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14. ABSTRACT
This slide presentation summarizes the results of streamlined, risk-based corrective action (RBCA) assessments performed at nine Air Force sites with fuel-contaminated groundwater. The goal of this risk-based remediation approach was to find the most cost-effective method of reducing current and future potential risk by combining chemical source reduction, chemical migration control, and receptor restriction risk-reduction techniques.

15. SUBJECT TERMS
risk-based, RBCA, risk reduction, natural attenuation, fuel hydrocarbons, source resuction, biodegradation, groundwater remediation, geochemistry, contaminant destruction rates

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Streamlined and Cost-Effective Closure of Petroleum Contaminated Sites

Presented by

John R. Hicks

Parsons

Parsons Engineering Science, Inc.

Objectives

- Demonstrate a more affordable risk-based site closure process for small petroleum sites
- Take advantage of RBCA rules recently promulgated by many states, and of increasing acceptance of natural attenuation as a remedial alternative

Site Descriptions

- 9 sites in 4 states (TX, MS, FL, NC)
- 6 gas stations, 1 fire training area, 1 jet fuel pipeline leak, 1 heating oil tank farm
- Size of contaminated area ranges from 1 to 7 acres (average 2.5 acres)

Air Force Streamlined Risk-Based Closure Initiative Locations

Project Elements

- Field site characterization
- Tier 1 screening to determine COPCs
- Natural attenuation analysis
- BIOSCREEN fate and transport modeling
- Tier 2 risk assessment
- Optional focused feasibility study

Typical Scope of Field Activities

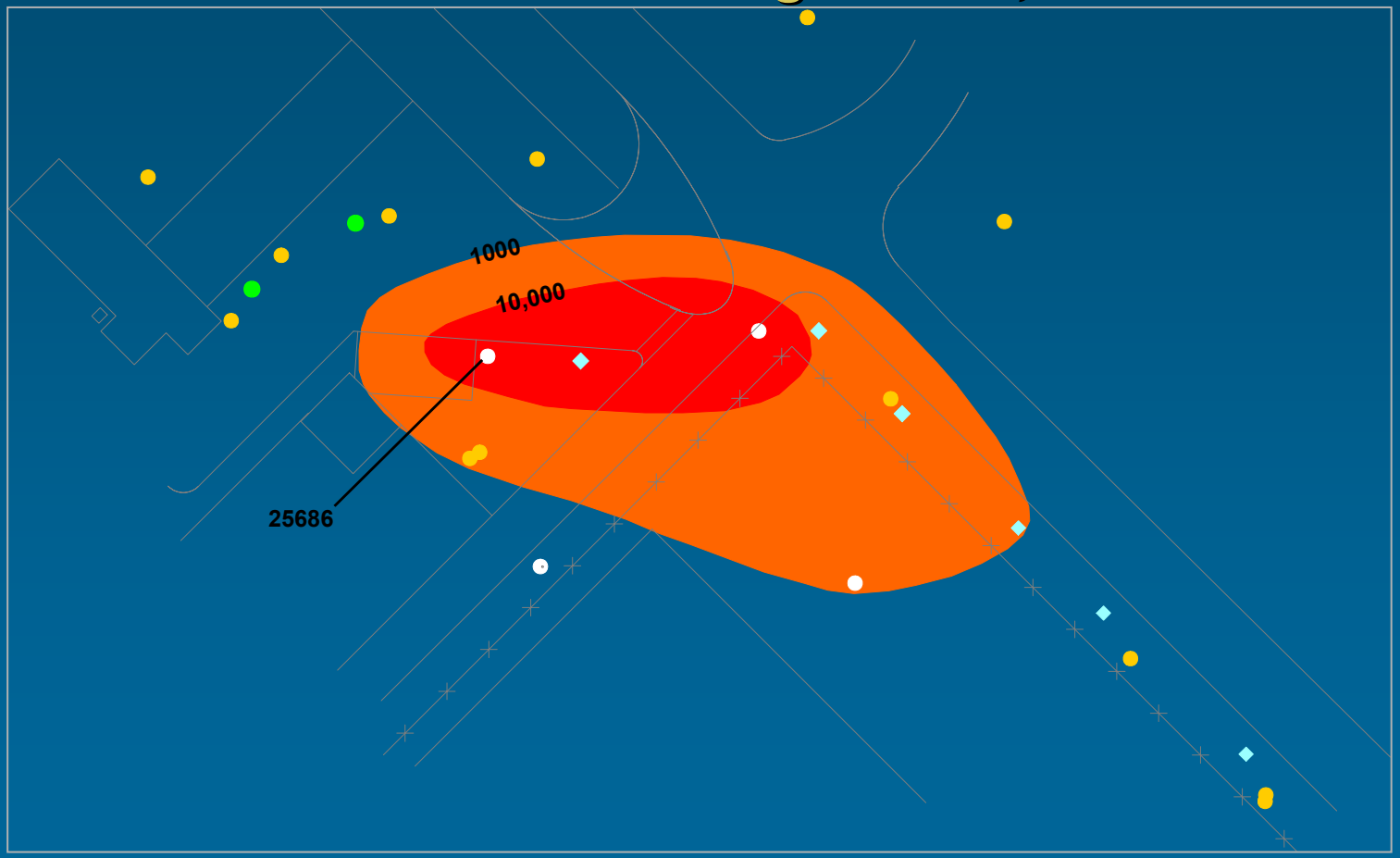
- **Use a Geoprobe® to collect soil samples and install small-diameter groundwater monitoring points (inexpensive, easy to use, no wastes)**
- **Average 4 days of field work**

Case Study: Seventh Street Service Station, Eglin AFB, FL

- Gasoline leak reported 1983 (est. 3600 gal)
- 2 product recovery wells, 6 GW recovery wells, air stripper, operational 1989
- Recirculating bioventing system installed 1992
- Periodic groundwater monitoring

BTEX in Groundwater

Seventh Street Service Station - Eglin AFB, FL



Tier 1 Screening

- **Identify chemicals of potential concern**
- **Conservative, generic RBSLs typically available in look-up tables prepared by the State**
- **Sometimes developed for industrial sites**
- **No soil gas RBSLs developed--used OSHA PELs/TLVs**

