



The miracles of science®

Overview of Human and Ecological Risk Assessment in Remedial Decisions

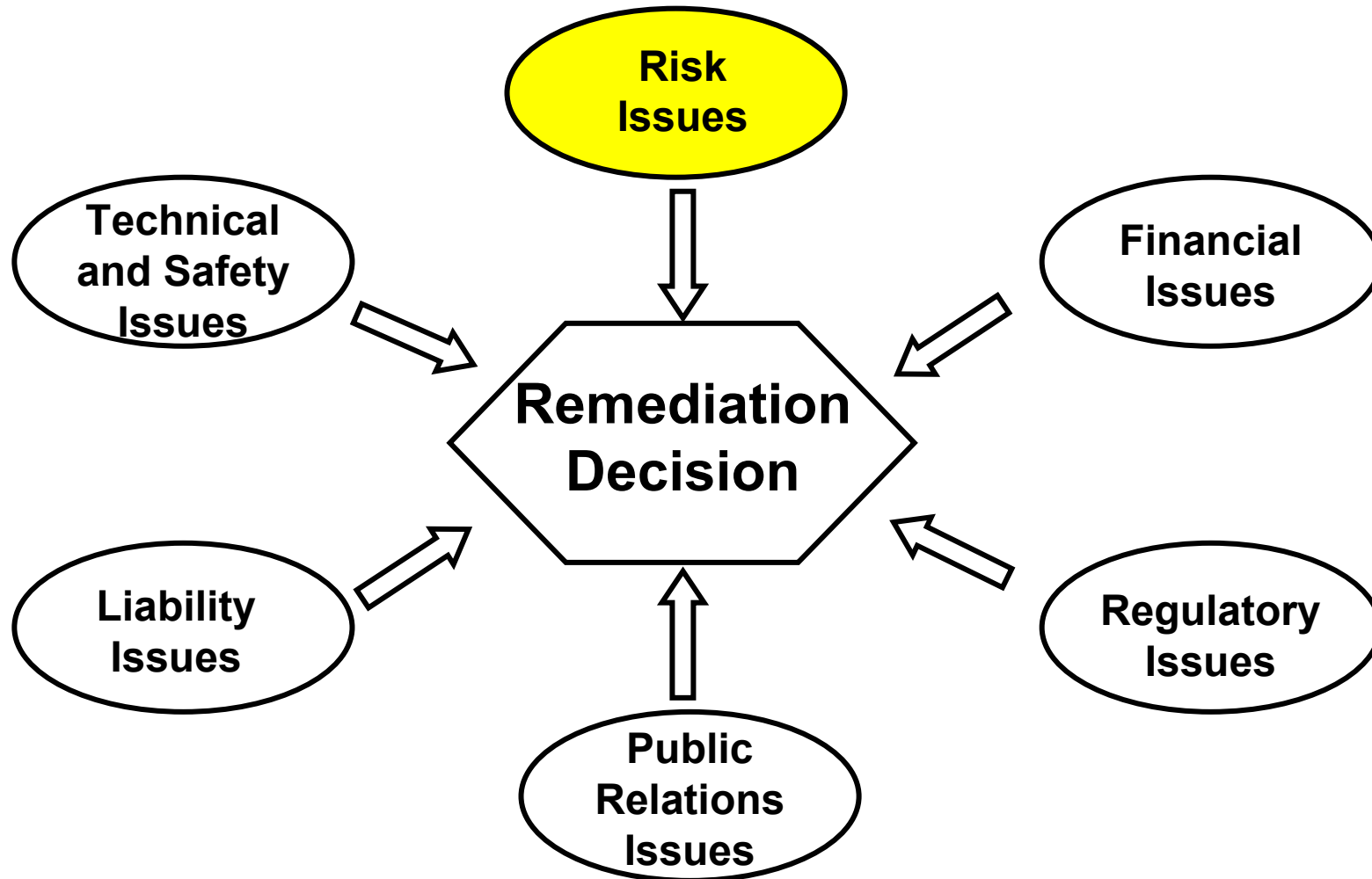
*Annette Guiseppi-Elie, Ph. D.
Principal Consultant, DuPont Engineering*

*Presented at
IV International Seminar on Remediation &
Redevelopment of Contaminated Sites
Sao Paulo, Brazil*

Risk in Remediation - Topics

- Introduction: use of risk in remediation
- General risk assessment principles
- Application of risk assessment
- Risk-based decision making (RBDM)
- Using risk in remedial decisions
- Key risk-based remediation messages

Remediation Decisions



Remediation: Key Early Steps

- Establish:
 - A multidisciplinary team (including human health and ecological risk assessors)
 - Open, frequent communication among team members
 - An open dialog between regulators and the regulated
- Understand:
 - Future land use
 - What is important to surrounding community

Main Themes...

