overline{I}_i}{P_i} = \text{mean probability of Injury to an individual at risk per year}$$

The death rate per 100,000 people at risk f_i is,

$$f_i = \overline{f}_i \times 10^5 = \frac{N_i \times \overline{F}_i \times 10^5}{\overline{P}_i}$$

and injury rate per 100,000 people at risk k_i is,

$$k_i = \overline{k}_i \times 10^5 = \frac{N_i \times \overline{I}_i \times 10^5}{\overline{P}_i}$$

The voluntary and involuntary risk rates can be found accordingly.

EVALUATION OF RISK RATE/FACTOR BASED UPON DATA FROM USCB, NHTSA

Item	1990	1995	2000	2001	2002	2003	2004	2005	2006
Fatal crashes, total	39,836	37,241	37,526	37,862	38,491	38,477	38,444	39,252	38,588
One vehicle involved	23,445	21,250	21,117	21,510	22,164	21,775	21,836	22,678	22,711
Two or more vehicles involved	16,391	15,991	16,409	16,352	16,327	16,702	16,608	16,574	15,877
Persons killed in fatal crashes \1	44,599	41,817	41,945	42,196	43,005	42,884	42,836	43,510	42,642
Occupants	37,134	35,291	36,348	36,440	37,375	37,341	37,304	37,646	36,902
Drivers	25,750	24,390	25,567	25,869	26,659	26,779	26,871	27,491	27,323
Passengers	11,276	10,782	10,695	10,469	10,604	10,458	10,355	10,069	9,473
Other	108	119	86	102	112	104	78	86	106
Nonoccupants	7,465	6,526	5,597	5,756	5,630	5,543	5,532	5,864	5,740
Pedestrians	6,482	5,584	4,763	4,901	4,851	4,774	4,675	4,892	4,784
Pedalcyclists	859	833	693	732	665	629	727	786	773
Other/unknown	124	109	141	123	114	140	130	186	183
Occupants killed by vehicle type:									
Passenger cars	24,092	22,423	20,699	20,320	20,569	19,725	19,192	18,512	17,800
Mini-compact (95 inches)	3,556	2,207	1,113	887	813	636	599	452	414
Subcompact (95 to 99 inches)	4,753	4,584	3,660	3,571	3,435	3,081	2,718	2,536	2,216
Compact (100 to 104 inches)	5,310	6,899	7,022	6,731	7,061	6,769	6,650	6,288	6,044
Intermediate (105 to 109) inches	4,849	4,666	5,204	5,402	5,514	5,583	5,667	5,571	5,420
Full-size (110 to 114) inches	2,386	2,116	2,287	2,344	2,434	2,451	2,354	2,491	2,508
Largest (115 inches and over)	2,249	1,297	897	864	828	782	807	796	769
Unknown	989	654	516	521	484	423	397	378	429
Motorcycles	3,129	2,114	2,783	3,077	3,150	3,583	3,827	4,418	4,654
Other motorized cycles	115	113	114	120	120	131	201	158	156
Light trucks \2	8,601	9,568	11,526	11,723	12,274	12,546	12,674	13,037	12,721
Pickup	5,979	5,938	6,003	6,139	6,100	5,957	5,838	6,067	5,984
Utility	1,214	1,935	3,358	3,530	4,031	4,483	4,760	4,831	4,910
Van	1,154	1,639	2,129	2,019	2,109	2,080	2,046	2,112	1,802
Other	254	56	36	35	34	26	30	27	25
Large trucks \3	705	648	754	702	689	726	766	804	805
Medium trucks	134	96	106	82	87	82	99	118	107
Heavy trucks	571	552	648	620	602	644	667	686	698
Buses	32	33	22	34	45	41	42	58	27
Other vehicles	296	307	401	401	424	477	512	492	499
Unknown	164	85	49	63	104	112	90	167	240
Persons involved in fatal crashes	107,777	102,102	100,716	101,175	101,784	101,862	100,760	101,262	98,040
Occupants	99,297	94,621	94,325	94,706	95,403	95,470	94,579	94,614	91,557
Drivers	58,893	56,164	57,280	57,586	58,113	58,517	58,395	59,220	57,695
Passengers	40,229	38,252	36,889	36,892	37,080	36,743	35,992	35,231	33,665
Other	175	205	156	228	210	210	192	163	197
Nonoccupants	8,480	7,481	6,391	6,469	6,381	6,392	6,181	6,648	6,483
Vehicle miles traveled (VMT) (billion)	2,144	2,423	2,747	2,797	2,856	2,890	2,965	2,989	3,014
Licensed drivers (1,000)	167,015	176,628	190,625	191,276	194,602	196,166	198,889	200,549	202,810
Registered vehicles (1,000)	184,275	197,065	217,028	221,230	225,685	230,788	237,949	245,628	251,423
Percent distribution of fatal accidents by									
the highest blood alcohol concentration									
(BAC) in accident:									
0.00 percent	49.5	57.7	58.7	58.9	59.2	60.2	60.5	59.5	58.7
0.01 to 0.07 percent	6.5	5.7	5.9	5.9	5.6	5.6	5.4	5.6	5.8
0.08 percent and over	44.0	36.7	35.4	35.2	35.3	34.3	34.2	34.9	35.6
Fatalities per 100,000 resident									
Under 5 years old	4.9	4.3	3.7	3.4	3.1	3.1	3.2	2.9	2.8
5 to 15 years old	6.4	6.0	4.7	4.3	4.3	4.4	4.4	3.9	3.6
16 to 24 years old	35.2	30.7	28.5	28.6	29.3	28.1	27.7	27.5	27.2
25 to 44 years old	19.7	17.2	16.1	16.2	16.2	16.0	15.8	16.3	16.1
45 to 64 years old	14.9	13.6	13.8	13.5	13.8	14.0	13.9	14.3	13.9
65 to 79 years old	18.8	18.5	17.1	17.1	17.0	16.3	16.3	16.3	14.8
80 years old and over	26.8	28.0	25.0	24.5	23.3	24.5	22.4	21.4	19.5
Fatalities per 100 million VMT \4	2.1	1.7	1.5	1.5	1.5	1.5	1.4	1.5	1.4
Fatalities per 100,000 licensed drivers	26.7	23.7	22.0	22.1	22.1	21.9	21.5	21.7	21.0
Licensed driver per person	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
VMT \4 per registered vehicle	11,637	12,294	12,657	12,644	12,653	12,522	12,461	12,168	11,988
Fatalities per 100,000 registered vehicles	24.2	21.2	19.3	19.1	19.1	18.6	18.0	17.7	17.0
Fatal crashes per 100 million VMT \4	1.9	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.3
Involved vehicles per fatal crash	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.5	1.5
Fatalities per fatal crash	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Fatalities per 100,000 resident	17.9	15.9	14.9	14.8	14.9	14.8	14.6	14.7	14.2
Source: U.S. National Highway Traffic Safety Administration,									
Fatality Analysis Reporting System, annual.									
See \<http://www-nrd.nhtsa.dot.gov/CATS/index.aspx\>.									
US Population	248,709,873	261,638,000	282,192,162	285,102,075	287,941,220	290,788,976	293,655,404	296,507,061	299,398,484

EVALUATION OF RISK RATE/FACTOR BASED UPON DATA FROM USCB, NHTSA

ITEM	Mean No. of Accidents (1990-2006)	Magnitude (Deaths/Event) Mode	Maximum	Average	Frequency (Event/Year)	Probability Death for One Individual	Voluntary Risk Mean Number Per Year	Voluntary Risk Risk Rate	Involuntary Risk Mean Number Per Year	Involuntary Risk Risk Rate
Fatal crashes, total	38,413	-	-	-	38,413	1.36E-04	38,413			
One vehicle involved	22,054	-	-	-	22,054	7.80E-05	22,054			
Two or more vehicles involved	16,359	-	-	-	16,359	5.78E-05	16,359			
Persons killed in fatal crashes \1	42,826	117	44,599.0	25,696	1.115	1.51E-04	42,826			
Occupants	36,865	101	37,646.0	22,119	9.60E-01	1.30E-04	29,492	1.30E-04	7373	1.33E-04
Drivers	26,300	72	27,491.0	15,780	6.85E-01	9.30E-05	21,040	9.30E-05	5260	9.72E-05
Passengers	10,465	29	11,276.0	6,279	2.72E-01	3.70E-05	8,372	3.70E-05	2093	3.99E-05
Other	100	0	119.0	60	2.61E-03	3.54E-07	80	3.54E-07	20	4.21E-07
Nonoccupants	5,961	16	7,465.0	3,577	1.55E-01	2.11E-05	1,192	2.11E-05	4769	2.64E-05
Pedestrians	5,078	14	6,482.0	3,047	1.32E-01	1.80E-05	1,016	1.80E-05	4063	2.29E-05
Pedalcyclists	744	2	859.0	446	1.94E-02	2.63E-06	595	2.63E-06	149	3.04E-06
Other/unknown	139	0	186.0	83	3.62E-03	4.91E-07	111	4.91E-07	28	6.58E-07
Occupants killed by vehicle type:										
Passenger cars	20,370	56	24,092.0	12,222	5.30E-01	7.20E-05	16,296.2	5.76E-05	4074.0	8.52E-05
Mini-compact (95 inches)	1,186	3	3,556.0	712	3.09E-02	4.19E-06	949.1	3.35E-06	237.3	1.26E-05
Subcompact (95 to 99 inches)	3,395	9	4,753.0	2,037	8.84E-02	1.20E-05	2,715.9	9.60E-06	679.0	1.68E-05
Compact (100 to 104 inches)	6,530	18	7,061.0	3,918	1.70E-01	2.31E-05	5,224.4	1.85E-05	1306.1	2.50E-05
Intermediate (105 to 109) inches	5,320	15	5,667.0	3,192	1.38E-01	1.88E-05	4,255.6	1.50E-05	1063.9	2.00E-05
Full-size (110 to 114) inches	2,375	7	2,508.0	1,425	6.18E-02	8.39E-06	1,899.6	6.72E-06	474.9	8.87E-06
Largest (115 inches and over)	1,032	3	2,249.0	619	4.68E-02	6.35E-06	825.7	2.92E-06	206.4	7.95E-06
Unknown	532	1	989.0	319	1.39E-02	1.88E-06	425.9	1.51E-06	106.5	3.50E-06
Motorcycles	3,415	9	4,654.0	2,049	8.89E-02	1.21E-05	2,732.0	9.66E-06	683.0	1.65E-05
Other motorized cycles	136	0	201.0	82	3.55E-03	4.82E-07	109.2	3.86E-07	27.3	7.11E-07
Light trucks \2	11,630	32	13,037.0	6,978	3.03E-01	4.11E-05	9,304.0	3.29E-05	2326.0	4.61E-05
Pickup	6,001	16	6,139.0	3,600	1.56E-01	2.12E-05	4,800.4	1.70E-05	1200.1	2.17E-05
Utility	3,672	10.06	4,910.0	2,203	9.56E-02	1.30E-05	2,938.0	1.04E-05	734.5	1.74E-05
Van	1,899	5.20	2,129.0	1,139	4.94E-02	6.71E-06	1,519.1	5.37E-06	379.8	7.53E-06
Other	58	0.16	254.0	35	1.51E-03	2.05E-07	46.5	1.64E-07	11.6	8.98E-07
Large trucks \3	733	2.01	805.0	440	1.91E-02	2.59E-06	586.6	2.07E-06	146.6	2.85E-06
Medium trucks	101	0.28	134.0	61	2.64E-03	3.58E-07	81.0	2.86E-07	20.2	4.74E-07
Heavy trucks	632	1.73	698.0	379	1.65E-02	2.23E-06	505.6	1.79E-06	126.4	2.47E-06
Buses	37	0.10	58.0	22	9.66E-04	1.31E-07	29.7	1.05E-07	7.4	2.05E-07
Other vehicles	423	1.16	512.0	254	1.10E-02	1.50E-06	338.6	1.20E-06	84.6	1.81E-06
Unknown	119	0.33	240.0	72	3.11E-03	4.22E-07	95.5	3.37E-07	23.9	8.48E-07
Persons involved in fatal crashes	101,720	278.68	107,777.0	61,032	2.65E+00	4.10E-04	81,375.8	2.88E-04	20344.0	3.81E-04
Occupants	94,952	260.14	99,297.0	56,971	2.47E+00	3.83E-04	75,962.0	2.69E-04	18990.5	3.51E-04
Drivers	57,985	158.86	59,220.0	34,791	1.51E+00	2.34E-04	46,387.8	1.64E-04	11597.0	2.09E-04
Passengers	36,775	100.75	40,229.0	22,065	9.57E-01	1.48E-04	29,419.8	1.04E-04	7355.0	1.42E-04
Other	193	0.53	228.0	116	5.02E-03	7.78E-07	154.3	5.45E-07	38.6	8.06E-07
Nonoccupants	6,767	18.54	8,480.0	4,060	1.76E-01	2.73E-05	5,413.9	1.91E-05	1353.5	3.00E-05
Vehicle miles traveled (VMT) (billion)	2,758	7.56	3,014.0	1,655	7.18E-02	1.11E-05	2,206.7	7.80E-06	551.7	1.07E-05
Licensed drivers (1,000)	190,951	523.15	202,810.0	114,571	4.97E+00	7.70E-04	152,760.9	5.40E-04	38190.2	7.17E-04
Registered vehicles (1,000)	223,452	612.20	251,423.0	134,071	5.82E+00	9.01E-04	178,761.9	6.32E-04	44690.5	8.89E-04
Percent distribution of fatal accidents by the highest blood alcohol concentration (BAC) in accident:										
0.00 percent	58.09	0.16	60.5	35	1.51E-03	2.34E-07	46.5	1.64E-07	11.6	2.14E-07
0.01 to 0.07 percent	5.77	0.02	6.5	3	1.50E-04	2.33E-08	4.6	1.63E-08	1.2	2.30E-08
0.08 percent and over	36.15	0.10	44.0	22	9.41E-04	1.46E-07	28.9	1.02E-07	7.2	1.56E-07
Fatalities per 100,000 resident					0.00E+00	0.00E+00	0.0	0.00E+00	0.0	0.00E+00
Under 5 years old	3.49	0.01	4.9	2	9.08E-05	1.41E-08	2.8	9.87E-09	0.7	1.73E-08
5 to 15 years old	4.67	0.01	6.4	3	6.27E-03	9.71E-07	3.7	1.32E-08	0.9	2.26E-08
16 to 24 years old	29.20	0.08	35.2	18	7.60E-04	1.18E-07	23.4	8.26E-08	5.8	1.24E-07
25 to 44 years old	16.62	0.05	19.7	10	4.33E-04	6.70E-08	13.3	4.70E-08	3.3	6.96E-08
45 to 64 years old	13.97	0.04	14.9	8	3.64E-04	5.63E-08	11.2	3.95E-08	2.8	5.27E-08
65 to 79 years old	16.91	0.05	18.8	10	4.40E-04	6.82E-08	13.5	4.78E-08	3.4	6.65E-08
80 years old and over	23.93	0.07	28.0	14	2.02E-02	3.12E-06	19.1	6.77E-08	4.8	9.90E-08
Fatalities per 100 million VMT \4	1.57	0.00	2.1	1	4.08E-05	6.31E-09	1.3	4.43E-09	0.3	7.42E-09
Fatalities per 100,000 licensed drivers	22.53	0.06	26.7	14	5.86E-04	9.08E-08	18.0	6.37E-08	4.5	9.44E-08
Licensed driver per person	0.69	0.00	0.7	0	1.81E-05	2.80E-09	0.6	1.96E-09	0.1	2.47E-09
VMT \4 per registered vehicle	12,336.00	33.80	12,657	7,402	3.21E-01	4.97E-05	9,868.8	3.49E-05	2467.2	4.47E-05
Fatalities per 100,000 registered vehicles	19.35	0.05	24.2	12	5.04E-04	7.80E-08	15.5	5.47E-08	3.9	8.55E-08
Fatal crashes per 100 million VMT \4	1.41	0.00	1.9	1	3.67E-05	5.69E-09	1.1	3.99E-09	0.3	6.72E-09
Involved vehicles per fatal crash	1.49	0.00	1.5	1	3.88E-05	6.01E-09	1.2	4.21E-09	0.3	5.30E-09
Fatalities per fatal crash	1.10	0.00	1.1	1	2.87E-05	4.44E-09	0.9	3.11E-09	0.2	3.91E-09
Fatalities per 100,000 resident	15.19	0.04	17.9	9	3.95E-04	6.12E-08	12.1	4.29E-08	3.0	6.33E-08

Source: U.S. National Highway Traffic Safety Administration,
Fatality Analysis Reporting System, annual.
See \<http://www-nrd.nhtsa.dot.gov/CATS/index.aspx\>.