Tier 1 Screening Summary

Seventh Street Service Station - Eglin AFB, FL

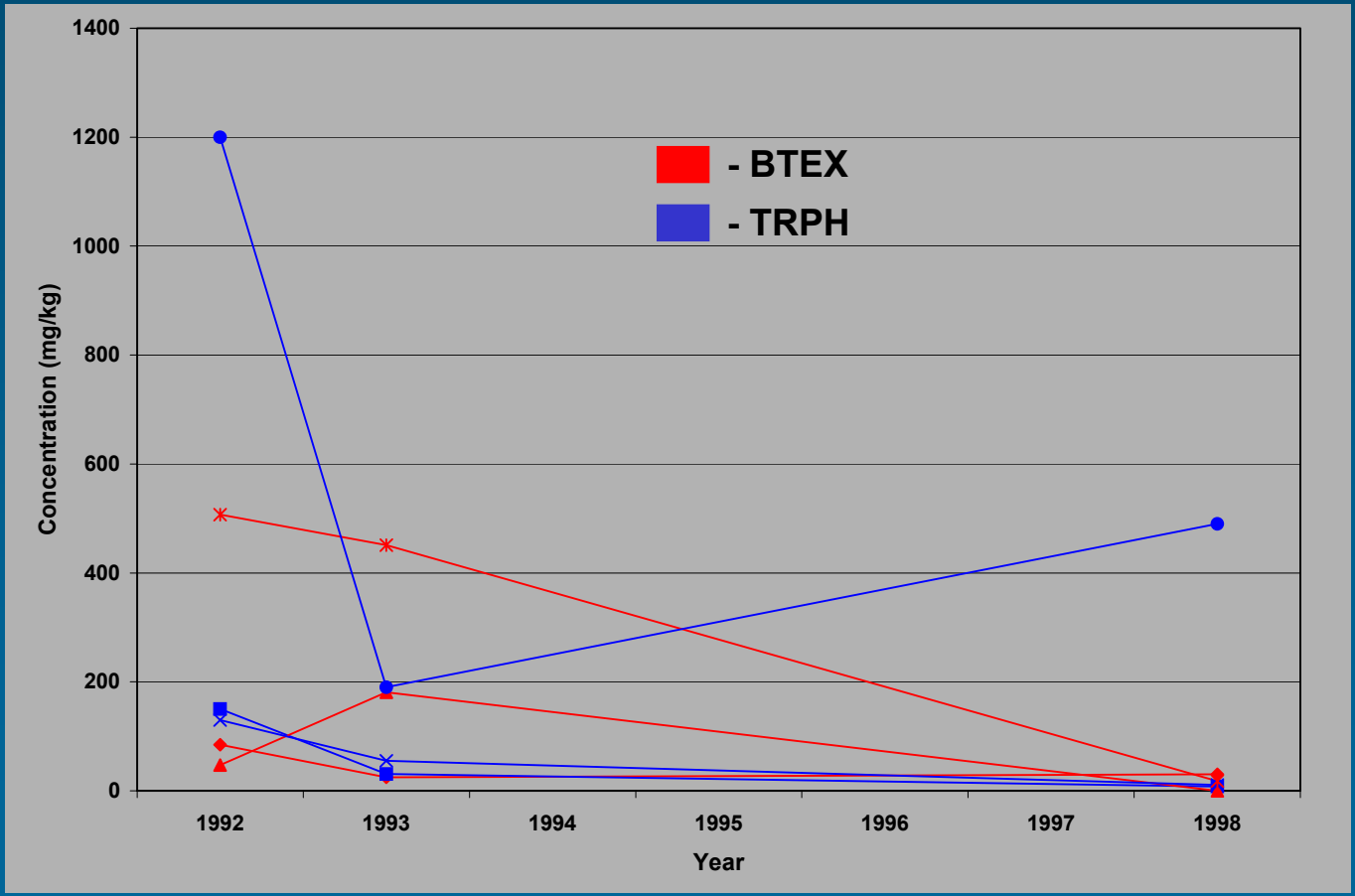
COPC	Matrix	Units	Maximum Detection	Tier 1 RBSL
Ethylbenzene	Soil	mg/kg	710	240
Xylenes (total)	Soil	mg/kg	1,400	290
Benzene	GW	µg/L	86	1
Toluene	GW	µg/L	11,000	40
Ethylbenzene	GW	µg/L	1,600	30
Xylenes (total)	GW	µg/L	13,000	20
Naphthalene	GW	µg/L	510	20
TRPH	GW	µg/L	38	5
Lead	GW	µg/L	19	15

Natural Attenuation Analysis

- **Are COPCs naturally attenuating over time?**
- **What attenuation processes are significant?**
- **How much dissolved contaminant mass can be degraded?**
- **What are site-specific biodegradation rates for "risk-driver" chemicals?**