- Focus on performance over process
- Make sure we are asking the right questions
- Make sure that there is a critical evaluation of the problem
- Perform realistic evaluations of risk, not hypothetical assessments
- Address the problem based on magnitude of risk versus simply investigating the problem

Topics

- Introduction: use of risk in remediation
- **General risk assessment principles**
- Application of risk assessment
- Risk-based decision making (RBDM)
- Using risk in remedial decisions
- Key risk-based remediation messages

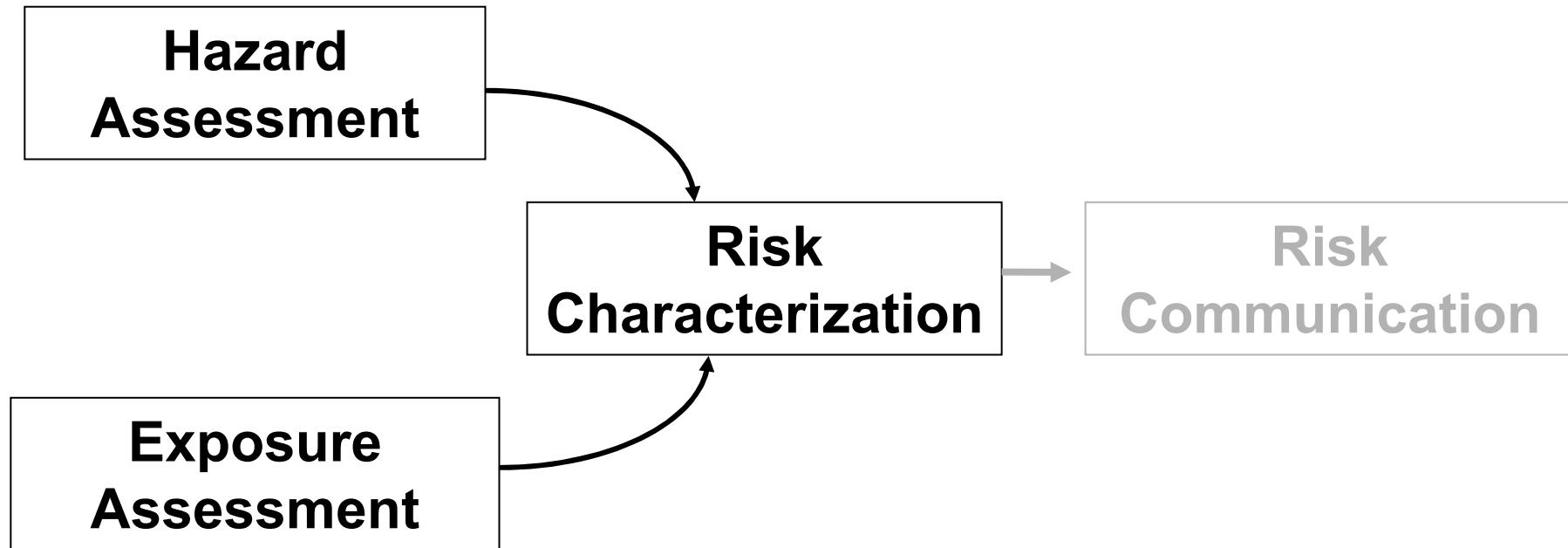
How Do We Define Risk?