US Population	282,881,472.78									

EVENT TREE BASED UPON DATA FROM USCB, NHTSA & DHS

(GENERAL FORM)

Probability Estimation based on Probability Model
(Risk Rates based on USCB, DHS and NHTSA):

P(Epedemic by Aquifer Contamination) Risk Rate to break a fence = 0.01

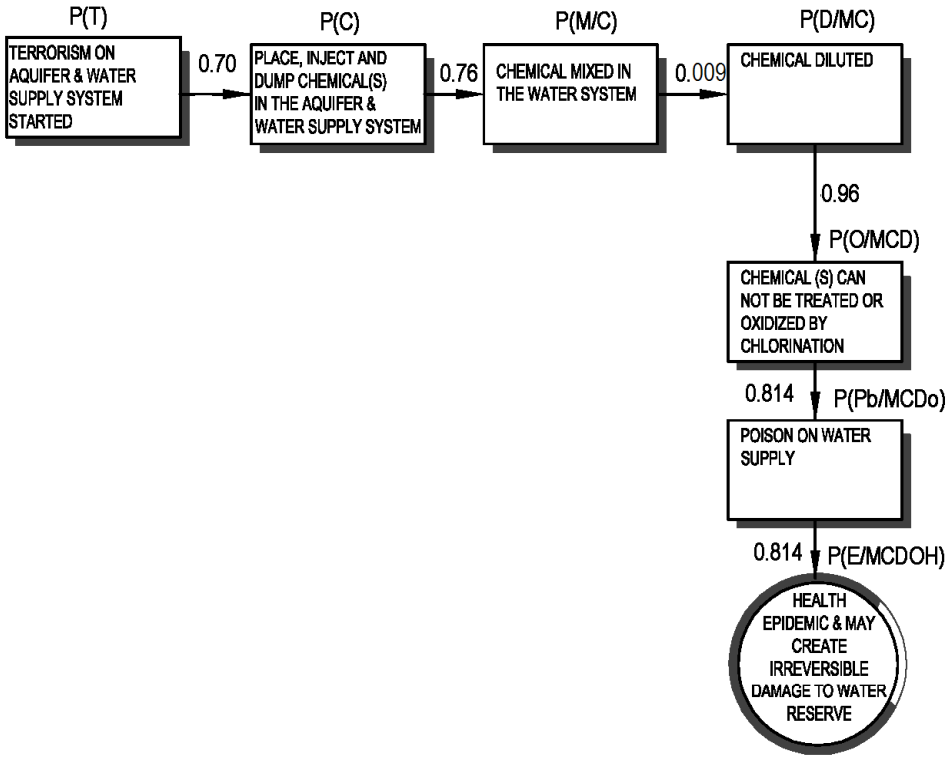
=[0.70 x 0.76 x 0.009 x 0.96 x 0.814 x 0.814]

$= 3.05 \times 10^{-5}$

FIGURE FT3

(GENERAL OUTLINE)
***EVENT TREE** FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM*

RISK ANALYSIS BASED UPON DATA FROM DEPT. OF HOMELAND SECURITY, US CENSUS BUREAU AND NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION



EVENT TREE BASED UPON ENGINEERING JUDGMENT

(GENERAL FORM)

Probability Estimation based on Probability Model (Engineering Judgment):

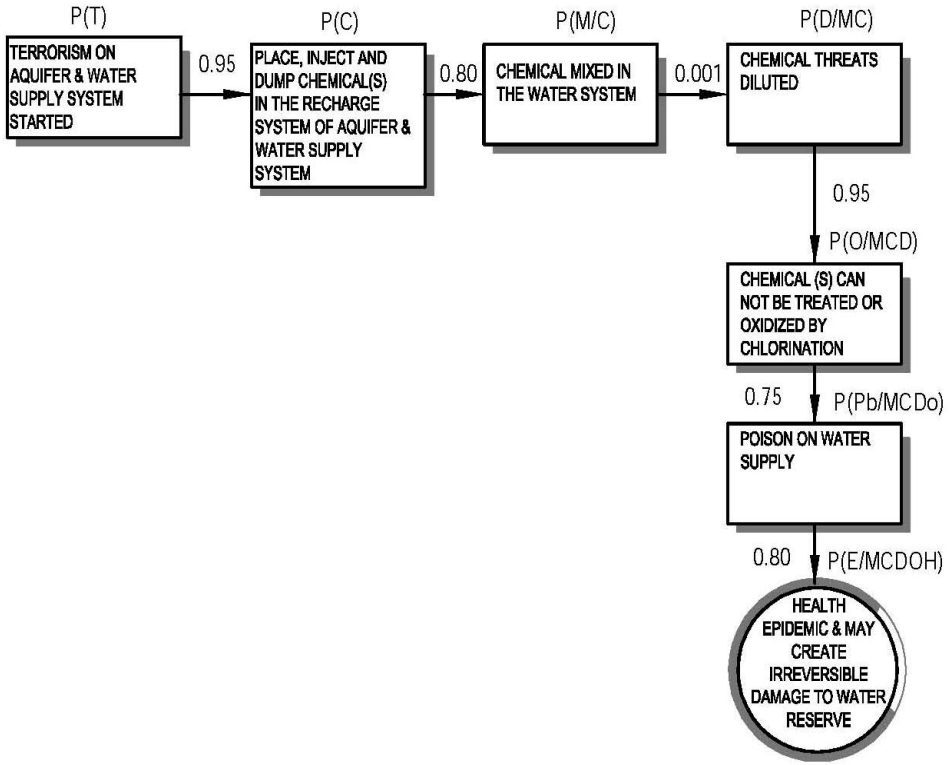
P(Epedemic by Aquifer Contamination)

Risk Rate to break a fence = 0.10

$=[0.95 \times 0.80 \times 0.001 \times 0.95 \times 0.75 \times 0.80] = 4.33 \times 10^{-5}$

FIGURE ET1

(GENERAL OUTLINE)
EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE USING RISK ANALYSIS BASED UPON ENGINEERING JUDGMENT



EVENT TREE BASED UPON ENGINEERING JUDGMENT WITH PARETO PRINCIPLE (80-20 RULE)

(GENERAL FORM)

Probability Estimation based on Probability Model (Engineering Judgment with Pareto Rule):

Risk Rate to break a fence = 0.20

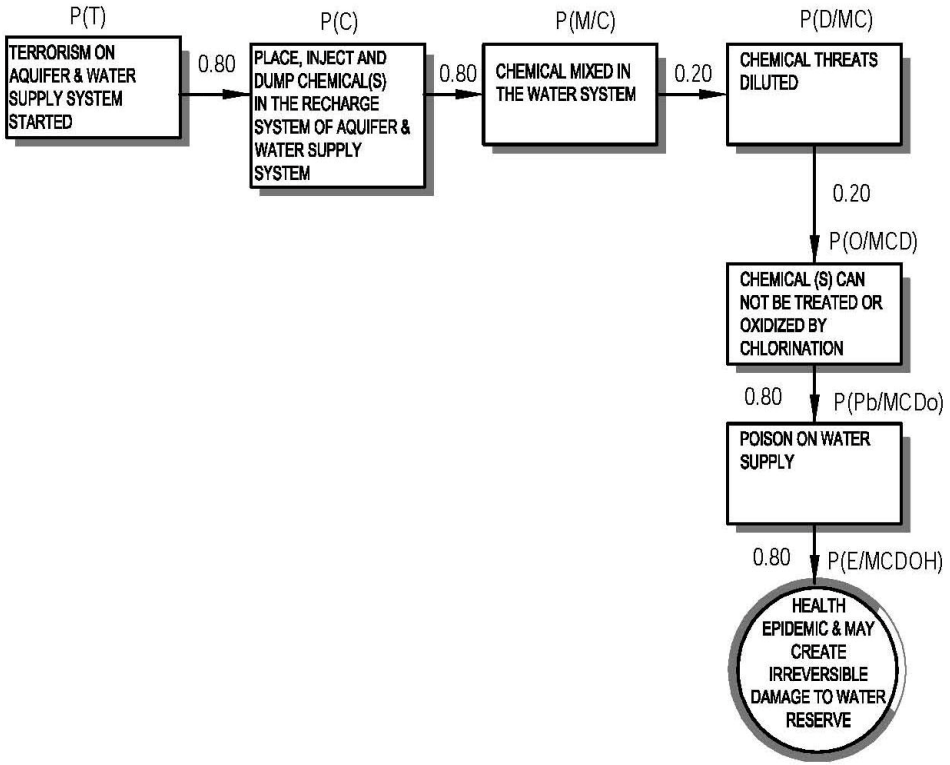
P(Epedemic by Aquifer Contamination)

$= [0.80 \times 0.80 \times 0.20 \times 0.20 \times 0.80 \times 0.80]$

$= 3.3 \times 10^{-3}$

FIGURE ET2

(GENERAL OUTLINE)
EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE USING RISK ANALYSIS BASED FROM ENGINEERING JUDGMENT WITH PARETO PRINCIPLE



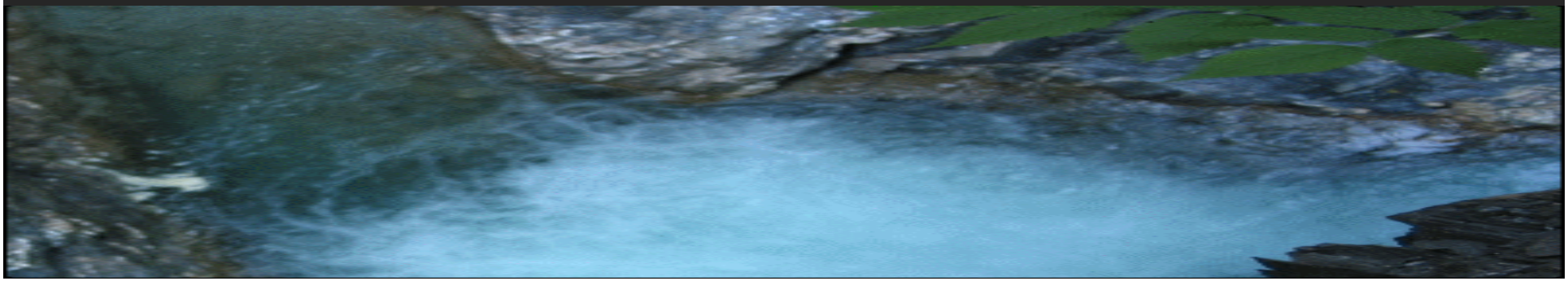
RISK ACCEPTABILITY ANALYSIS EMBEDDED WITH CUMULATIVE PROSPECT THEORY

Determines what level of Incremental risk is acceptable or allowed by Society for Specific risk situations.

RISK PERCEPTION

The intuitive and cognitive ability of the normal individual are simply
swamped by this complexity, thereby forcing him to rely on simplified rules of thumb.
These simplified information-straining and decision making rules
often produce erroneous judgments.

"An anatomy of human perception and its effect on choice behavior based on experimental evidence is generalized in cumulative prospect theory."



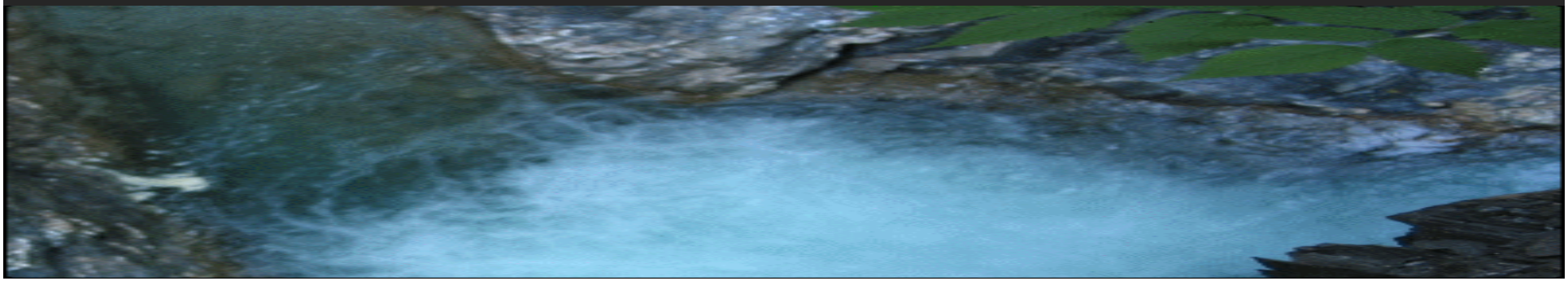
RISK ACCEPTABILITY ANALYSIS EMBEDDED WITH CUMULATIVE PROSPECT THEORY

Determines what level of Incremental risk is acceptable or allowed by Society for Specific risk situations.

RISK PERCEPTION

One of the most complete analyses, at least for the specific area of risk assessments, has been provided by Rowe. The factors for transforming objective reality in to subjective perception are summarized in the Table below:

Objective to Subjective Transformation Factors (Rowe, 1977)
Factors Involving Type of Consequences: • Voluntary or Involuntary • Discounting of Time • Identifiable of Statistical Risk Taker • Controllability
Factors Involving rupture of consequences: • Position in hierarchy of consequences • Ordinary or Catastrophic • Natural or man originated
Other Factors: • Magnitude of Probability of Occurrence • Propensity for Risk Taking



RISK ACCEPTABILITY ANALYSIS EMBEDDED WITH CUMULATIVE PROSPECT THEORY

Voluntary & Involuntary

Perception appears to be markedly effected by whether the risk is incurred by choice or not.

Discounting of Time

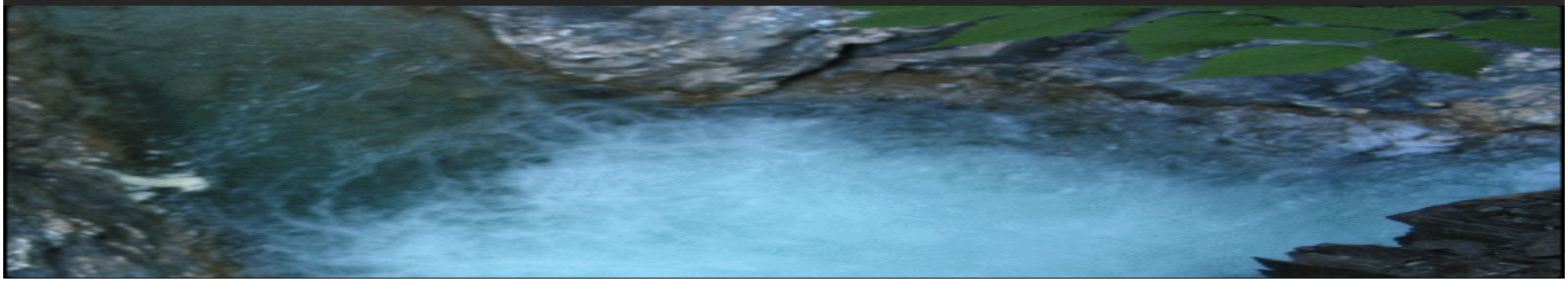
Events happening now tend to be valued higher than the same event sometime in the future.

Identifiable of statistical Risk Takers

Whether a risk will be taken (for imposed) on individuals or groups with which we identify or just a “number in the crowd” affects one’s perception.

Controllability

People appear to accept much higher risk when they feel that the situation is well controlled such as when they are driving the car.



RISK ACCEPTABILITY ANALYSIS EMBEDDED WITH CUMULATIVE PROSPECT THEORY

Position of Hierarchy of Consequence

The wish to avoid a consequence depends heavily on the perceived undesirability, i.e., position in a desirable-undesirable hierarchy, of the consequence

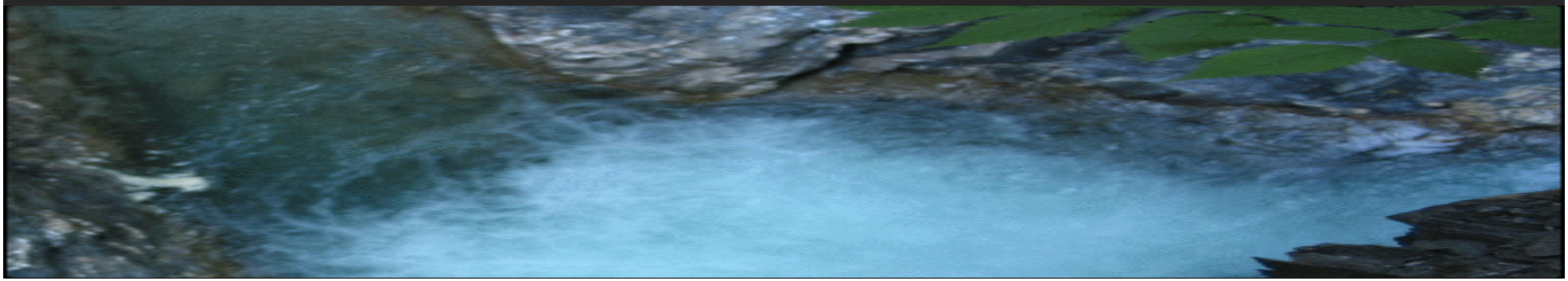
Consequence Hierarchy	
Lowest Priority	Self-Actualization
	Egocentric
	Belonging/Love
	Security
	Exhaustible Resources
	Security
	Exhaustible Resources
	Survival Factors
	Illness & Disability
Highest Priority	Death

Ordinary or Catastrophic

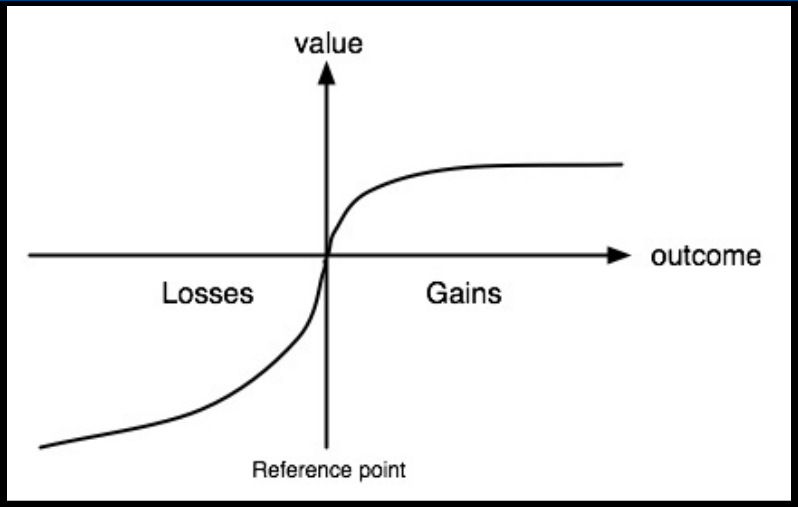
Large numbers of fatalities, etc, in a single accidents has much more pronounced impact than the same number of fatalities spread over a number of small accidents.

Natural or Man-Originated

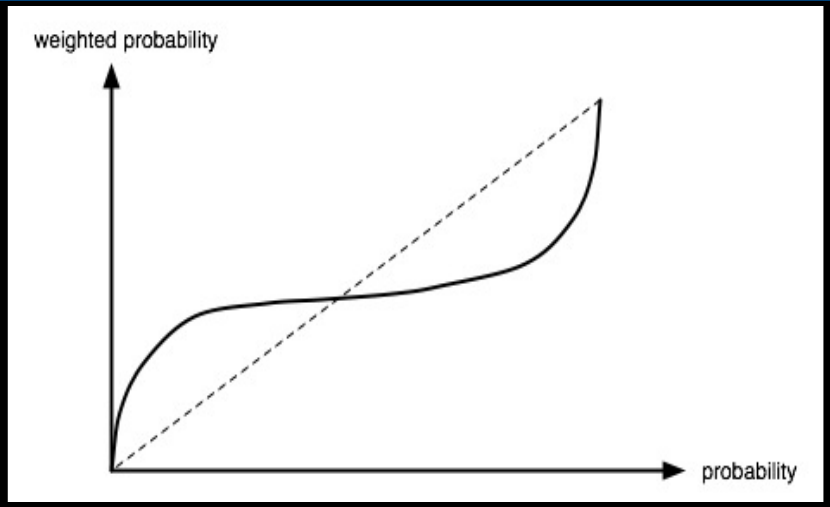
Risk imposed by natural cases tends to be much more easily tolerated than man-made risks probably because there are few if any alternatives to accepting the natural risk.