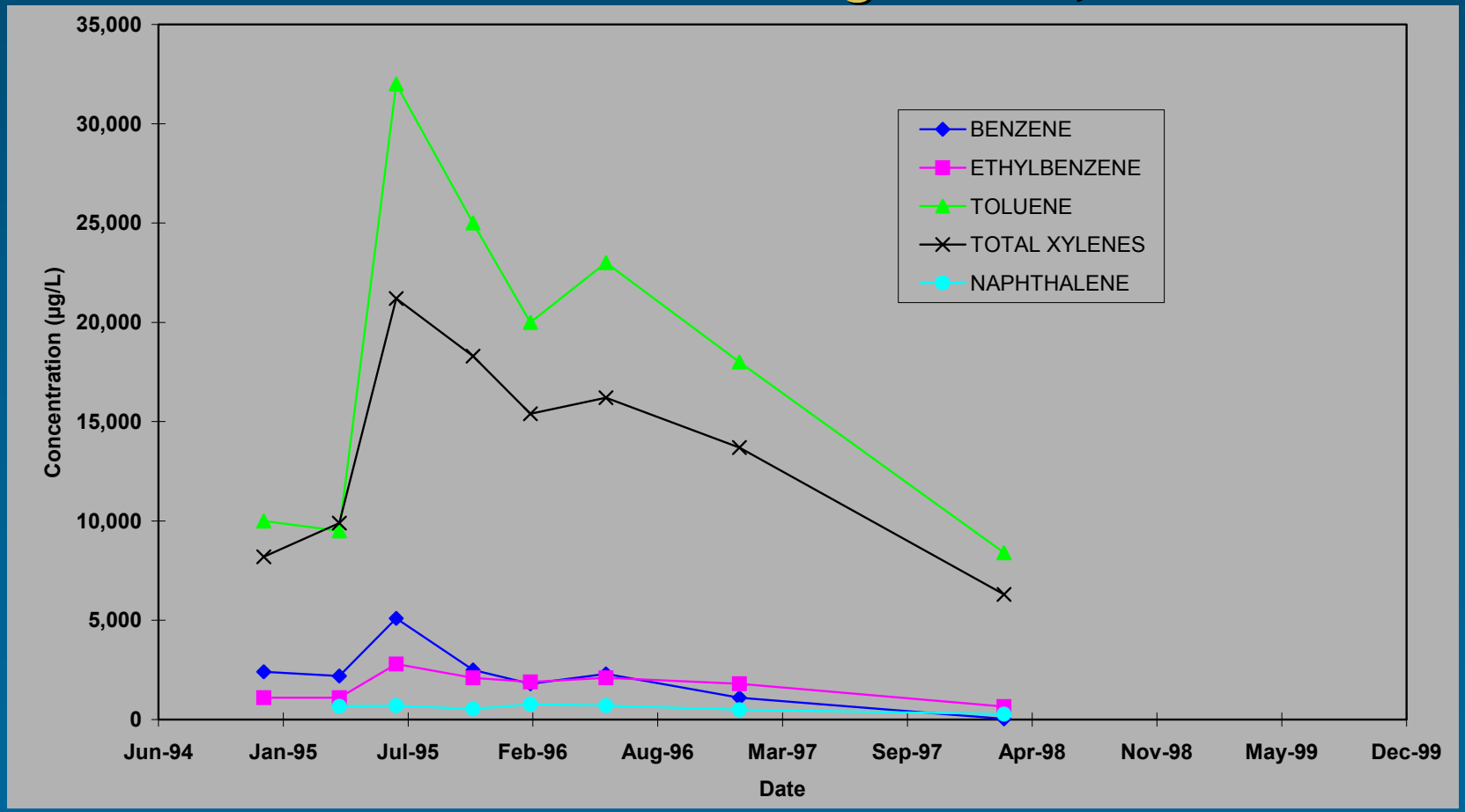
BTEX and TRPH in Soil Over Time

Seventh Street Service Station - Eglin AFB, FL



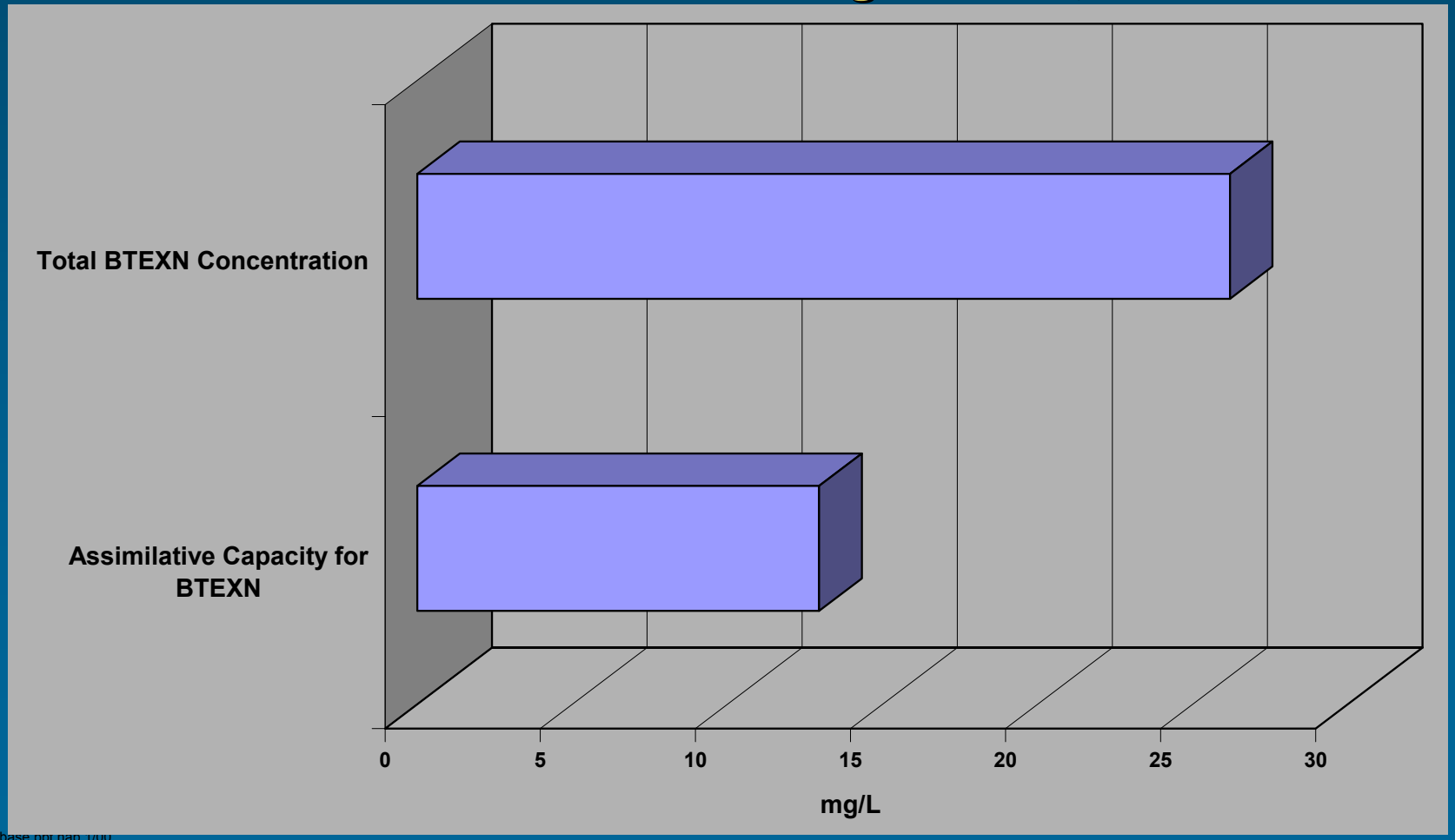
Dissolved COPC Concentrations vs Time at MW-2