TVERSKY & KAHNEMAN'S CUMULATIVE PROSPECT THEORY



TYPICAL VALUE FUNCTIONS



TYPICAL WEIGHING FUNCTIONS

$$V(f) = \omega(p)v(x)$$

$V(f)$ = **Risk**

$\omega(p)$ = **decision weight associated with probability of occurrence**

$v(x)$ = **values associated with occurrence**

RISK ASSESSMENT

1. Develop Risk Estimates

2. Calculate Risk Referent:

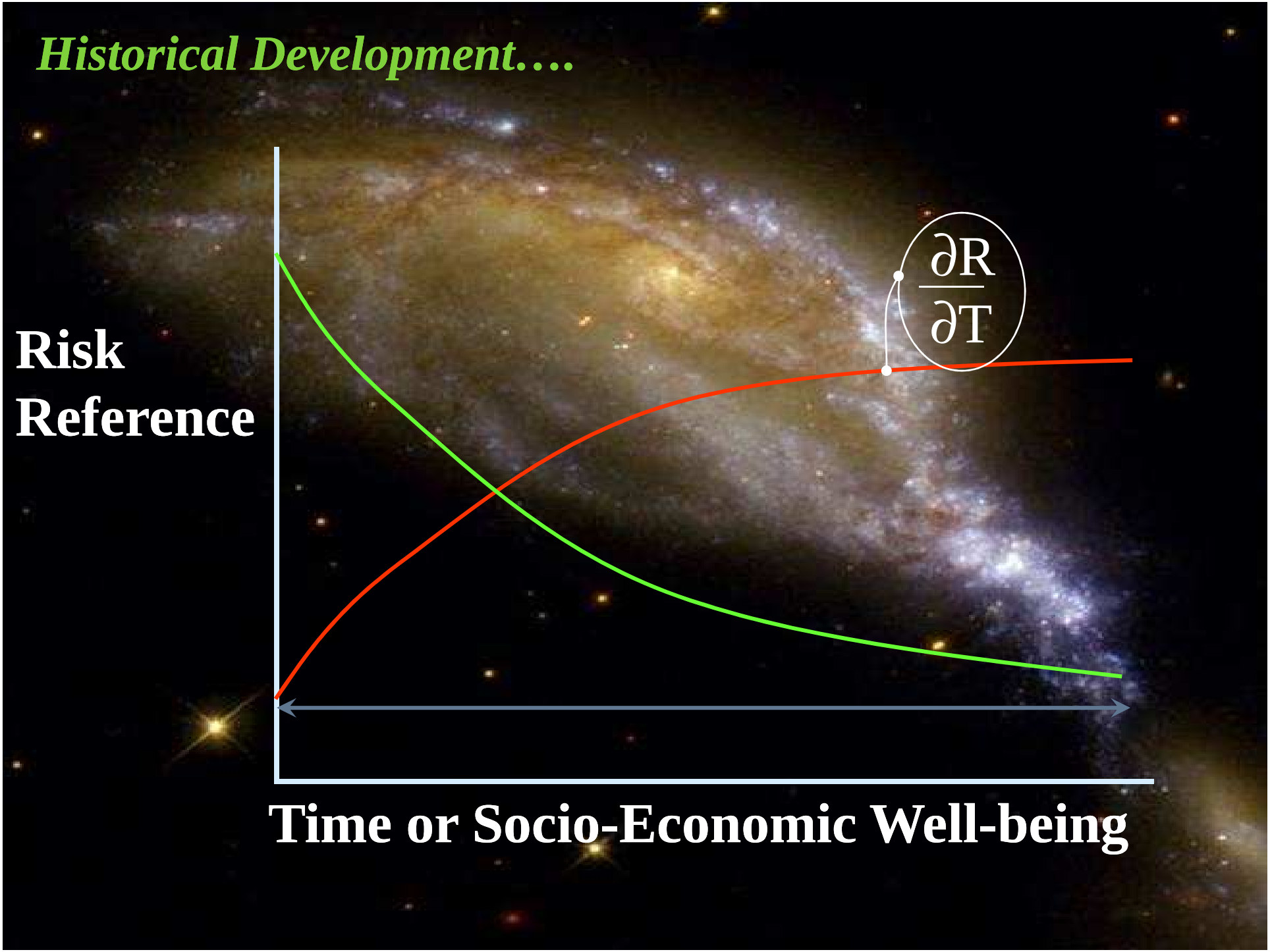
Historical Revealed Preference

Long Term Acceptable Risk Level = Risk Reference

$$\frac{\partial R}{\partial T}$$ = Risk Referent = Incremental Acceptable Level

3. Modify or Eliminate any Decision Branch whose estimate is more than one order of magnitude greater than the referent.

Historical Development….



ACCEPTABLE LEVEL OF RISK

1. *How Safe is Safe Enough?*
2. *Who are the Parties Determining the Acceptability?*

Risk Reference = Current Acceptable Risk

Risk Referent = Incremental Acceptable Risk

THE NEW RISK ASSESSMENT METHODOLOGY

RELATIONSHIP OF CUMULATIVE PROSPECT THEORY & RISK REFERENT

$$R = \omega(P) \times V(C)$$ ----------(1) *Cumulative Prospect Theory Equation*

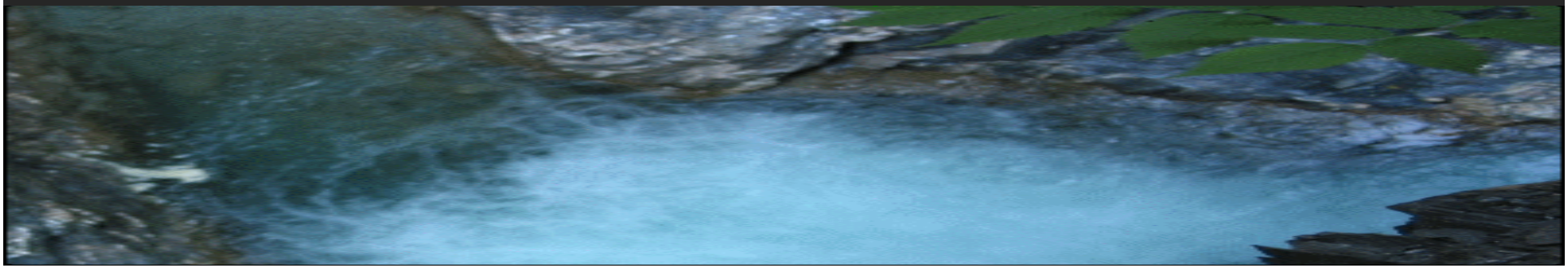
$V(c) =$ *Risk Reference* ----------(2) is a currently acceptable risk

$\omega(p) =$ *F1 x F2 x F3* ----------(3)

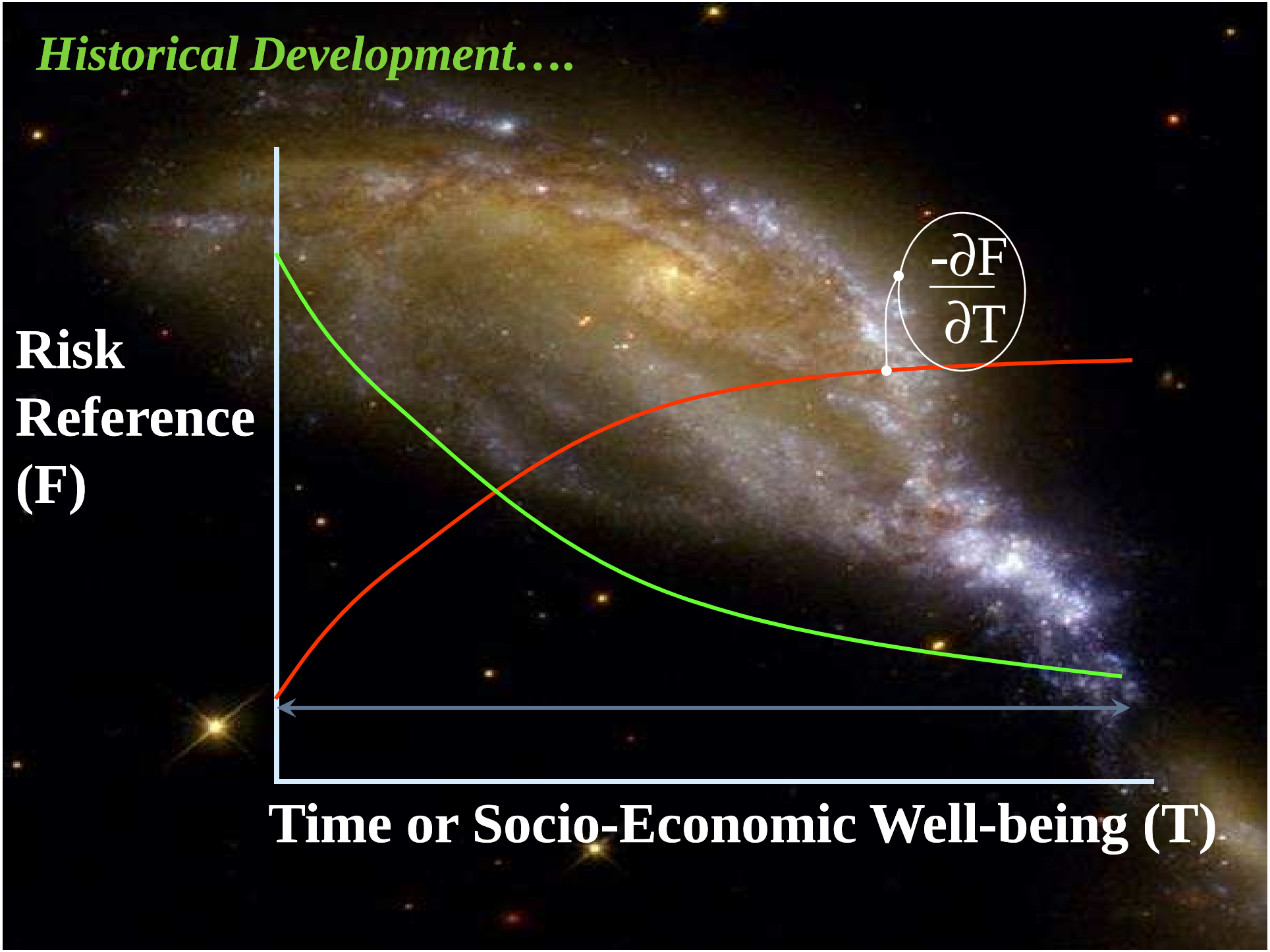
Therefore,

$$\textit{Risk Referent} *= \omega(p) \times V(c)$$

* R = *Risk Referent which is the incremental acceptable Risk in the United States at this time.*



Historical Development….



QUANTITATIVE REVEALED SOCIETAL PREFERENCES *EMBEDDED WITH CUMULATIVE PROSPECT THEORY*

STEP 1: Behavior and Risk Attitude

Societal preferences as revealed are used to provide a risk referent, based on the idea that "society is as what society does."

STEP 2: Establishing Risk Comparison Factors

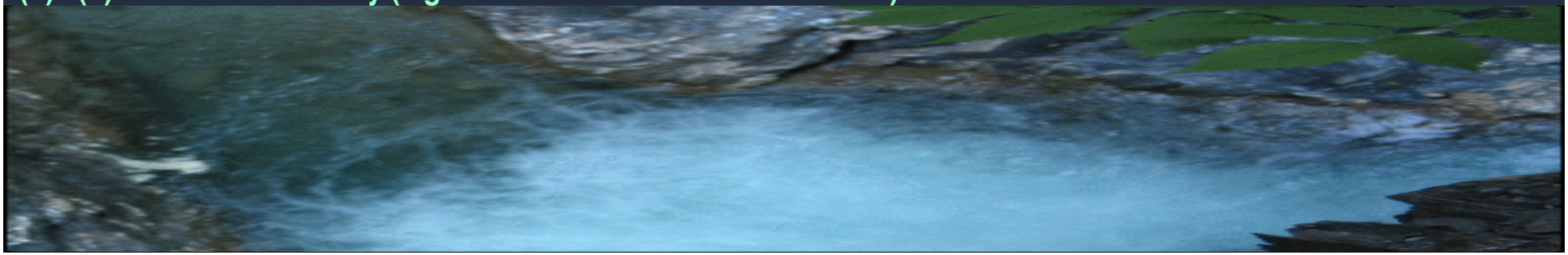
. Risk data are generally available for fatalities, illness, property damage, life shortening, and productive days lost, which can be measured with reasonable objectivity.

"Nevertheless, there is not enough risk data for terrorism → *Therefore data of fatal motor vehicle accidents data will be utilized for Risk Analysis for terrorist attacks on Critical Infrastructure in the United States."*

Additional area involves on consequences of types that are less amenable to objective measures, such as those involving aesthetic values and quality of life.

Recently, the USEPA actually list four (4) major life factors (USEPA Quality of Life Indicators,2009) :

(a) Household and Environmental Economic Condition (e.g. Adequate income and job opportunities);
(b) (b) Health (e.g. Safety and Environmental Sustainability);
(c) (c) Natural Resources and Amenities and
(d) (d) Vibrant Community (e.g. attracts businesses and retirees).



QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

STEP 3: Controllability of Risk

(a) Increase ability to control risk in terms of one's perception of controllability as an individual,

(b) the degree of systematic control provided by technological and institutional processes generally are expected to make value of consequences and risk acceptability somewhat higher.

…On the other hand, society is becoming increasingly serious in requiring that sophisticated technology be used to protect the population.

Reduction of risk is in itself considered to be a benefit.

Three main classes of benefit:

(a) Materialistic (economic survival);

(b) (b) Physical Protection and Security (e.g. protection from terrorist attacks);

(c) Self-advancement (free from chaos and distress).

QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

STEP 4: Benefit-Cost Balance

A BENEFIT-COST (BALANCE)

The first step consists of a broad, gross comparison of gains and losses, direct and indirect, to determine whether the undertaking for which the analysis is made is such that direct gains outweigh direct losses and indirect gains and losses can be balanced or inequities reasonably ameliorated.

EXAMPLE :

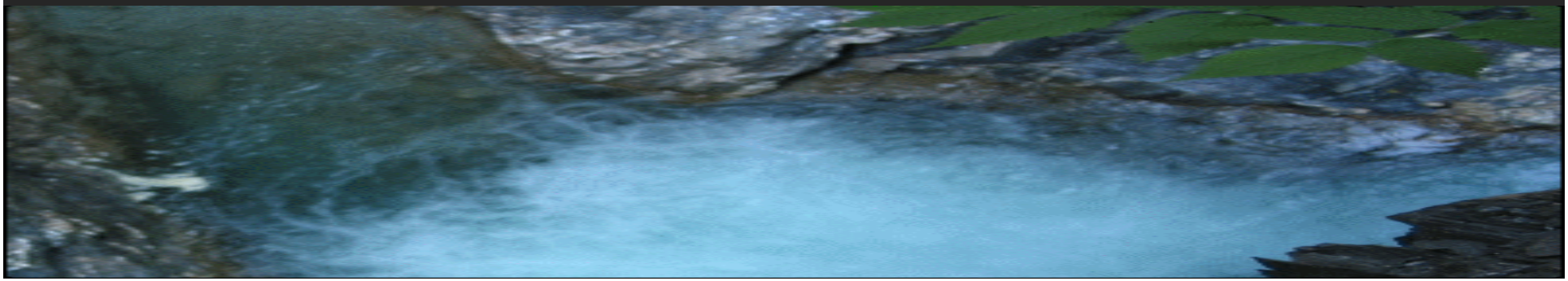
MOST FAVORABLE: CAR

FAVORABLE: HIGHWAY SYSTEM

MARGINAL FAVORABLE: SMOKER

MARGINAL UNFAVORABLE: SECOND-HAND SMOKER.

MOST UNFAVORABLE: TERRORISM



QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

STEP 5: Cost – Risk Rate/Factor and Risk Reference Determination

Interrelationships Among Risk Factors Based on Differences in Voluntary and Involuntary Risks (Rowe, 1977)

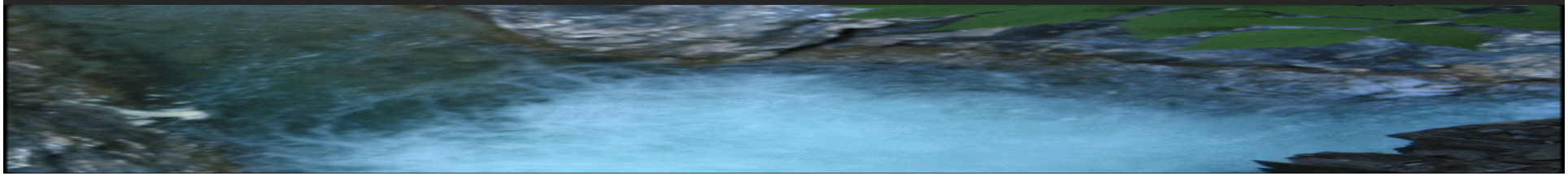
BENEFITS	RISK FACTORS	
	Voluntary: Risk-Benefit Tradeoffs Possible on Direct Basis	Involuntary: Inequities Prevent Direct Risk-Benefit Tradeoffs
Avoidability and availability of alternatives	Avoidable by definition Existence of alternatives makes game theory possible, although expected utility is only one criterion for decision All alternatives undesirable; becomes more like an involuntary risk	***Unavoidable: no alternatives but*** reduction in exposure possible Natural Risk: act of God (minimize exposure) Manmade risk: risk/benefit inequity (minimize exposure and flight) ***Unavoidable: only alternative to flee*** Natural risk: perceived degree of Control Man-made risk: perceived degree of control and flight based on degree of satisfaction with status quo ***Avoidable risk: other alternatives*** Spatial distribution; spread risk, insurance, etc Controllability; reduce risk, implemented systemic control for man-made risk
Time discount	5%per year or higher; risk to progeny discounted only if new children not sought	Less than 1%per year; No discount for irreversible risk or risk of progeny
Statistical distribution	Depends on individual propensity for risk and perceived degree of satisfaction with status quo	Avoidable; may not happen to risk taker; not only one at risk (i.e., risk takers, statistical risk)
Controllability	Random vs. perceive degree of control Degree of systemic control Man-made vs. natural	***Unavoidable***, no alternatives except flee or flight, if manmade; perceived degree of personal control ***Unavoidable***, but can reduce exposure (probability and magnitude of consequences); degree of systemic control and flight (if man-made) Avoidable; existence of alternatives; perceived degree of personal control; degree of systemic control

QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

STEP 5: Cost – Risk Rate/Factor and Risk Reference Determination

SUMMARY OF RISK REFERENCE

Risk Classification			Class of Consequences	
	Fatality/Year	Health Effects/Year	Property Damage Dollar($)/Year	Life Span Shortened /Year
Naturally Occurring Catastrophic	1×10^{-6}	5×10^{-6}	0.02	3×10^{-2}
Ordinary	7×10^{-5}	4×10^{-5}	3	0.2
Man originated Catastrophic				
Voluntary	2×10^{-6}	2×10^{-6}	0.4	6×10^{-2}
Regulated Voluntary	3×10^{-6}	3×10^{-6}	0.4	6×10^{-2}
Involuntary	1×10^{-5}	5×10^{-5}	2.0	3×10^{-1}
Ordinary				1×10^{-2}
Involuntary	5×10^{-6}	3×10^{-5}	1	1
Voluntary	6×10^{-4}	3×10^{-1}	200	0.1
Regulated Voluntary	1×10^{-4}	6×10^{-2}	30	
Man Triggered Catastrophic				
Involuntary	2×10^{-7}	1×10^{-6}	4×10^{-2}	6×10^{-4}
Voluntary	4×10^{-6}	4×10^{-6}	0.80	6×10^{-2}
Ordinary				
Involuntary	1×10^{-5}			3×10^{-2}
Voluntary	1×10^{-2}			2
Regulated Voluntary	2×10^{-4}			0.2



QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

STEP 6: Risk Proportionality/Degree of Voluntarism (F1) and Risk Derating Factor (F2)

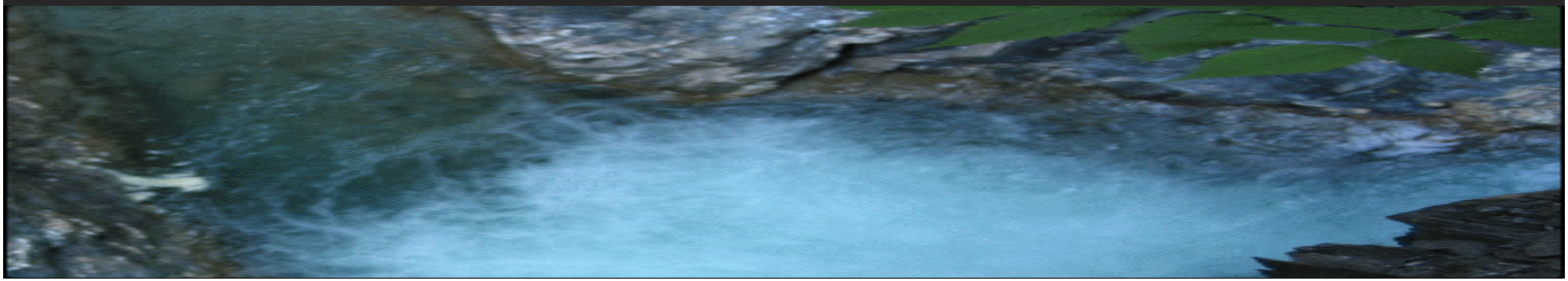
Risk Proportionality (F_1) and Risk Proportionality Derating Factors (F_2)

Factor	Involuntary Risk	Regulated Voluntary
Proportionality factor Derating factor	0.01	1.0
Balance		
Favorable	1.0	1.0
Marginal favorable	0.1	0.2
Indecisive	0.01	0.1
Marginal unfavorable	0.001	0.02
Unfavorable	0.0001	0.01

QUANTITATIVE REVEALED SOCIETAL PREFERENCES EMBEDDED WITH CUMULATIVE PROSPECT THEORY

Table 6.16 Controllability Factors

Control Approach		Degree of Control		State of Implementation		Control Effectiveness	
Factor	**C_1**	**Factor**	**C_2**	**Factor**	**C_3**	**Factor**	**C_4**
Systematic Control	1.0	Positive	1.0	Demonstrated	1.0	Absolute	1.0
Risk Management System	0.8						
Special Design Features	0.5			Proposed	0.5	Relative	0.50
Inspection and Regulation	0.3	Level	0.3				
		Negative	0.2				
No Control Scheme	0.1	Uncontrolled	0.1	No Action		None	



Risk Referent, Comparator for Determining Accepability

Definition,

$$Referent = Risk\ Reference \times F_1 \times F_2 \times F_3$$

Where,

$$Referent = Incremental\ Acceptable\ Level$$

and,

$$Reference = Historically\ revealed\ Preference$$

F_1 = *Proportionality Factor*
(based on degree of Volunteerism)

F_2 = *Derating Factor*
(modifies F_1 based on cost/benefit ratio)

F_3 = *Controllability Factor*

RISK RATES/FCTORS BASED ON US CENSUS BUREAU, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, AND DEPT. OF HOMELAND SECURITY

USING ARSENIC AS A CHEMICAL THREAT

Risk Rates based on US Census Bureau, National Highway Traffic Safety Administration & Department of Homeland Security for Event Tree Analysis using Arsenic

Event Tree List of Events		Risk Rate
Symbol	**Description**	
Ftv	**Event Tree Analysis where risk rates/factors based on Fatal Motor Vehicle Accident**	
Ftv-a1	Terrorist made real estate investments in the United States	1.00
Ftv-b1	Homegrown terrorists radicalized in the North America	1.00
Ftv-ia1	Terrorist(s) bought/purchased homes and land adjacent to US Borders	1.00
Ftv-ia2	Build tunnels or install pipes underneath the house for inflow of Arsenic & illegal alien	0.96
Ftv-ia3	Inflow of Arsenic through tunnel/pipeline system to United States	0.96
Ftv-hsa1	Homeland Security scarce technology for security & protection	0.96
Ftv-hsa2	United States CBP Agents do not discover tunnels/pipes on US borders	0.96
Ftv-hsa3	Arsenic loaded in the truck(s)/vehicle(s) regularly	0.96
Ftv-hsb1	Homeland Security with usual security strategy	0.96
Ftv-hsb2	Border Patrols/CBP Agent(s) stop the vehicle for short and temporary inspection	0.53
Ftv-hsb3	No thorough investigation by Border Patrol(s)/CBP Agent(s)	0.53
FTv-tma1	Transport of deadly Arsenic from US Borders with Fake Documentations	0.20
FTv-tma2	Arsenic are Transported to Urban Areas	0.96
FTv-hra1	Terrorists or Illegal Aliens hired by terrorists to import cyanide chemicals	0.10
FTv-hra2	20 million illegal aliens per year crossing the US Borders. Approx. 5 million alliens per	0.10
	year and 20lbs of Arsenic per alien assumingly will carry the chemicals.	-
FTv-hra3	20 lbs x 5 million = 75,000,000 lbs or 37,000 tons per year (can be minimum)	0.10
FTv-pua1	Randomly buy large quantity of Arsenic	0.10
FTv-pub1	Not able to buy or purchase large quantity of Arsenic	0.30
FTv-puc1	Stealing Arsenic from Manufacturer's warehouse, laboratory facilities or plants	0.10
FTv-tra1	Arsenic are transported to Urban Areas after the event stealing	0.96
FTv-hrc1	Presedential Directive 7: U.S. EPA Typical or "as usual" strategy and policy	1.00
FTv-tga1	Absence of technology on groundwater protection	1.00
FTv-hrb1	Absence of technology on other water supply water system	1.00
FTv-hrc1	Defficiency of Policy on groundwater and water supply watr system	1.00
FTv-sca1	No camera surveillance and no fence on major recharge zone of Edwards	0.96
FTv-sca2	No intrusion detection on sensitive and major recharge zone	0.96
FTv-sca3	No Checkpoints within the major recharge facilities	0.96
FTv-sca4	No surveillance and no technology detection on roads leading to recharge zone	0.96
FTv-sca5	No Hazardous chemicals detection on recharge zone wells	0.96
FTv-sca6	No security/no surveillance for artificial aquifer recharge	0.96
FTv-scb1	No background investigation prior to purchasing properties on top of aquifer	0.69
FTv-scb2	No background investigation prior to purchasing large amount of chemicals	0.69
FTv-scb3	No regular inspection on underground tanks (e.g. septic tank, water tank)	0.69
FTv-scb4	No regular inspection on underground (septic or water) tanks	0.69
FTv-scb5	No regulations required to install technology detecting pure/high concentration of chemicals	0.69
	(i.e. Cyanide or Arsenic)	
FTv-scb6	Lack of funding for policy making on groundwater protection	0.53

******Probability values/ from (Frequency of Events) US Census Bureau, US National Highway Traffic Safety Administration & Department of Homeland Security***

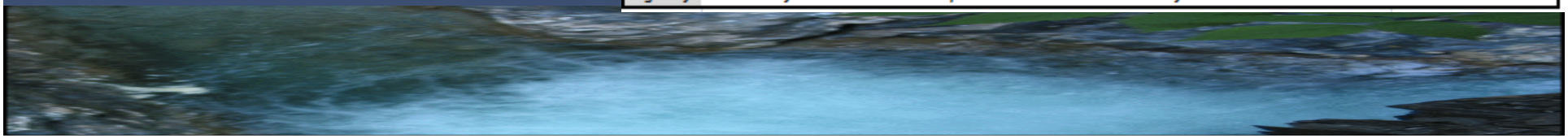
RISK RATES/FCTORS BASED ON US CENSUS BUREAU, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, AND DEPT. OF HOMELAND SECURITY

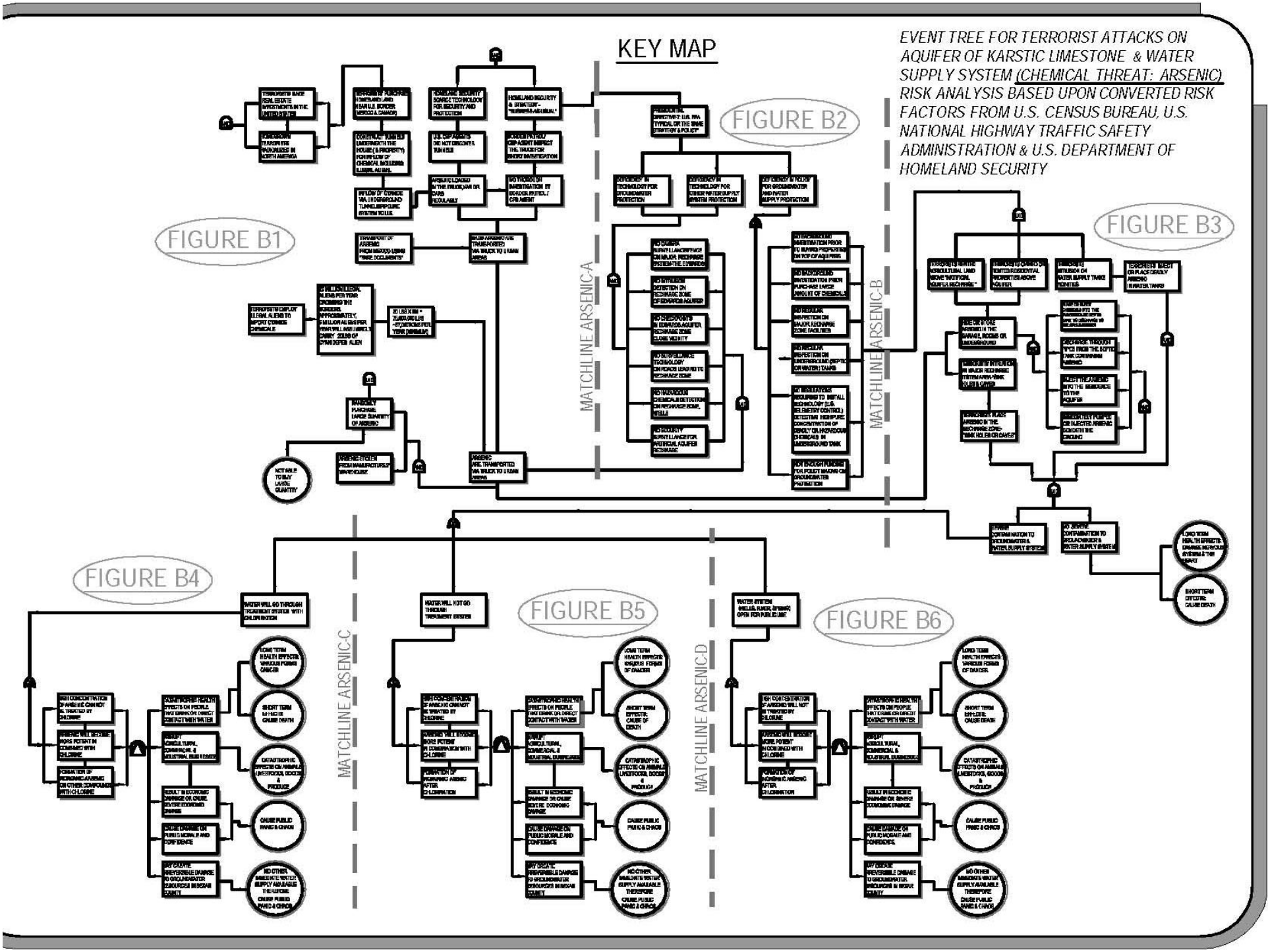
USING ARSENIC AS A CHEMICAL THREAT

Risk Rates based on US Census Bureau, National Highway Traffic Safety Administration & Department of Homeland Security for Event Tree Analysis using Arsenic

Event Tree List of Events		Risk Rate
Symbol	Description	
Ftv	Event Tree Analysis where risk rates/factors based on Fatal Motor Vehicle Accident	
FTv-tia1	Terrorist(s) rented agricultural land above artificial aquifer recharge	1.00
FTv-tia2	Terrorist(s) owned or rented residential properties (including land) above aquifer	1.00
FTv-tia3	Terrorist(s) intrusion on unsecured water supply	0.96
FTv-tia4	Terrorist(s) injected or dumped deadly chemical in the water tank.	0.96
FTv-tib1	Hide/store the chemicals in the garage, rooms or underground	0.30
FTv-tib2	Terrorist(s) intrusion on major recharge zone areas like sink holes, faults, caves, wells	0.96
FTv-tib3	Terrorist(s) dump chemicals in the recharge zone, e.g. sink holes, faults, caves, wells	0.96
FTv-tic1	Pump or inject chemicals into the underground septic tank	0.96
FTv-tic2	Discharge through pipes from the septic tank containing deadly chemicals	0.96
FTv-tic3	Inject the chemicals beneath the residence to the aquifer	0.96
FTv-tic4	Immediately pumped or injected chemical beneath the ground	0.96
FTv-cg1	Severe contamination to groundwater and water supply system	0.69
FTv-cg2	No sever contamination to groundwater and water supply system	0.20
FTv-csa1	Long Term Health Effects: Damage nevous system and the hearth	-
FTv-csa2	Short Term Effects: Cause death	-
FTv-csa3	Catastrophic effects on Animals (Livestocks), Goods, produce and the environment	-
FTv-csa4	Cause Public Panic and Chaos	-
FTv-csa5	No other immediate water supply available	-
FTv-wa1	High Concentration of Arsenic will likely not be treated with chlorine	0.96
Ftv-wa2	Arsenic will become more potent in combination with chlorine	0.96
Ftv-wa3	Formation of other Arsenic Compounds after Chlorination	0.96
FTv-wb1		0.96
Ftv-wb2		0.96
Ftv-wb3		0.96
Ftv-wb4		0.96
Ftv-wb5		0.96
Ftv-ww1	Water Will go through Water Treatment Facility	0.96
Ftv-ww2	Water will not go through Water Treatment Facilities	0.53
Ftv-ww3	Water on wells, lakes, rivers, springs, etc. (no treatment at all)	1.000

***Probability values based from (Frequency of Events) US Census Bureau, US National Highway Traffic Safety Administration & Department of Homeland Security*




KEY MAP
EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)
RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY
FIGURE B1
FIGURE B2
FIGURE B3
FIGURE B4
FIGURE B5
FIGURE B6
MATCHLINE ARSENIC-A
MATCHLINE ARSENIC-B
MATCHLINE ARSENIC-C
MATCHLINE ARSENIC-D