Seventh Street Service Station - Eglin AFB, FL



Assimilative Capacity of Groundwater

Seventh Street Service Station - Eglin AFB, FL



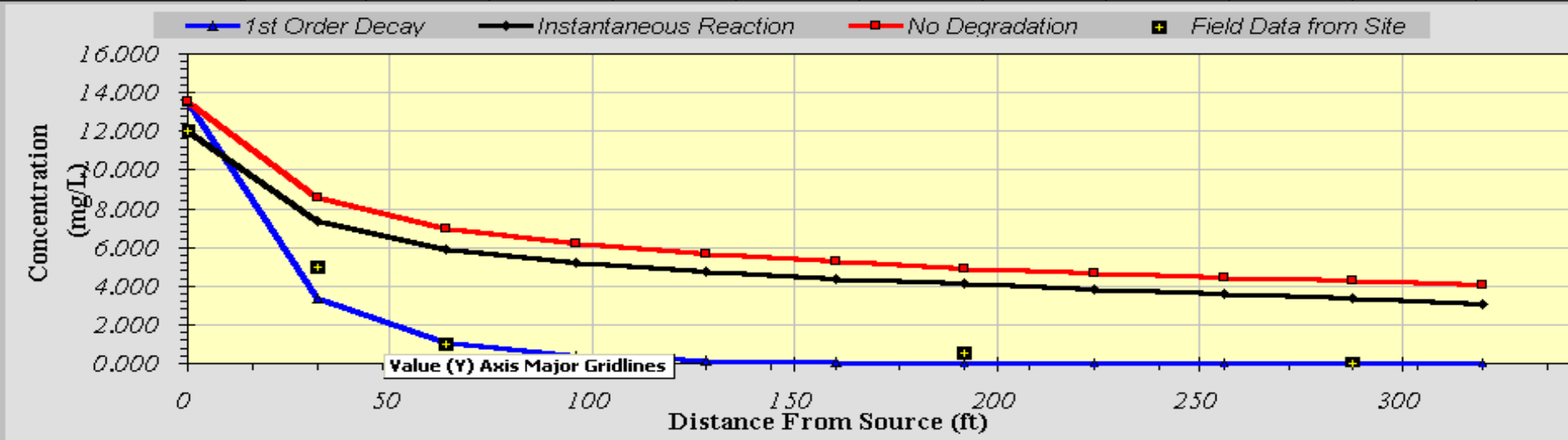
Biodegradation Rates for BTEX

Seventh Street Service Station - Eglin AFB, FL

Method	Rate (day^{-1})	Half-Life (year)
TMB Tracer	0.006	0.3
Busheck and Alcantar (1995)	0.01	0.2
Shrinking Plume Method	0.008	0.2

Bioscreen Output - Concentrations Along Plume Centerline

TYPE OF MODEL	Distance from Source (ft) 0	32	64	96	128	160	192	224	256	288	320
No Degradation	13.544	8.586	6.990	6.183	5.649	5.252	4.936	4.674	4.451	4.256	4.081
1st Order Decay	13.544	3.341	1.059	0.364	0.130	0.047	0.017	0.006	0.002	0.001	0.000
Inst. Reaction	12.021	7.387	5.927	5.208	4.742	4.392	4.101	3.841	3.595	3.352	3.099
Field Data from Site	12.000	5.000	1.000				0.500			0.001	



Calculate Animation

Time: 6 Years

Return to Input

Recalculate This Sheet

Bioscreen Input

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or
0.02 → 2. Calculate by filling in grey cells below. (To restore formulas, hit button below)

Variable* → *Data used directly in model.*
20 → *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	Vs	113.8	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	13.3	(ft)
Transverse Dispersivity*	alpha y	1.3	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	280	(ft)

3. ADSORPTION

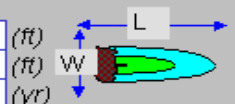
Retardation Factor*	R	1.0	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	38	(L/kg)
FractionOrganicCarbon	foc	5.7E-5	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	4.6E+0	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	1.65	(mg/L)
Delta Nitrate*	NO3	0.7	(mg/L)
Observed Ferrous Iron*	Fe2+	16.6	(mg/L)
Delta Sulfate*	SO4	22.4	(mg/L)
Observed Methane*	CH4	6.6	(mg/L)

5. GENERAL

Modeled Area Length*	320	(ft)
Modeled Area Width*	200	(ft)
Simulation Time*	6	(yr)



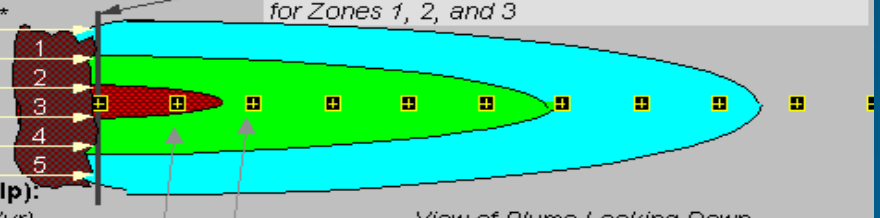
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
28	0.057
30	2.508
14	13.68
30	2.508
28	0.057

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



Source Halflife (see Help):