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

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FIGURE B1

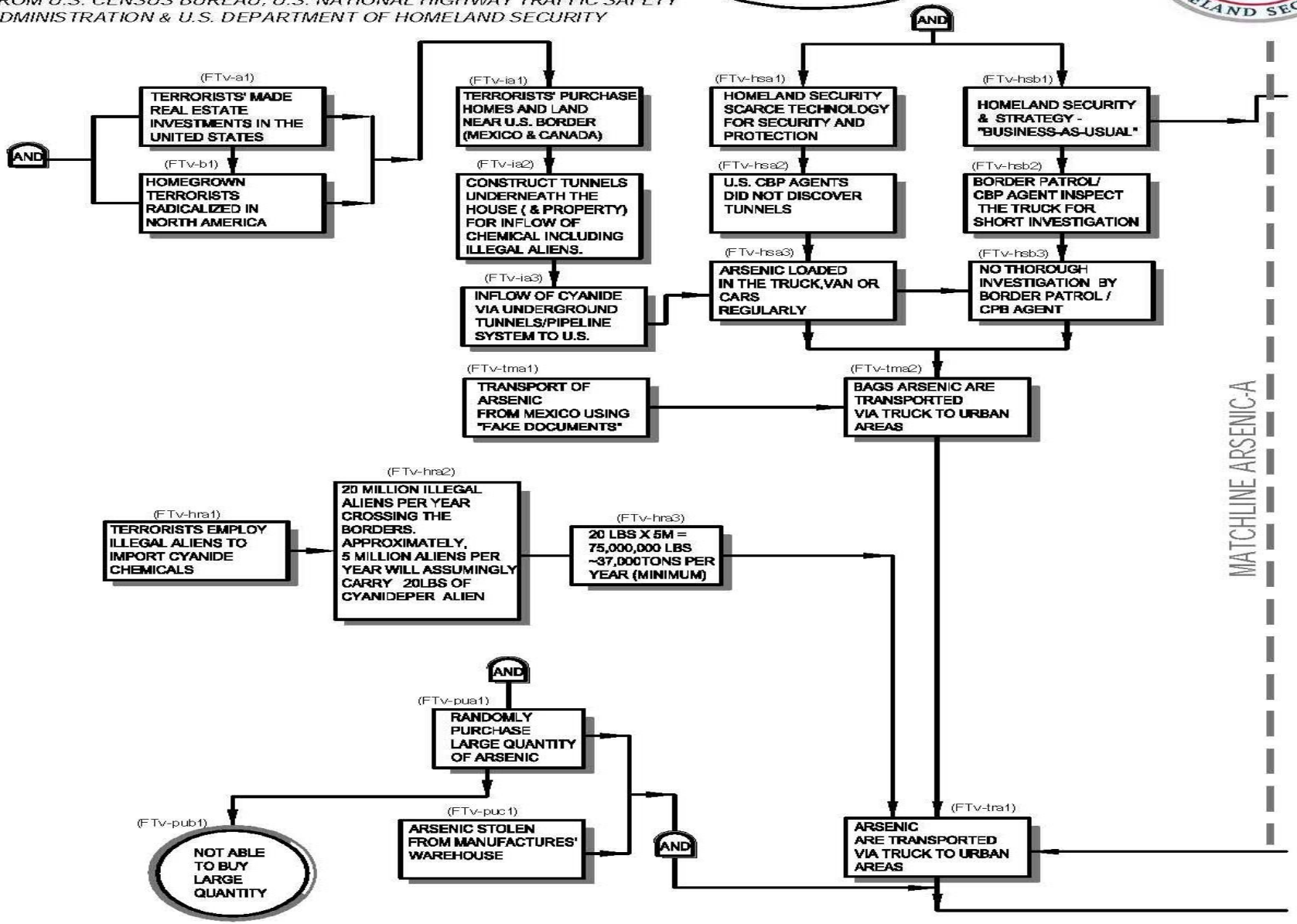

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FIGURE B2

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

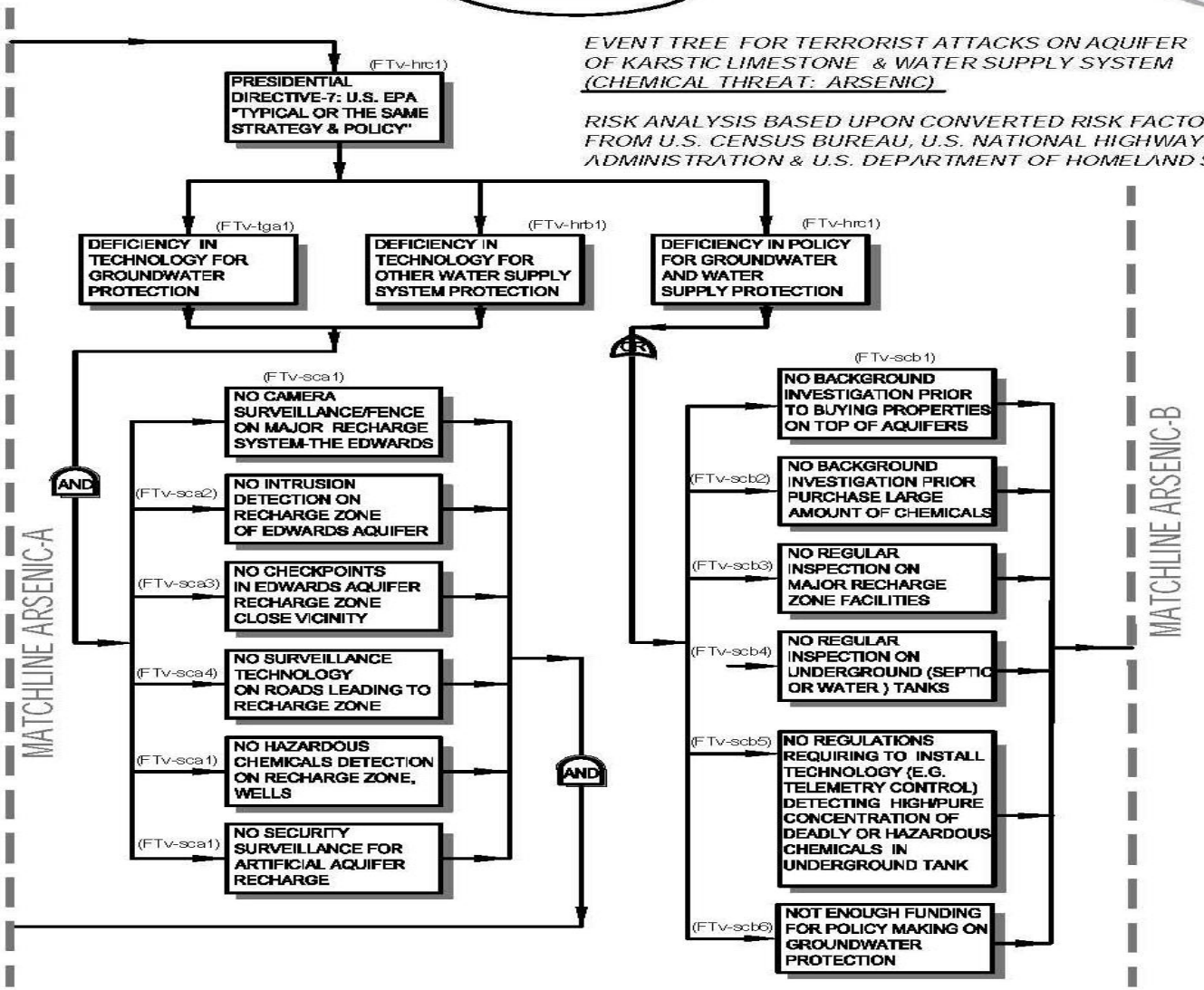

FIGURE B3

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EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

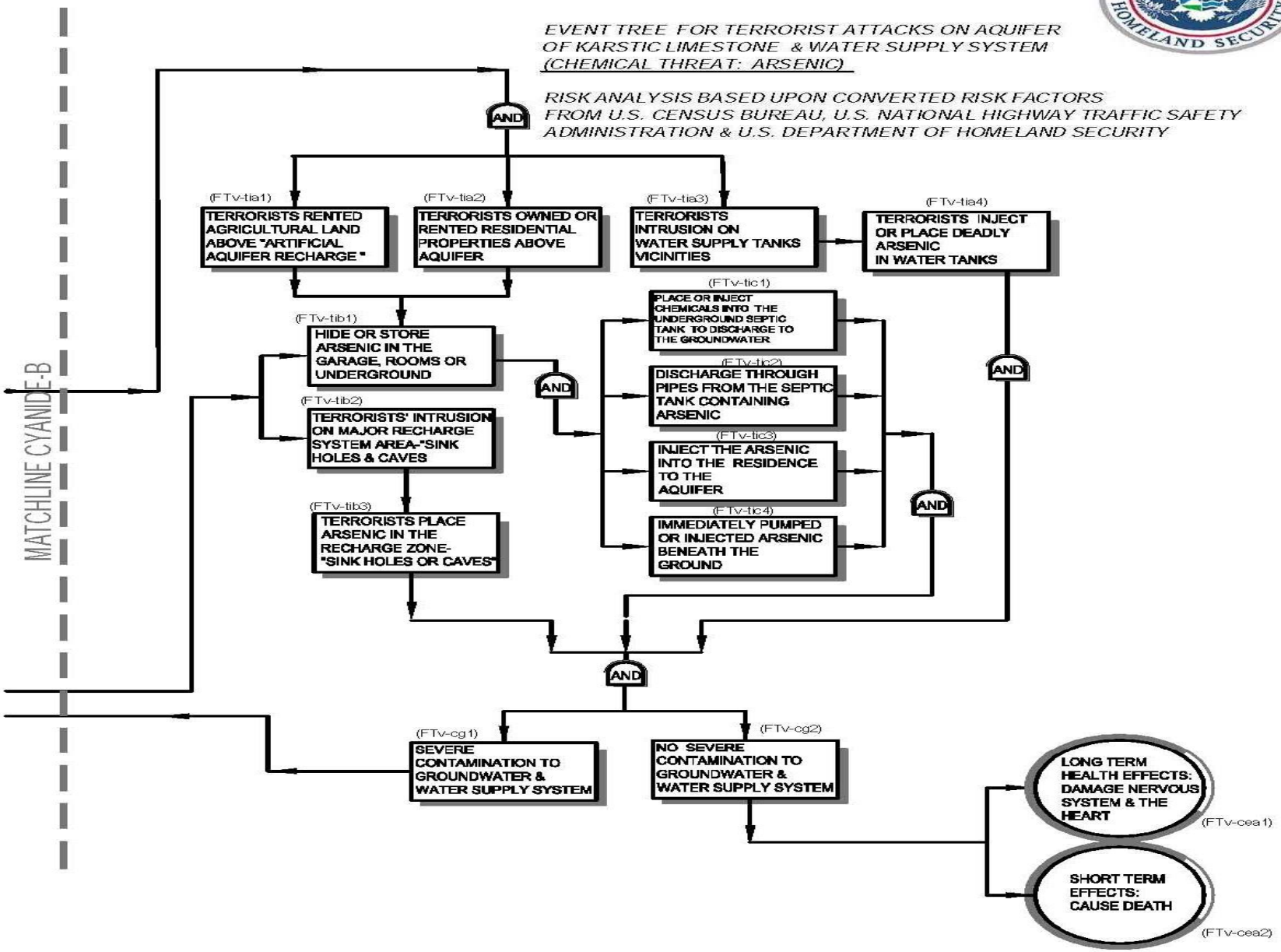

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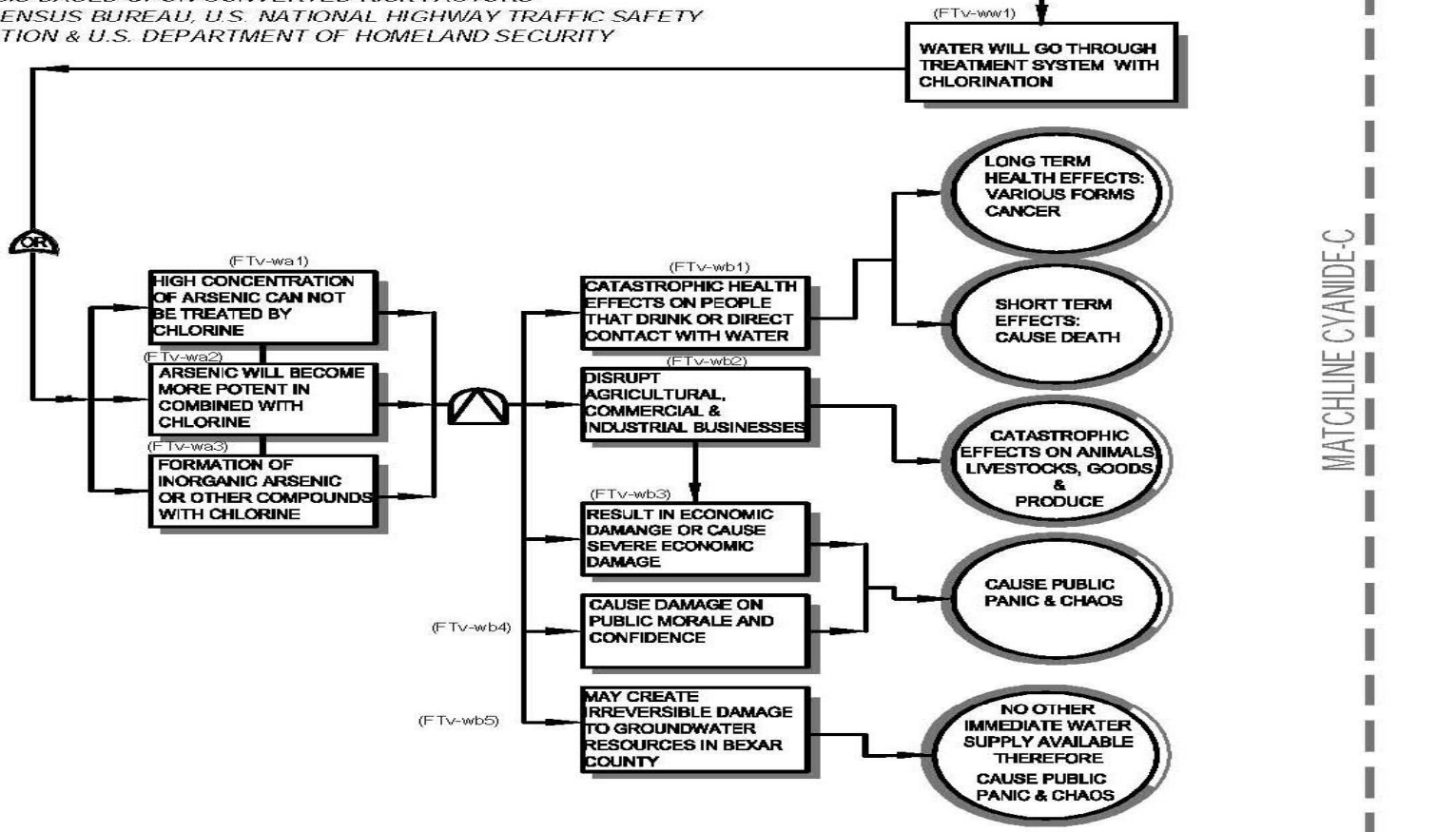
FIGURE B4

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY



National Highway Traffic Safety Administration
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FIGURE B5

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

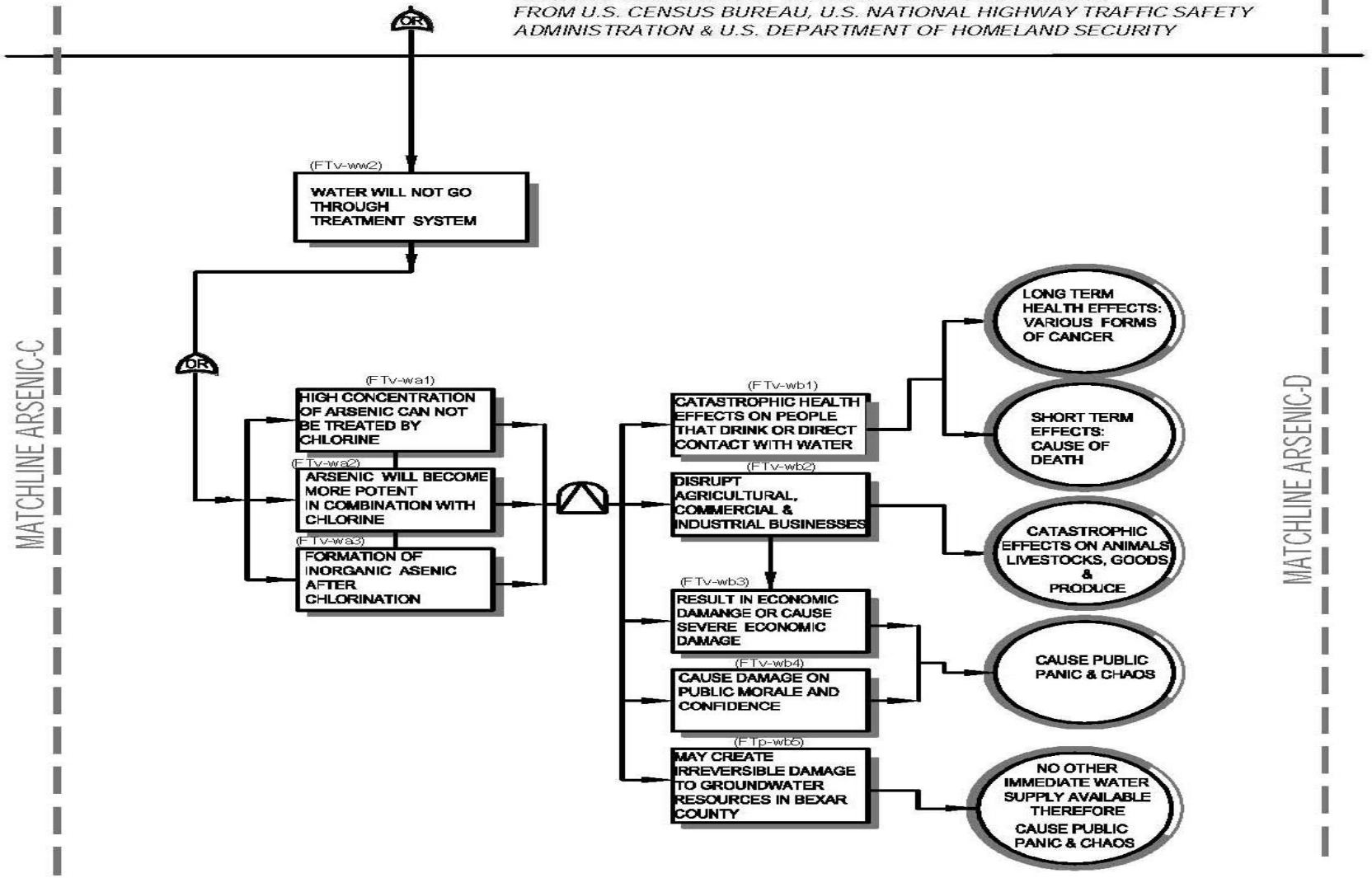

FIGURE B6

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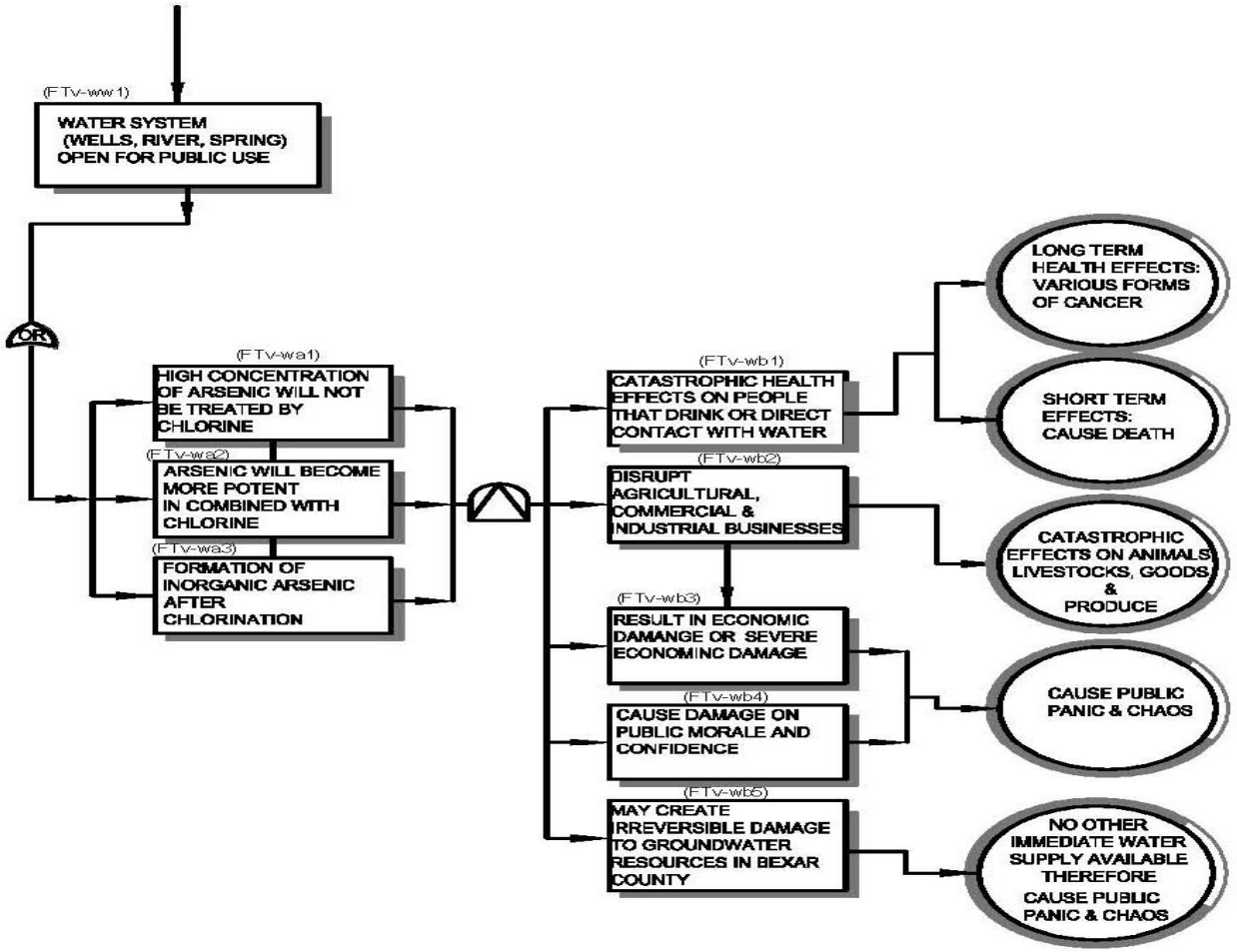
EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: ARSENIC)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

MATCHLINE ARSENIC-D



RISK RATES/FCTORS BASED ON US CENSUS BUREAU, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, AND DEPT. OF HOMELAND SECURITY

USING CYANIDE AS A CHEMICAL THREAT

Risk Rates/Factors based on data from US Census Bureau, National Highway Traffic Safety Administration and Dept. of Homeland Security for Event Tree Analysis on Terrorist Attacks on Aquifer of Karstic Limestone & Water Supply System using Cyanide