60	400 (yr)
Inst. React.	1st Order
Soluble Mass	2000 (Kg)
In Source NAPL, Soil	

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	12.0	5.0	1.0				.5			.001	
Dist. from Source (ft)	0	32	64	96	128	160	192	224	256	288	320

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Modeling Objectives for Eglin AFB

- Estimate the max. migration distance of the plume assuming that the pump and treat and bioventing systems are not operating
- Assess plume persistence over time
- Support selection of remedial actions
- Simulated fate and transport of xylenes and benzene (2 remedial scenarios)

BIOSCREEN Results
(Scenario 1-- No Engineered Remedial Action)

- **Xylene plume will migrate up to 950 feet from source area in 20 years, then recede**
- **Xylene plume will not reach Weekly Pond**
- **Maximum dissolved xylene concentration will be < Tier 1 RBSL within 150 years**
- **Benzene plume will not migrate to Weekly Pond**

BIOSCREEN Results
(Scenario 2-- 80% Source Removal in 3 Years)

- **Xylene plume will migrate up to 600 feet from source area within 10-15 years, then recede**

- **Maximum dissolved xylene concentration will be < Tier 1 RBSL within 30 years**

Tier 2 Comparison to SSTLS

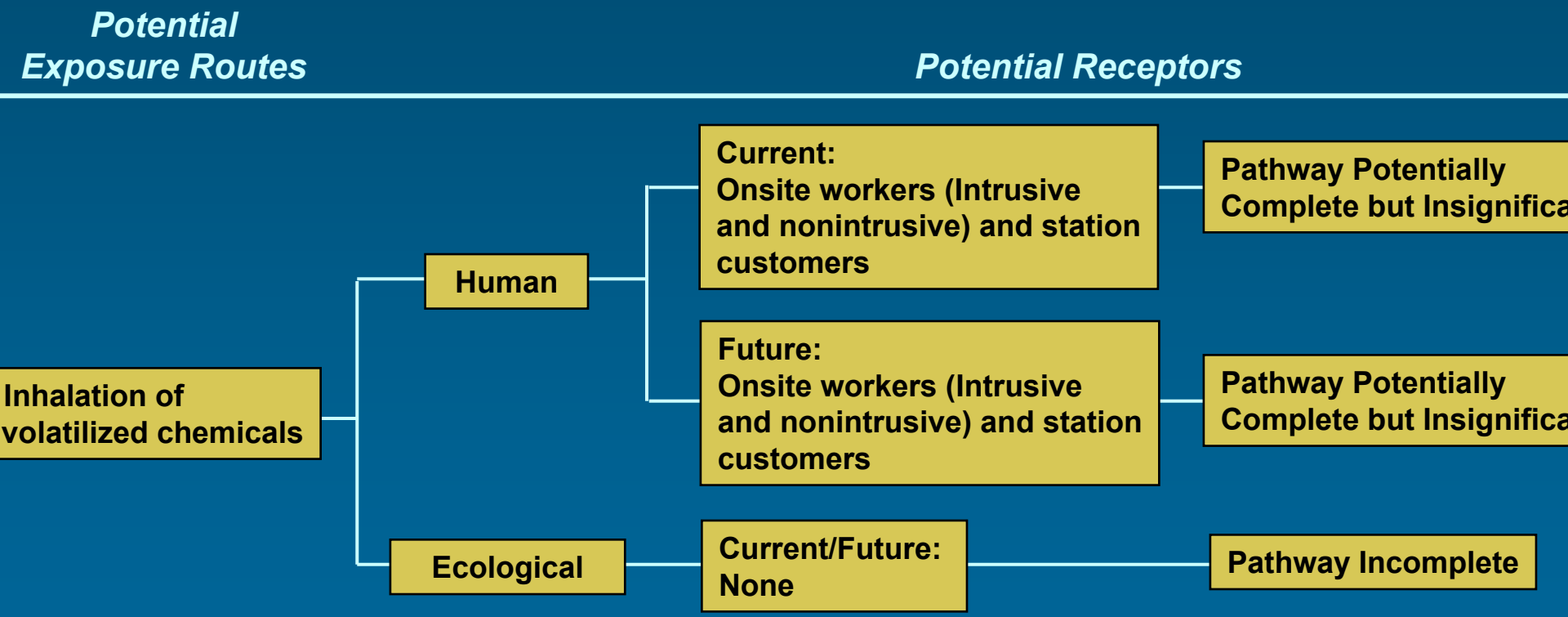
Seventh Street Service Station - Eglin AFB, FL

COPC	Matrix	Units	Maximum Detection	Tier 2 Health-Based SSTL	Max. Detect Exceeds SSTL
Ethylbenzene	Soil	mg/kg	710	240	No
Xylenes	Soil	mg/kg	1,400	290	No
Benzene	GW	µg/L	86	1	No
Toluene	GW	µg/L	11,000	40	No
Ethylbenzene	GW	µg/L	1,600	30	No
Xylenes (total)	GW	µg/L	13,000	20	No
Naphthalene	GW	µg/L	510	20	No