Event Tree List of Events		Risk Rate
Symbol	Description	
Ftv	Event Tree Analysis where risk rates/factors based on Fatal Motor Vehicle Accident	
Ftv-a1	Terrorist made real estate investments in the United States	1.00
Ftv-b1	Homegrown terrorists radicalized in the North America	1.00
Ftv-ia1	Terrorist(s) leased/purchased homes and land adjacent to US Borders (Mexico & Canada)	1.00
Ftv-ia2	Build tunnels or install pipes underneath the house for inflow of cyanide & illegal alien	0.96
Ftv-ia3	Inflow of cyanide through tunnel/pipeline system to United States	0.96
Ftv-hsa1	Homeland Security scarce technology for security & protection	0.96
Ftv-hsa2	United States CBP Agents do not discover tunnels/pipes on US borders	0.96
Ftv-hsa3	Cyanide loaded in the truck(s)/vehicle(s) regularly	1.00
Ftv-hsb1	Homeland Security with usual security strategy	0.96
Ftv-hsb2	Border Patrols/CBP Agent(s) stop the vehicle for short and temporary inspection	0.96
Ftv-hsb3	No thorough investigation by Border Patrol(s)/CBP Agent(s)	0.10
FTv-tma1	Transport of deadly Cyanide from Mexico with "FAKE" documents.	0.96
FTv-tma2	Cyanide are Transported to Urban Areas	0.96
FTv-hra1	Terrorists or Illegal Aliens hired by terrorists to import cyanide chemicals	0.10
FTv-hra2	20 million illegal aliens per year crossing the US Borders. Approx. 5 million alliens per	0.10
	year and 20lbs of cyanide per alien assumingly will carry the chemicals.	-
FTv-hra3	20 lbs x 5 million = 75,000,000 lbs or 37,000 tons per year (can be minimum)	0.10
FTv-pua1	Randomly buy large quantity of Cyanide	0.50
FTv-pub1	Not able to buy or purchase large quantity of Cyanide	0.10
FTv-puc1	Stealing Cyanide from Manufacturer's warehouse, laboratory facilities or plants	0.10
FTv-tra1	Cyanide are transported to Urban Areas after stealing	0.96
FTv-hrc1	Presedential Directive 7: U.S. EPA Typical or "as usual" strategy and policy	1.00
FTv-tga1	Deficiency of technology on groundwater protection from Cyanide	1.00
FTv-hrb1	Deficiency of technology on other water supply water system protection from Cyanide	1.00
FTv-hrc2	Deficiency of Policy on groundwater and water supply water system	1.00
FTv-sca1	No camera surveillance and no fence on major recharge zone of Edwards	0.96
FTv-sca2	No intrusion detection on sensitive and major recharge zone	0.96
FTv-sca3	No Checkpoins within the major recharge facilities	0.96
FTv-sca4	No surveillance and no technology detection on roads leading to recharge zone	0.96
FTv-sca5	No Cyanide detection on recharge zone wells	1.00
FTv-sca6	No security/no surveillance for artificial aquifer recharge	0.96
FTv-scb1	No background investigation prior to purchasing properties on top of aquifer	0.69
FTv-scb2	No background investigation prior to purchasing large amount of chemicals	0.69
FTv-scb3	No regular inspection on underground tanks (e.g. septic tank, water tank)	0.69
FTv-scb4	No regular inspection on underground (septic or water) tanks	0.69
FTv-scb5	No regulations required to install technology detecting pure/high concentration of chemicals	0.96
	(e.g. Cyanide and Arsenic)	
FTv-scb6	Lack of funding for policy making on groundwater protection	0.53

Probability values converted from data based on US Census Bureau, US National Highway Traffic Safety Administration & Department of Homeland Security

RISK RATES/FCTORS BASED ON US CENSUS BUREAU, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, AND DEPT. OF HOMELAND SECURITY

USING CYANIDE AS A CHEMICAL THREAT

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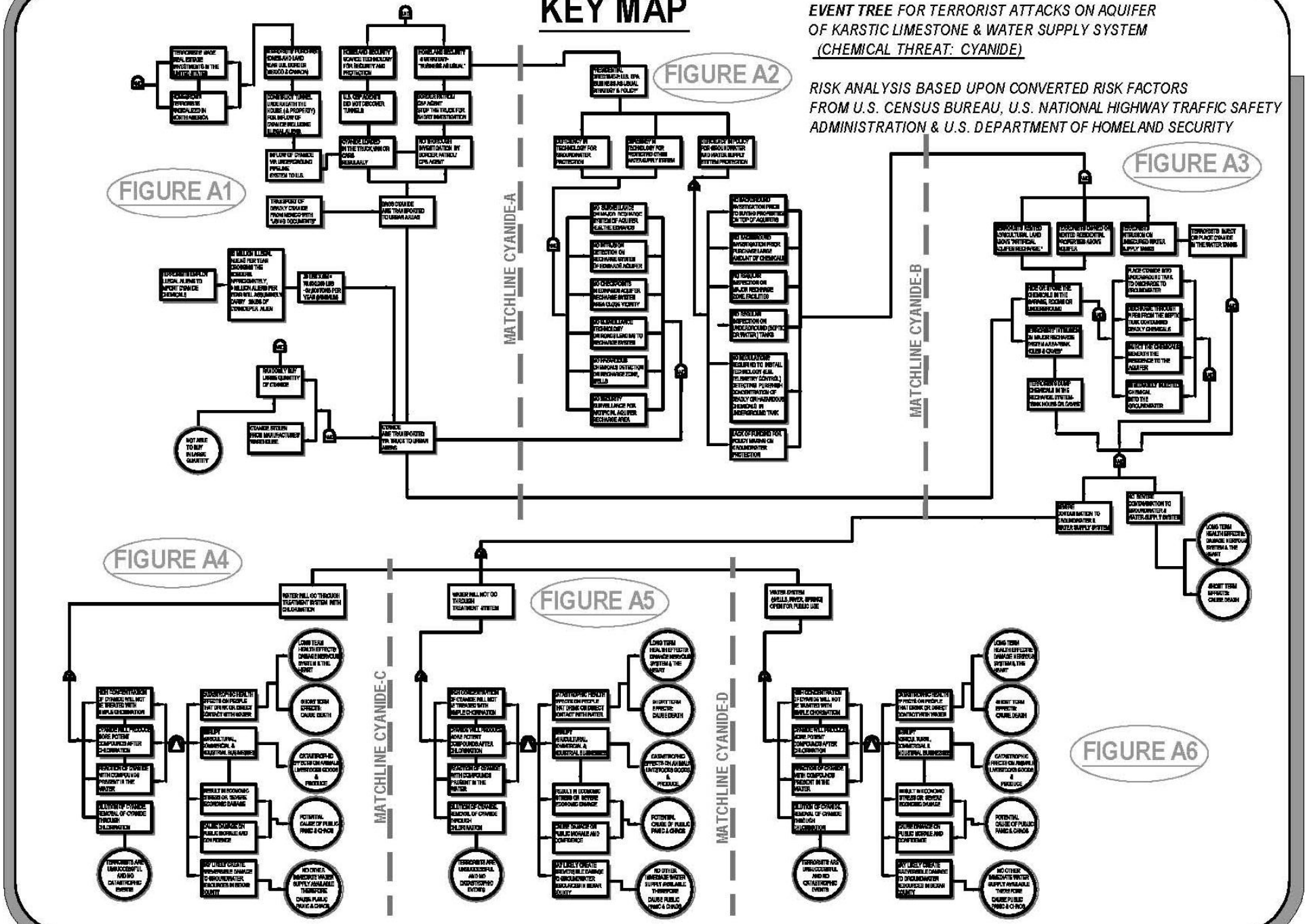
FTv-tia4	Terrorist(s) injected or dumped deadly chemical in the water tank.	0.96
FTv-tib1	Hide/store the chemicals in the garage, rooms or underground	0.96
FTv-tib2	Terrorist(s) intrusion on major recharge zone areas like sink holes, faults, caves, wells	0.53
FTv-tib3	Terrorist(s) dump chemicals in the recharge zone, e.g. sink holes, faults, caves, wells	0.96
FTv-tic1	Pump or inject chemicals into the underground septic tank	1.00
FTv-tic2	Discharge through pipes from the septic tank containing deadly chemicals	1.00
FTv-tic3	Inject the chemicals beneath the residence to the aquifer	1.00
FTv-tic4	Immediately pumped or injected chemical beneath the ground	1.00
FTv-cg1	Severe contamination to groundwater and water supply system	0.69
FTv-cg2	No severe contamination to groundwater and water supply system	0.20
FTv-csa1	Long Term Health Effects: Damage nevous system and the hearth	-
FTv-csa2	Short Term Effects: Cause death	-
FTv-csa3	Catastrophic effects on Animals (Livestocks), Goods, produce and the environment	-
FTv-csa4	Cause Public Panic and Chaos	-
FTv-csa5	No other immediate water supply available	-
FTv-wa1	High Concentration of Cyanide will not be treated with chlorine	1.00
Ftv-wa2	Cyanide will become more potent in combination with chlorine	1.00
Ftv-wa3	Formation of other Cyanide Compounds after Chlorination	0.96
Ftv-wa4	Cyanogen Chloride is produced by the oxidation of sodium cyanide chlorination	0.96
Ftv-wa5	Terrorists are unsuccessful and no catastrophic events	0.20
FTv-wb1	High Concentration of Cyanide will not be treated with chlorine	0.96
Ftv-wb2	Cyanide will become more potent in combination with chlorine	0.96
Ftv-wb3	Formation of other Cyanide Compounds after Chlorination	0.96
Ftv-wb4	Cyanogen Chloride is produced by the oxidation of sodium cyanide chlorination	0.96
Ftv-wb5	Terrorists are unsuccessful and no catastrophic events	0.96
Ftv-ww1	Water Will go through Water Treatment Facility	0.96
Ftv-ww2	Water will not go through Water Treatment Facilities	0.53
Ftv-ww3	Water on wells, lakes, rivers, springs, etc. (no treatment at all)	1.00

***Probability values converted from data based on US Census Bureau, US National Highway Traffic Safety Administration & Department of Homeland Security*