SSTL = Site-Specific Target Level

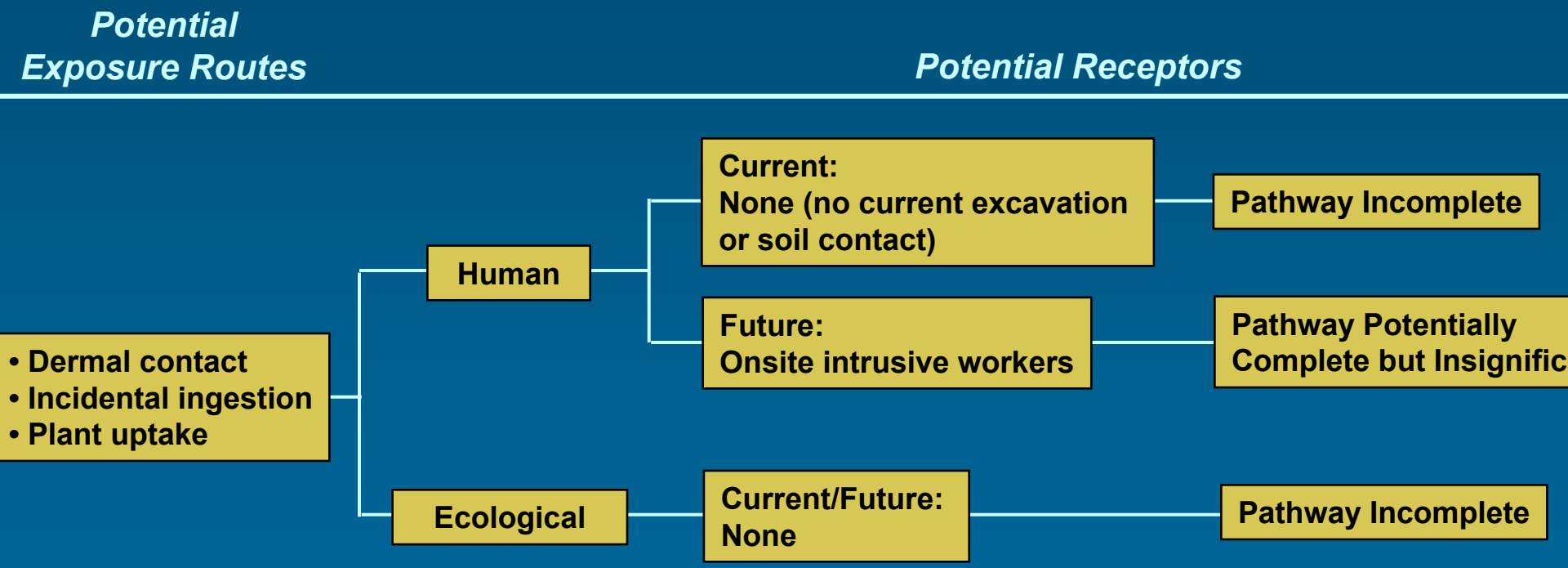
Conceptual Site Model for Air

Seventh Street Service Station - Eglin AFB, FL



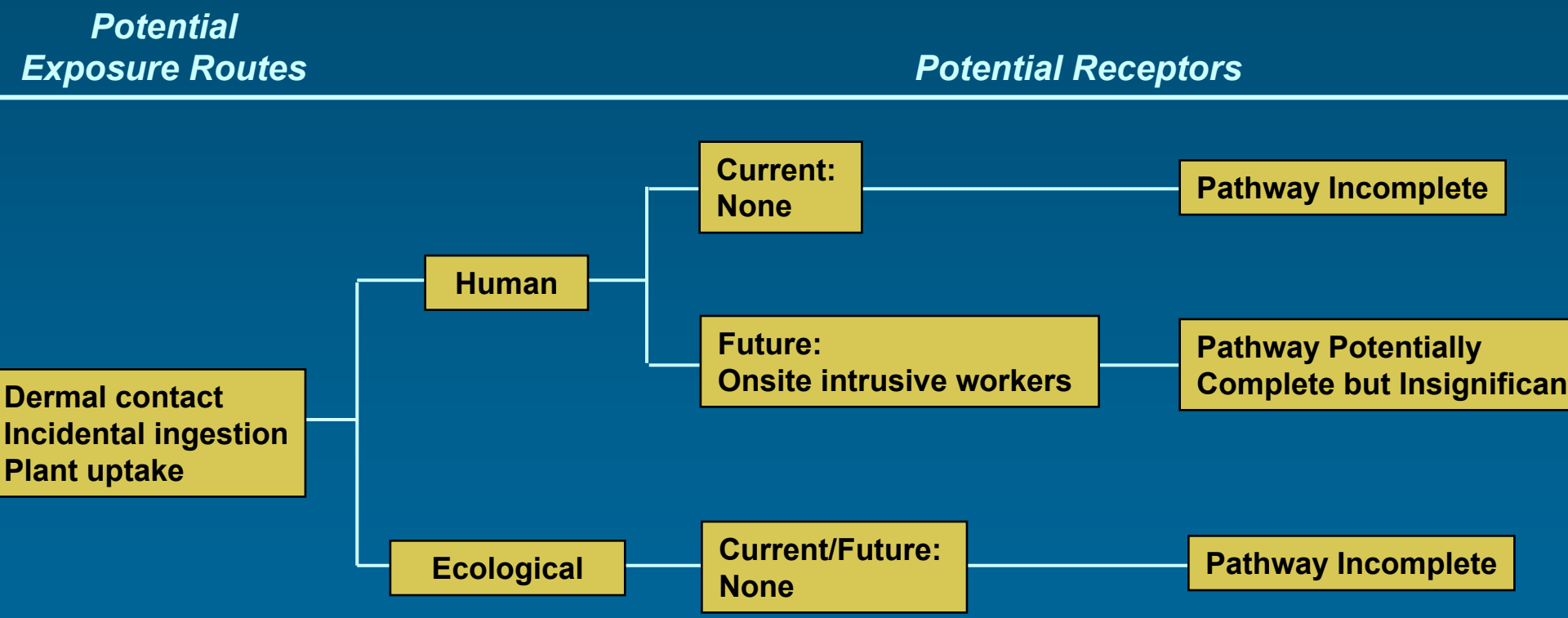