KEY MAP

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY



EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

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FIGURE A1

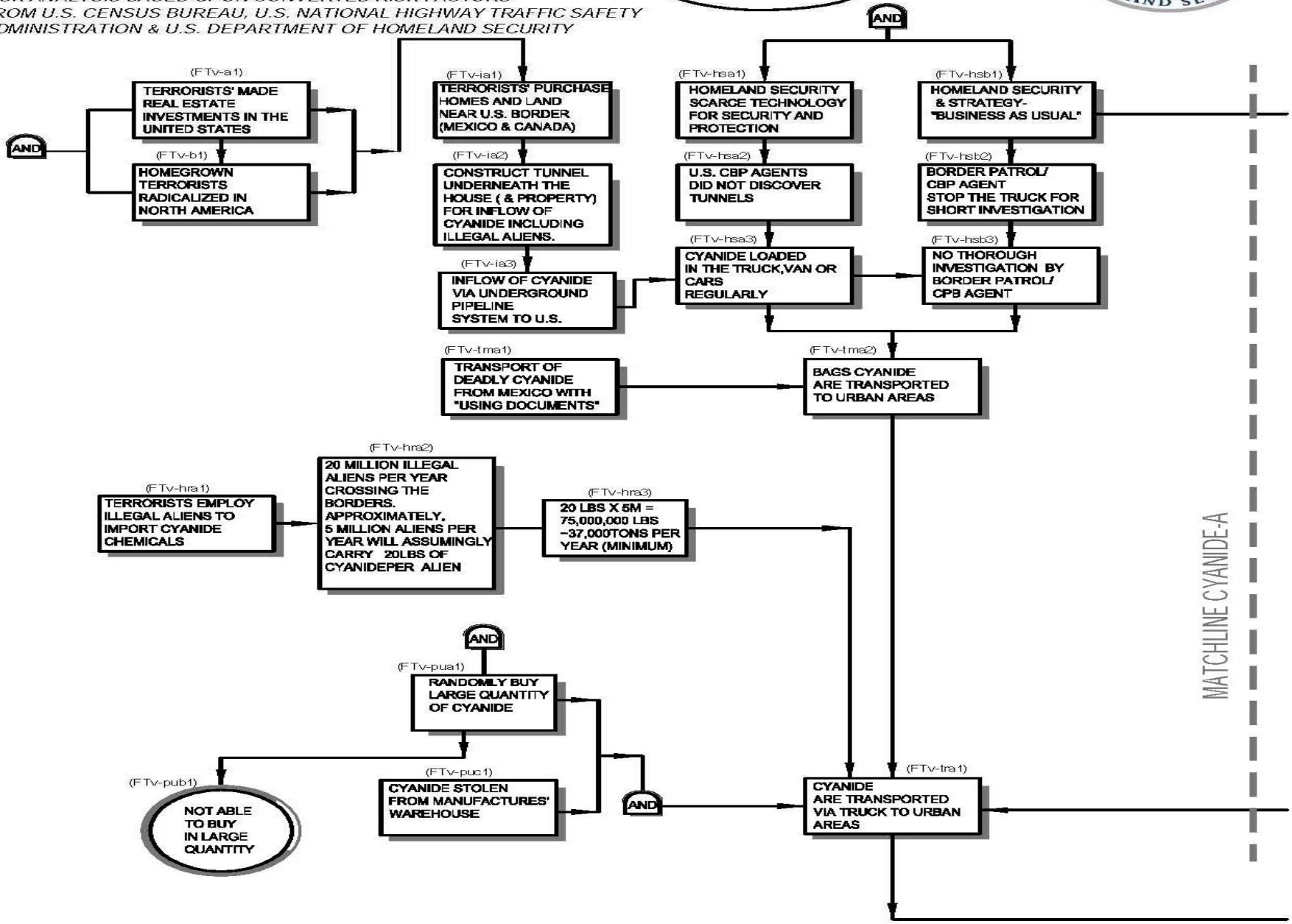

FIGURE A2

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

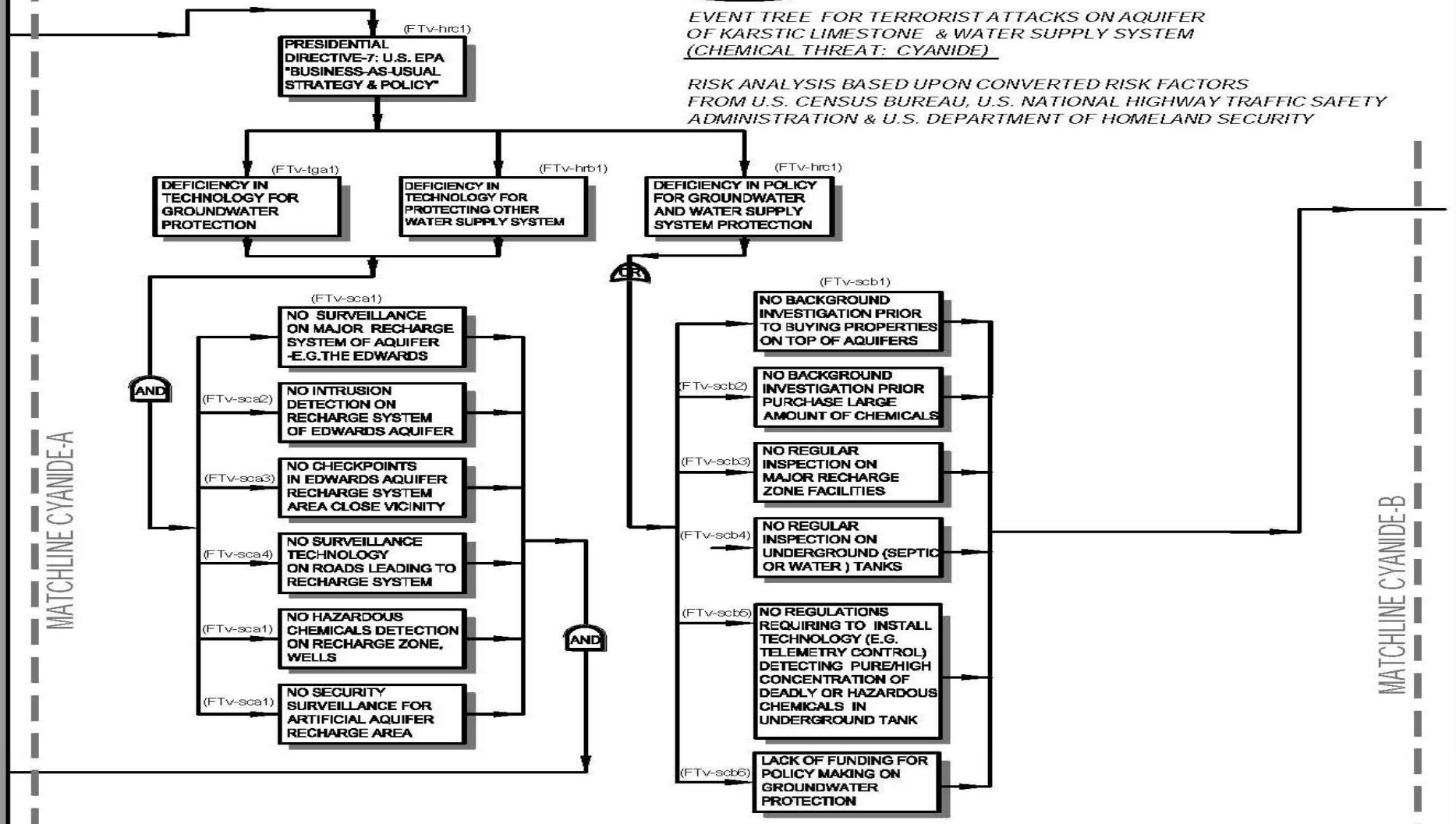

FIGURE A3

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

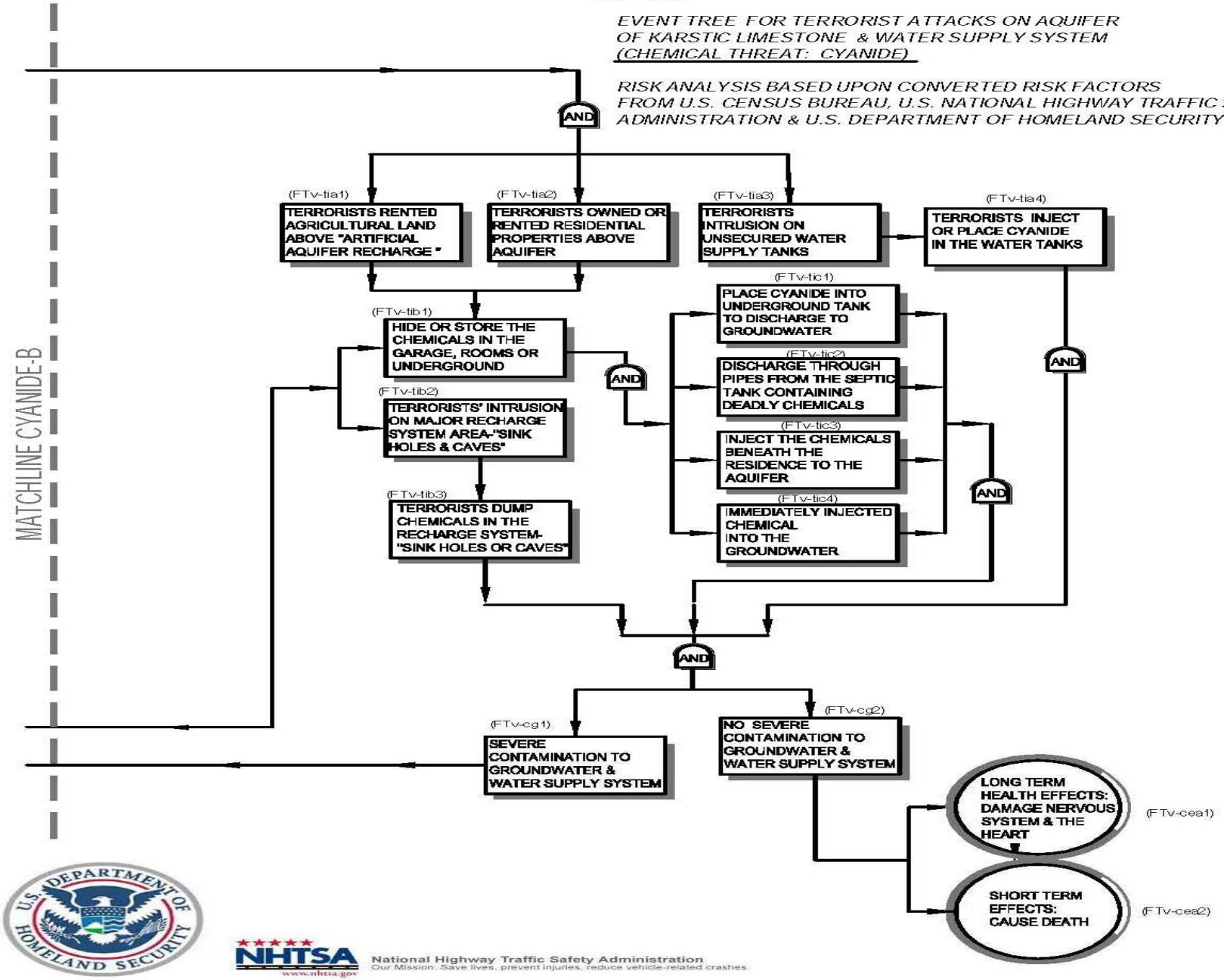

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FIGURE A4

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

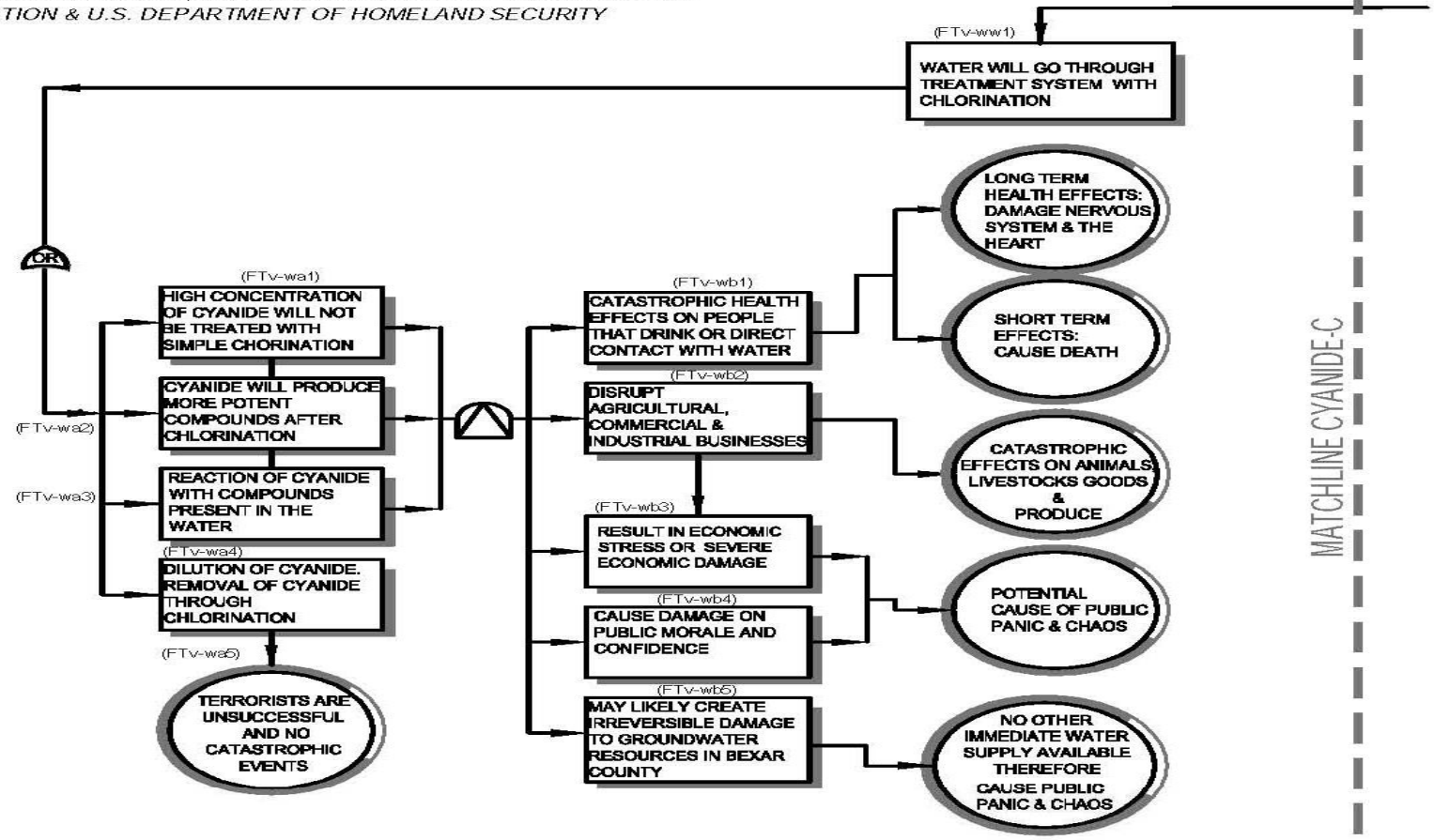

FIGURE A6

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY

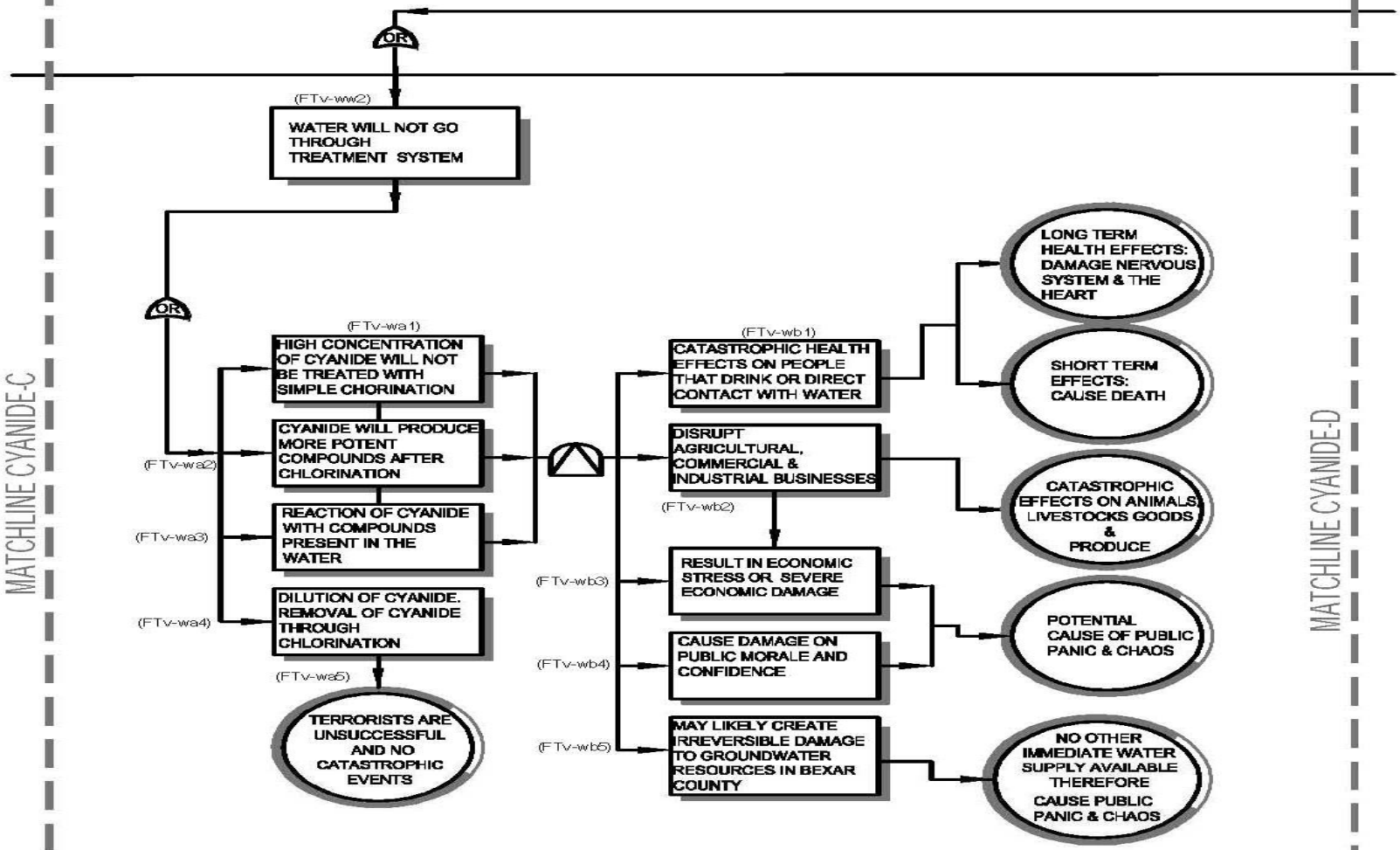

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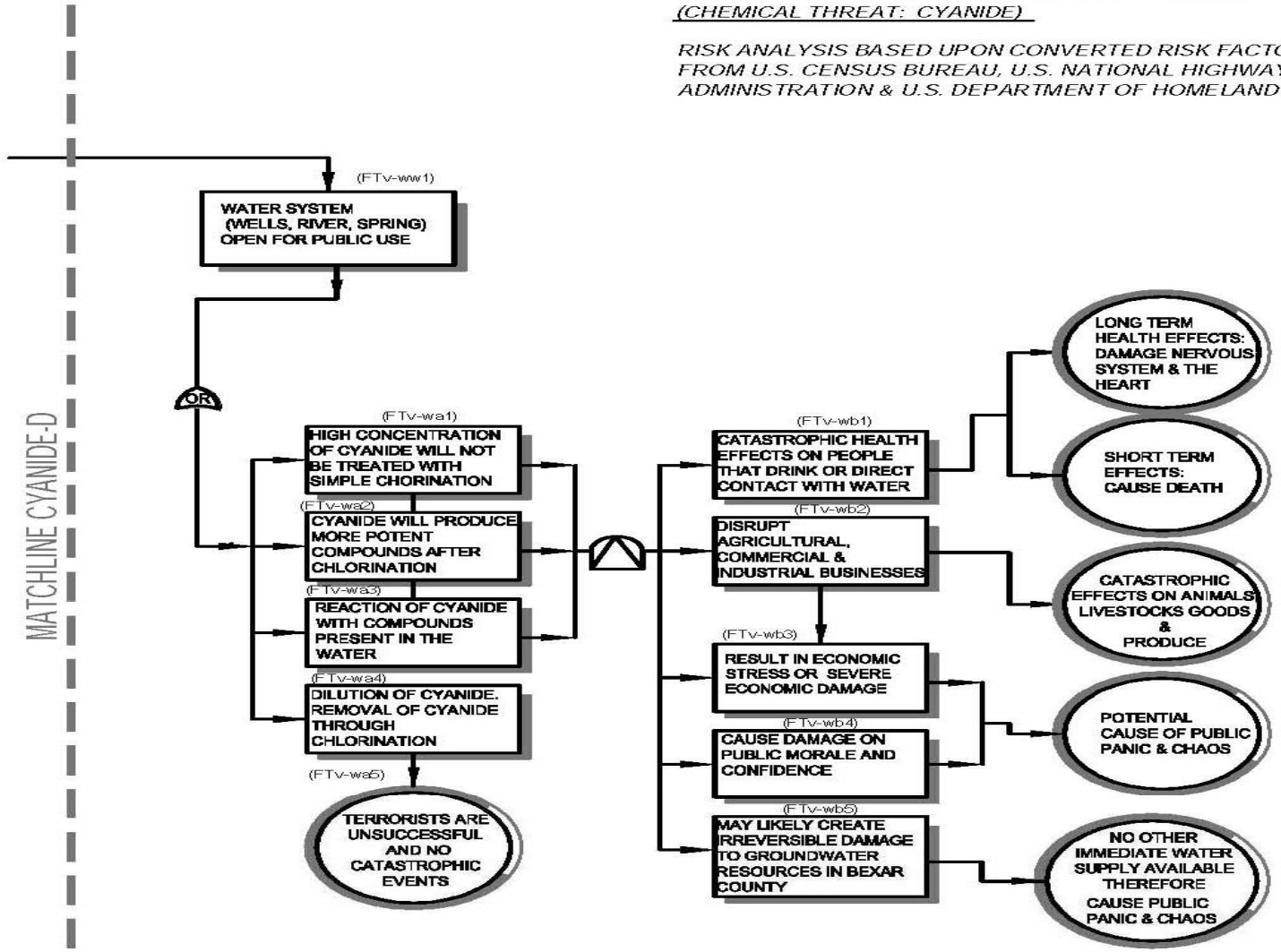
FIGURE A6

EVENT TREE FOR TERRORIST ATTACKS ON AQUIFER OF KARSTIC LIMESTONE & WATER SUPPLY SYSTEM (CHEMICAL THREAT: CYANIDE)

RISK ANALYSIS BASED UPON CONVERTED RISK FACTORS FROM U.S. CENSUS BUREAU, U.S. NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION & U.S. DEPARTMENT OF HOMELAND SECURITY



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OPERATION COST ESTIMATE OF HOMEGROWN TERRORIST ATTACKS USING CYANIDE ON EDWARDS AQUIFER					
DESCRIPTION	QUANTITY	PRICE	PER UNIT	REFERENCE OR MANUFACTURER	COST
Cyanide	150	$ 7.00	ton	US-Mexico Border	$ 1,050.00
Home for Lease on Recharge Zone	1	$ 1,300.00	month	www.mysanantonio.com	$ 1,300.00
Home for Lease near US-Mexico Border	2	$ 800.00	month	www.mysanantonio.com	$ 800.00
Uhaul 17-ft Long Truck	1	$ 150.00	month	Uhaul, Penske	$ 150.00
plus Mileage cost	1	$ 0.55	mile	Uhaul, Penske	
a.) Trip from US-Mexico Border	1500	$ 0.55	mile	Uhaul, Penske	$ 825.00
b.) Trip to Aquifer Recharge Zone	1000	$ 0.55	mile	Uhaul, Penske	$ 550.00
c.) Trip to Properties on or near Aquifer	1000	$ 0.55	mile	Uhaul, Penske	$ 550.00
Rental Cargo Van (Full/Luxury)	1	$ 1,200.00	month	Enterprise Rental Car	$ 1,200.00
Supplies Food & Equipments	4	$ 700.00	person	Walmart/Shops	$ 2,800.00
Construction of Tunnel		$ 5,000.00			$ -
Gas	1	$ 1,500.00	month		$ 1,500.00
Utilites, Communication Supplies	4	$ 1,000.00	month	Walmart/Shops	$ 4,000.00
				TOTAL MINIMUM COST	$ 14,725.00

OPERATION COST ESTIMATE OF HOMEGROWN TERRORIST ATTACKS USING ARSENIC ON EDWARDS AQUIFER					
DESCRIPTION	QUANTITY	PRICE	PER UNIT	REFERENCE OR MANUFACTURER	COST
Arsenic	20000	$ 1.77	lb	Tradekey.com/Walmart	$ 35,400.00
Home for Lease	1	$ 1,300.00	month	www.mysanantonio.com	$ 1,300.00
Home for Lease near US-Mexico Border	2	$ 850.00	month	www.mysanantonio.com	$ 1,700.00
Uhaul 17-ft Long Truck	1	$ 150.00	month	Uhaul, Penske	$ 150.00
plus Mileage cost		$ 0.55	mile	Uhaul, Penske	$ -
a.) Trip from US-Mexico Border	3000	$ 0.55	mile	Uhaul, Penske	$ 1,650.00
b.) Trip to Aquifer Recharge Zone	1000	$ 0.55	mile	Uhaul, Penske	$ 550.00
c.) Trip to Properties on or near Aquifer	1000	$ 0.55	mile	Uhaul, Penske	$ 550.00
Rental Cargo Van (Full/Luxury)	2	$ 1,200.00	month	Enterprise Rental Car	$ 2,400.00
Supplies Food & Equipments	5	$ 700.00	person	Walmart/Shops	$ 3,500.00
Construction of Tunnel	0	$ 5,000.00			$ -
Gas	4	$ 1,000.00	month		$ 4,000.00
Utilites, Communication Supplies	3	$ 700.00	month	Walmart/Shops	$ 2,100.00
				TOTAL MINIMUM COST	$ 53,300.00

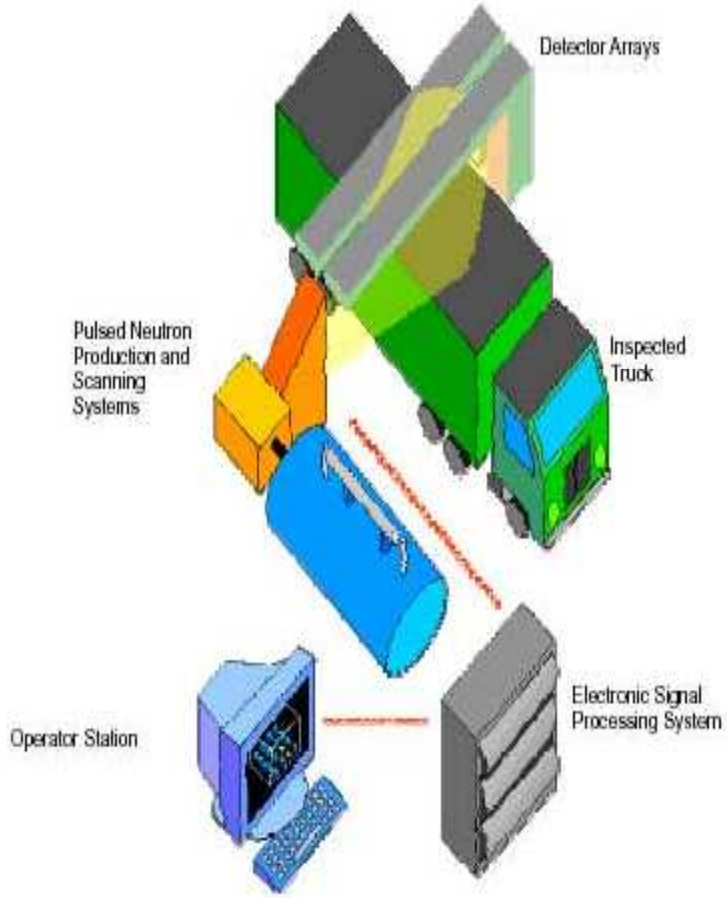
QUANTITATIVE RISK ESTIMATION FOR TERRORIST ATTACK

#	Description	ARSENIC	CYANIDE	ARSENIC & CYANIDE
1	Illegal intrusion on US Borders for inflow of Chemical Threats and Aliens	1.6×10^{-4}	7.8×10^{-6}	6.4×10^{-6}
2	Terrorist Intrusion on Major Recharge System Area (e.g. Sinkholes, Wells, Faults, Caves)	1.44×10^{-5}	6.38×10^{-6}	4.8×10^{-6}
3	Terrorist Intrusion on Water Supply System, where Water Tanks are situated	9.8×10^{-5}	4.6×10^{-5}	1.2×10^{-6}
4	Installation of Underground Tanks or Station to inject/discharge Chemical Threats (Cyanide or Arsenic	3.1×10^{-4}	4.9×10^{-5}	1.6×10^{-6}
5	Injection/discharge of Chemical Threats From Mexico/Canada (on US Borders) to US Groundwater or Water Supply System	1.5×10^{-4}	5.2×10^{-6}	3.3×10^{-6}
6	Injection/discharge of Chemical(s) on Sinkholes, Faults and Cracks towards Aquifer System	1.4×10^{-4}	6.36×10^{-6}	5.3×10^{-6}
7	Immediately dump Chemical directly to unsecured Aquifer Recharge System	1.4×10^{-4}	6.36×10^{-6}	5.3×10^{-6}
8	Injection of Cyanide and Arsenic to "Artificial Aquifer Recharge" (Aquifer Storage and Recovery Area)	3.1×10^{-4}	5×10^{-6}	1.6×10^{-6}
9	Contamination of Groundwater Resources through injection of chemical via sinkholes, faults, cracks, cave	6.7×10^{-4}	4.1×10^{-5}	3.3×10^{-6}
10	Contamination of Groundwater Resources through dumping of chemicals immediately	6.7×10^{-3}	4×10^{-4}	3.3×10^{-6}
11	Contamination of Artificial Aquifer Recharge	2.7×10^{-4}	4.4×10^{-5}	9.9×10^{-6}
12	Contamination of Water Supply System-e.g. Water in the storage Tanks	8.6×10^{-7}	2.9×10^{-5}	7.5×10^{-5}
13	Contamination of Water System Along US Borders	1.3×10^{-4}	3.3×10^{-5}	2.0×10^{-6}

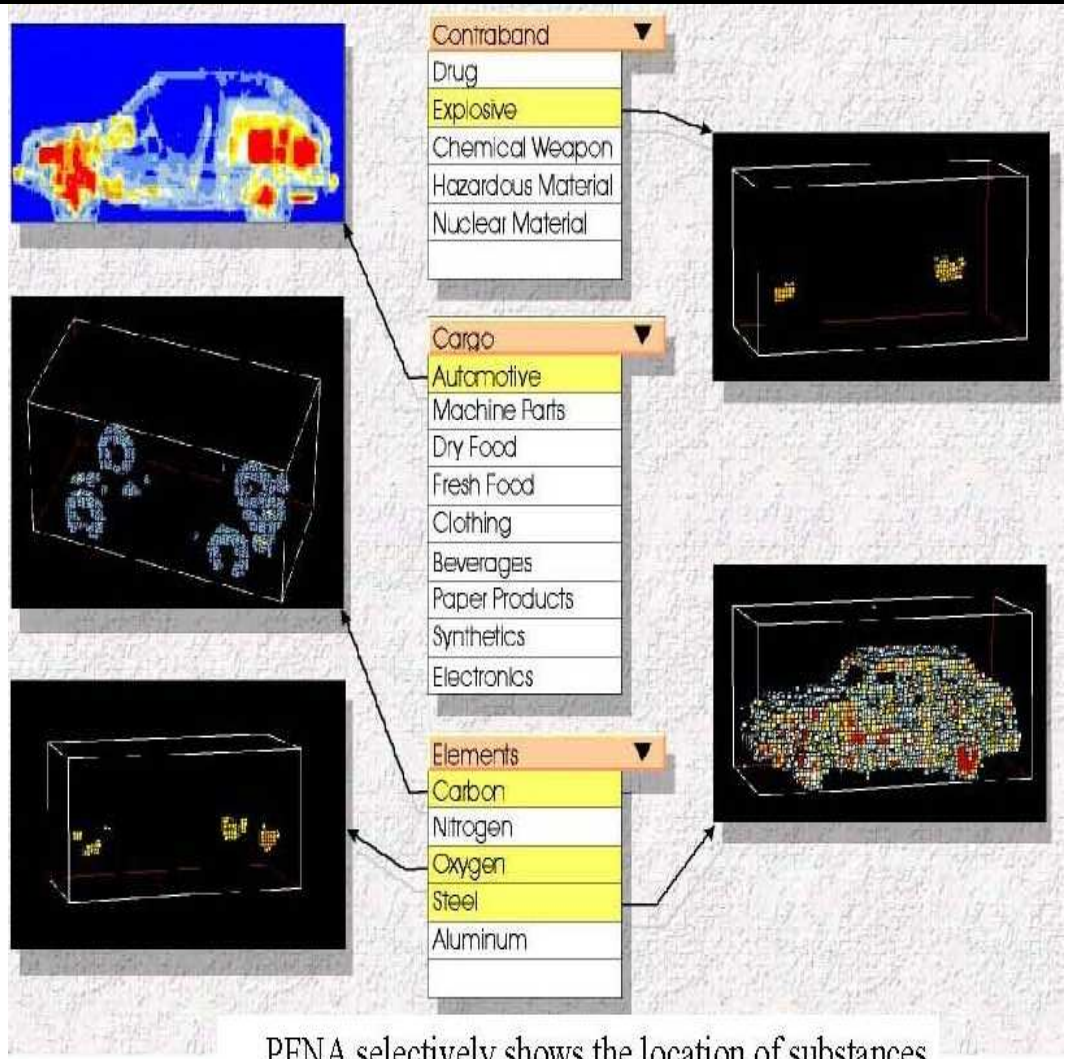
QUANTITATIVE RISK ACCEPTABILITY FOR TERRORIST ATTACKS

#	Description	Risk Reference	Proportionality by Degree of Voluntarism (F1)	Derating – Cost Benefit Balance (F2)	Controllability (F3)	Risk Acceptability (Risk Reference x F1 x F2 x F3) Result
1	Intruding into US illegally for inflow of chemical threats and aliens	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	0.5	5×10^{-13}
2	Terrorists purchased or leased properties near Recharge Area System and/or Water Supply System	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-2}	.1	1×10^{-11}
3	Installation of Underground Tanks or Station to inject/discharge Chemical Threats (Cyanide or Arsenic	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-2}	.1	1×10^{-12}
4	Injection/discharge of Chemical Threats From Mexico/Canada (on US Borders) to US Groundwater or Water Supply System	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.01	1×10^{-14}
5	Injection/discharge of Cyanide/Arsenic on Sinkholes, Faults and Cracks towards Aquifer System	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.001	1×10^{-15}
6	Immediately dump truck loads of Cyanide and Arsenic directly to unsecured Aquifer Recharge System	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.005	5×10^{-15}
7	Intrusion of Terrorist(s) to Water Supply System Facilities	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.01	1×10^{-14}
8	Injection of Cyanide and Arsenic to "Artificial Aquifer Recharge" (Aquifer Storage and Recovery Area)	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.01	1×10^{-14}
9	Severe Groundwater Contamination (and/or Water Supply System	1×10^{-6} Man Originated Catastrophic Involuntary	1×10^{-2}	1×10^{-4}	.0001	7×10^{-16}

PULSE FAST NEUTRON ANALYSIS (PFNA) FACILITY



The heart of the PFNA Cargo Inspection System is the pulsed neutron production and scanning systems.



PFNA selectively shows the location of substances based on gamma ray "fingerprints."

PROPOSED ENHANCED PROTECTIVE MEASURES AGAINST

	DESCRIPTION
Groundwater & Water Supply System Security	Groundwater and water supply system *source point* should be fenced, be well lighted, and have a perimeter that is monitored by surveillance cameras and motion detectors with chemical threats detectors on wells.
Water Infrastructure Security	To prevent hacking, supervisory control and data acquisition systems for monitoring and controlling water parameters should not be connected to the Internet. Remaining cyber security should be enhanced, and passwords should be changed regularly.
Grants for Research and Protection Policies Development	The United States (US) Government through USEPA should give grants for research and protection policies development for groundwater resources and water supply system, including ensuring secured or tamperproof entry points to the water distribution system. Surveillance cameras should be located on-site at key points, such as at the groundwater aquifer recharge zone, aquifer artificial recharge facilities, chlorine storage facilities, chlorine injection areas, filter beds, hazardous chemical and fuel storage areas, and finished water storage areas.
Grants for Research and Technology Development to Enhanced Security & Protection for Water Infrastructure	The US Government through USEPA should give grants for research on technology and policy development for detecting chemical treats in the underground tank or above tank, monitoring wells and major recharge area system. High or pure concentration of Arsenic, Cyanide and other chemicals that cannot be destroyed easily by standard treatment system shall be detected by a special type of sensor and telemetry control with alarm to help notify authorities or governing agencies of illegal discharge and leaks immediately prior contamination.
Grants for Research, Education, Advance Training & Symposium Development	The US Government through USEPA should give grants for education and advance training development related to Security/Protection Policies for Water Infrastructure.
Protection Measures for *Raw Water Supply System* against Terrorism.	Residential, commercial and agricultural industries that depend on *raw water system* (untreated water) need to install detectors and telemetry control with alarm notifying homeowners or administrators of the facilities for detection of high concentration of chemical threats such as Arsenic and Cyanide on their water main pipeline. Note: Shut off valves may be installed to avoid water flow within pipelines when contamination is detected.
Protection Measures for *Water Supply Storage and Treatment facilities (including wastewater treatment facilities)* against Terrorism.	1.) Mandatory installation of small or *mini-"Pulse Fast Neutron Analysis (FPNA) cargo inspection system"* similar to FPNA shown on Appendix 31 at the entry area of major and/or large water supply storage and treatment facilities including wastewater treatment system 2.) Chemical Threats (e.g. Cyanide & Arsenic) detectors with telemetry control shall be installed to any large above ground water supply storage tanks serving urban/metropolitan areas. 3.) "Shut-off systems shall be installed or constructed when severe contamination is detected to prevent discharge, flow or transport of contaminated water.

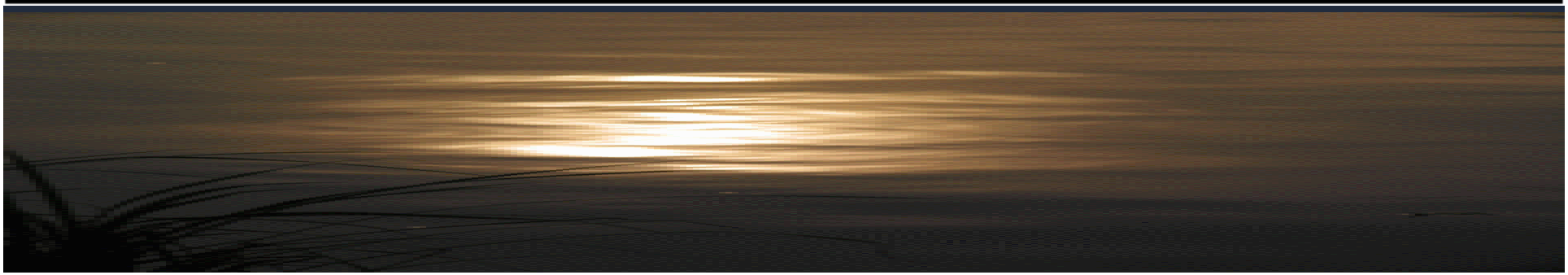
PROPOSED ENHANCED PROTECTIVE MEASURES AGAINST TERRORISM

	Description
Protection Measures for *Surface Water System* against Terrorism.	1.) Telemetry control with chemical threats detector notifying authorities and/or governing agencies shall be installed on underground storage tanks (e.g. water and wastewater treatment tanks) located near surface water system. 2.) Mandatory regular inspection by governing agencies on any underground storage tanks installed located near surface water system. 3.) Chemical threats detectors with telemetry controls notifying authorities, governing agencies and/or facility administrators similar or equivalent to "Pulse Fast Neutron Analysis (FPNA)" Cargo detector system (Appendix 31) shall be installed on entrance area leading to surface water system potential use for water supply (e.g., springs, lakes, reservoir, and rivers) (specially were dilution is difficult to acquire). 2.) "Shut-off systems (eg. valves, dams and any other designed structures)" to prevent discharge, flow or transport of contaminated water particularly to surface water system, storage system and water pipelines shall be installed or constructed when severe contamination is detected.
Protection Measures for *Treated Water Supply System* against Terrorism.	1.) Chemical threats detectors with telemetry control on monitoring area (e.g. monitoring well or monitoring small reservoir notifying authorities, governing agencies and/or facility administrators on treated water supply storage system facilities. 2.) "Shut-off systems (eg. valves and structures)" shall be installed or constructed to prevent discharge, flow or transport of contaminated water storage system and pipelines when severe contamination is detected.
Protection Measures for *Aquifers, Surface Waters and Water Storage Systems located on or near US Borders (Mexico and Canada)* against Terrorism.	1.) Monitoring System (e.g. monitoring wells or basins) with chemical threats detector and telemetry controls notifying authorities and governing agencies shall be installed on Aquifers Recharge Areas and Surface Waters located along US Borders. 2.) "Shut-off systems (eg. valves and structures)" shall be installed or constructed to prevent discharge, flow or transport of contaminated water particularly to surface water system, storage system and water pipelines when severe contamination is detected. 3.) All other protection measures mentioned above shall be applied.
Preventive Measures against *Illegal inflow of Chemical Threats & Terrorist Activities along US Borders*	1.) Mandatory installation of "*Pulse Fast Neutron Analysis (FPNA) cargo inspection system*" similar to FPNA shown on Appendix 31 on US Borders (Canada and Mexico) Port of Entry. 2.) Mandatory installation of "*Pulse Fast Neutron Analysis (FPNA) cargo inspection system*" similar or equivalent to FPNA shown on Appendix 31 located on Interstate Border Checkpoints. 3.) Mandatory regular inspection by governing agencies to any ongoing constructions or other major activities on properties and or open land on US borders. 4.) Mandatory regular inspection by authorities and governing agencies to any Residential, Commercial and Agricultural Industries located on US borders. 5.) US Borders should be fenced, be well lighted, and have a perimeter that is monitored by surveillance cameras and motion detectors (infrared rays). 6.) Wide easements should be required on future developments from US Borders.

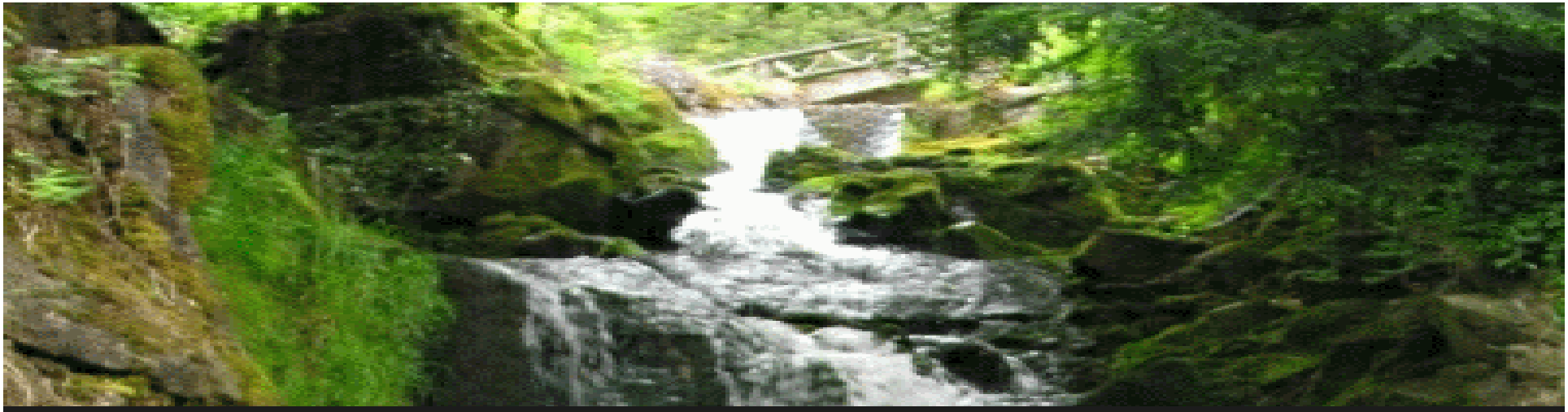
	Description
Chemical Threats	1.) Arsenic should be included in the CIA and Homeland Security Handbook as one of the Chemical weapon. 2.) Legal documentations should be required upon purchasing of large quantity of Chemicals. 3.) Sophisticated Security System should be installed on Chemicals facilities.

ALTERNATIVES

#	ALTERNATIVE (BASED UPON PROPOSED PROTECTIVE MEASURES)	ESTIMATED RISK	RISK REFERENT
1	Business as Usual	4.33×10^{-8}	1×10^{-1}
2	Groundwater and Water Supply System source point should be fenced, be well lighted and have a perimeter that is monitored by surveillance cameras and motion detectors with chemical threats detectors on wells.	9.5×10^{-18}	1×10^{-16}
3	(a) Monitoring System (e.g. monitoring wells or basins) with chemical threats detector and telemetry controls/control panels notifying authorities and governing agencies shall be installed on Aquifer Recharge System Areas and Surface Waters located along US Borders. (b) Shut-off systems (e.g. valves and structures) shall be installed or constructed to prevent discharge, flow or transport of contaminants to surface water systems, storage systems and water pipelines when severe contamination is detected. (c) Mandatory Inspection by governing agencies	9.5×10^{-16}	1.5×10^{-16}



Commercial & Residential Development on Top of Recharge zone.
Recharge Zone is open to Public for Enjoyment



Unfortunately, There have been no studies conducted,

Nor historical data collected which can be utilized

explicitly to determine risk associated

with Critical Infrastructure Destruction (e.g. Groundwater & Water Supply System)

from terror threats.

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THANK YOU.