Conceptual Site Model for Soil

Seventh Street Service Station - Eglin AFB, FL



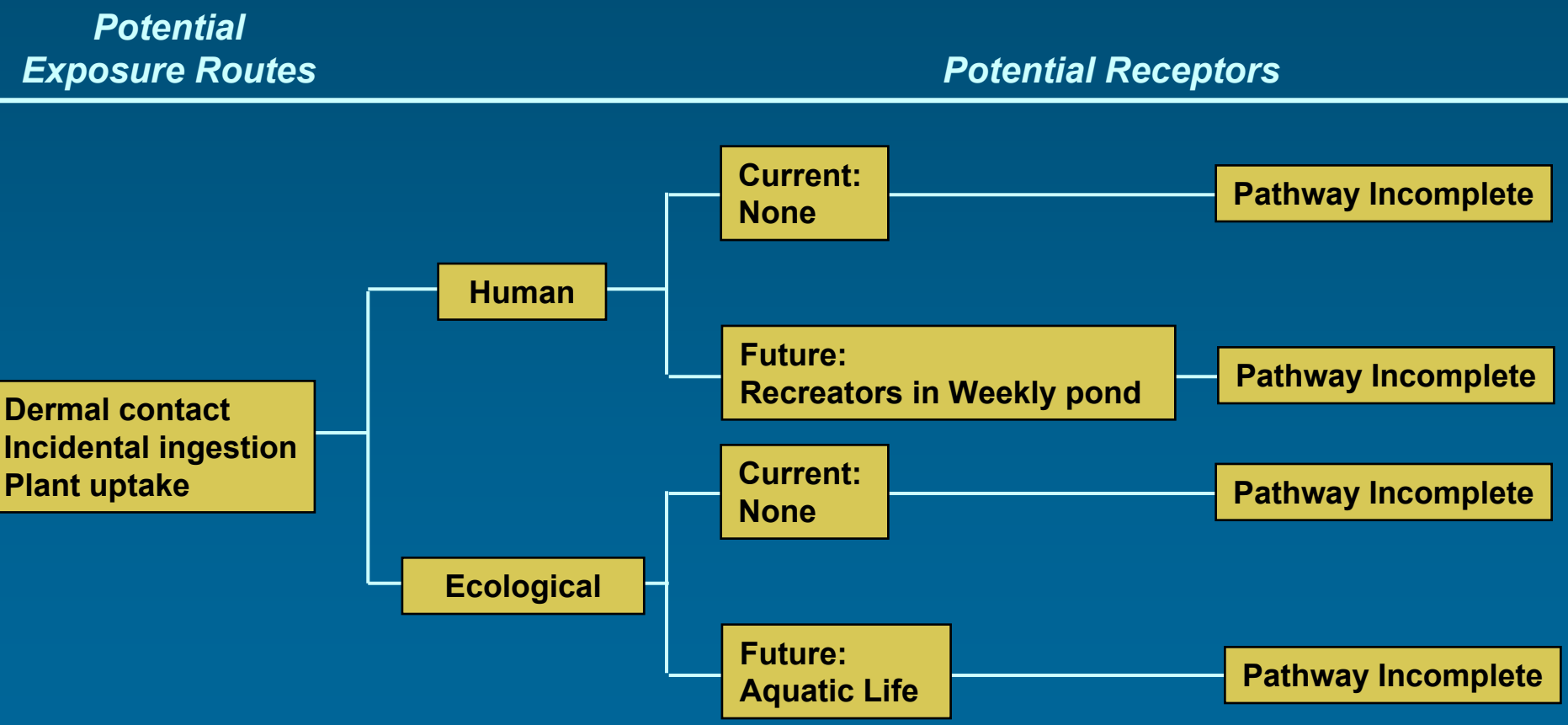
Conceptual Site Model for Shallow Groundwater

Seventh Street Service Station - Eglin AFB, FL

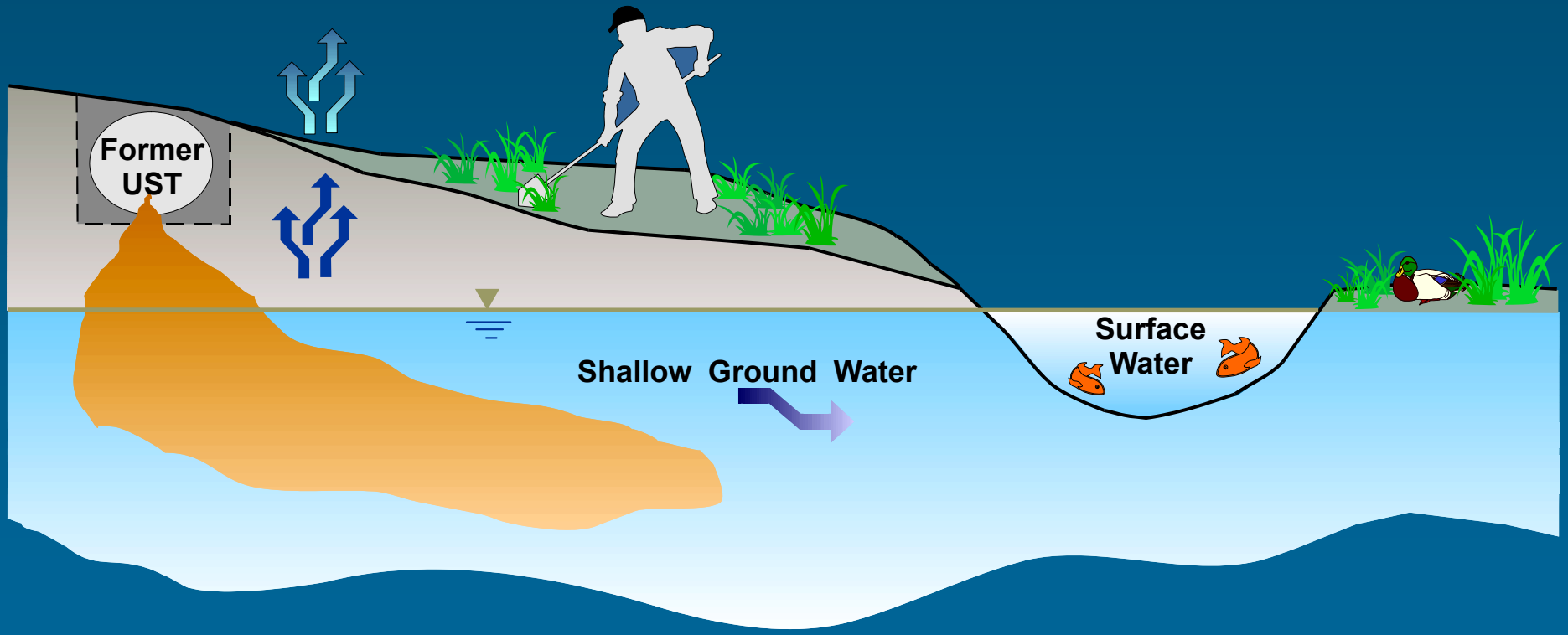


Conceptual Site Model for Surface Water

Seventh Street Service Station - Eglin AFB, FL

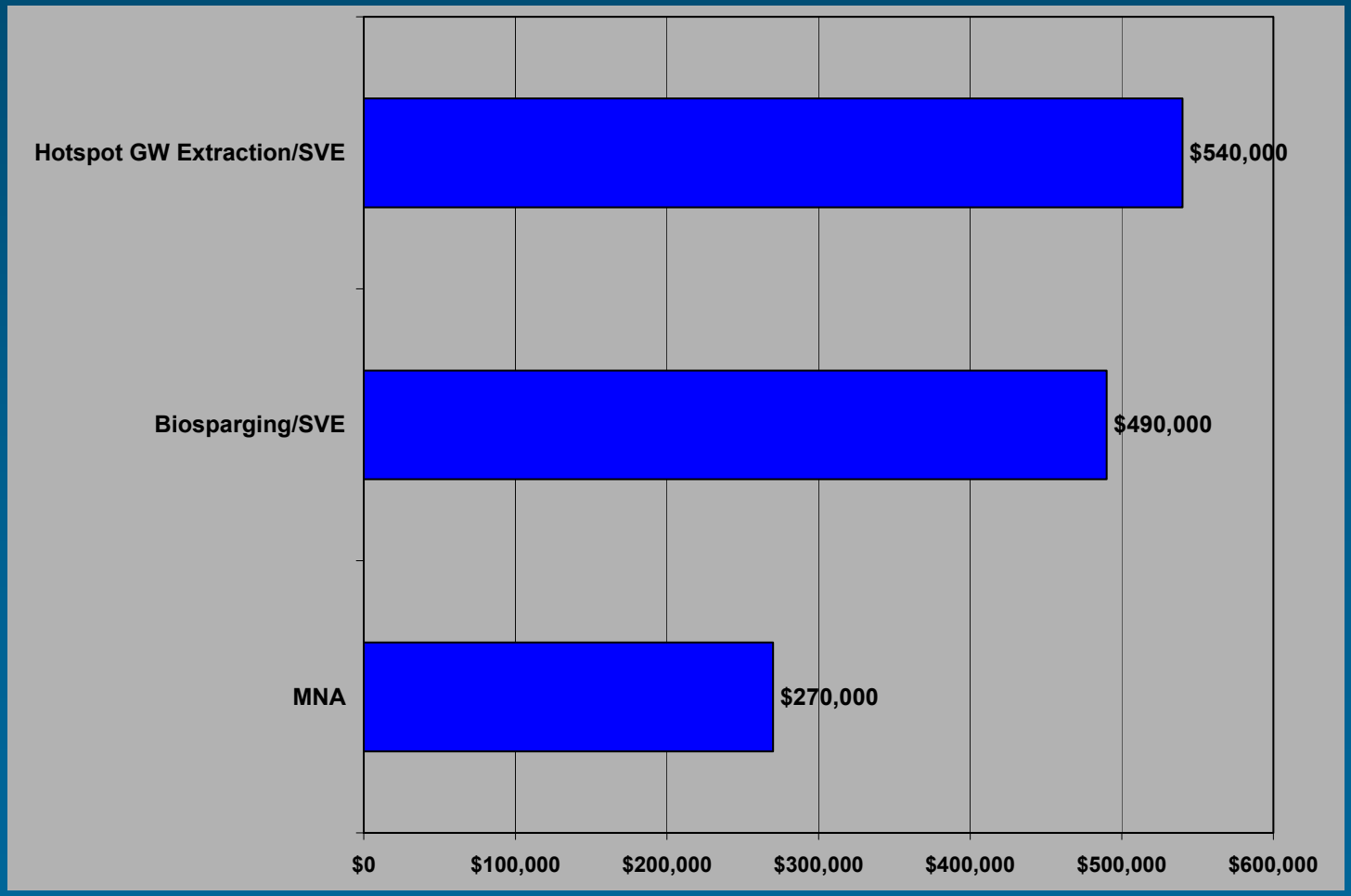


Conceptual Site Model



Remedial Alternatives Evaluation

Seventh Street Service Station - Eglin AFB, FL



Summary and Conclusions - Eglin AFB

- COPCs are biodegrading
- No significant risk to potential receptors
- Institutional controls can be maintained
- GW pumping not required to protect receptors
- COPCs in GW > RBSLs for >100 yrs unless engineered source reduction is performed
- Alternatives 2 or 3 will substantially accelerate cleanup

Recommendations and Site Status

Site	Recommendation	Status
Kelly AFB	Immediate Closure	Closure Granted
Randolph AFB	Conditional Closure	Conditional Closure
Keesler AFB	Conditional Closure	Conditional Closure
Eglin 7th St SS	MNA + Biosparging/SVE	Plan to Biosparge Source Area
Eglin Milgas	Conditional Closure	New Release-Return to Start
Tyndall BX SS	MNA	MNA +Source Reduction
Tyndall FT-16	Conditional Closure	Conditional Closure
Seymour Johnson	Product Recovery, then Closure	Product Recovery, then Closur
Pope AFB	No Recommendation	Regulatory Review

Average Streamlined RBCA Site Costs

	Average Cost Assuming Geoprobe® Rental and Subcontracted Drilling
Labor	$32,000
Other Direct Costs	$10,600
Project Management	$4,000
Average Cost per Site	**$46,600**

Lessons Learned

- **Risk Assessment**
  - know the State RBCA requirements
  - use up-to-date and defensible data and algorithms
  - analyze soil gas samples
- **Value of Source Reduction**
  - regulators more likely to accept MNA
  - reduces risks to future intrusive workers and allows lower level of institutional control

Lessons Learned (continued)

- **Closure process for low-risk petroleum sites is being streamlined**
- **Feasible to perform entire RBCA process for <$50K per site**
- **Simple models acceptable to regulatory agencies**
- **Ability to limit exposure via institutional controls important**