Human Health Risk = Hazard x Exposure

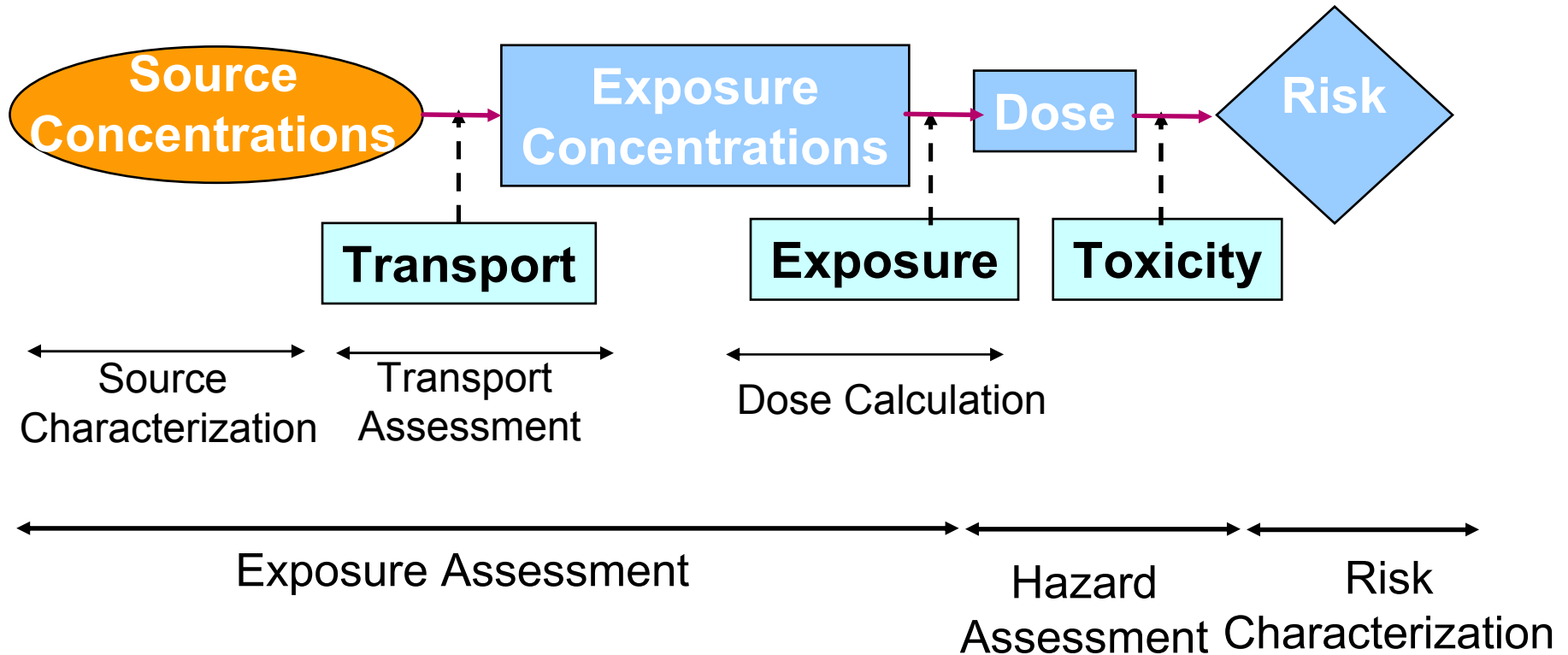
Ecological Risk = Stress x Exposure

Risk Assessment (RA) Paradigm...

Fundamental Steps



RAGS* Type Process



*RAGS = Risk Assessment Guidance for Superfund (USEPA Guidance)

The Basis for Hazard and Exposure Information...

$$\text{Risk} = f(\text{hazard}, \text{exposure})$$

Hazard Assessment:

- Toxicity Testing: General
- The Dose-Response Curve
- Carcinogens vs. Non-Carcinogens
- Output: Toxicity Criteria

Exposure Assessment:

- Exposure Pathways
- Quantifying Exposure
- Output: Average Daily Dose

Exposure Pathway Analysis

Groundwater Ingestion Example

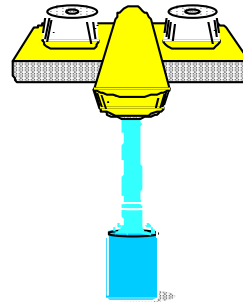
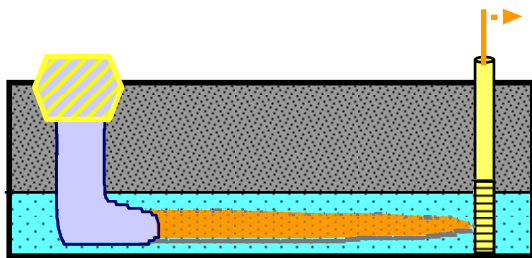
**Exposure
Concentration**

x

**Exposure
Factors**

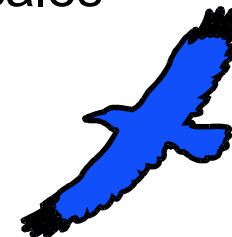
x

Hazard = Health Risk



Human Health vs. Ecological RA

- Human health
 - Multi-step paradigm
 - Single species (humans)
 - Heavy focus on cancer
 - Sensitive individuals and populations
 - Available toxicity database
- Ecological
 - Multi-step paradigm
 - Multiple species
 - Heavy focus on noncancer endpoints
 - Species and populations
 - Toxicity database lacking
 - Large spatial scales



Products of the Risk Assessment

- Who/What is at risk?
- What is causing the risk?
- What is the level of risk?
- What are the uncertainties?

Topics

- Introduction: use of risk in remediation
- General risk assessment principles
- **Application of risk assessment**
- Risk-based decision making (RBDM)
- Using risk in remedial decisions
- Key risk-based remediation messages

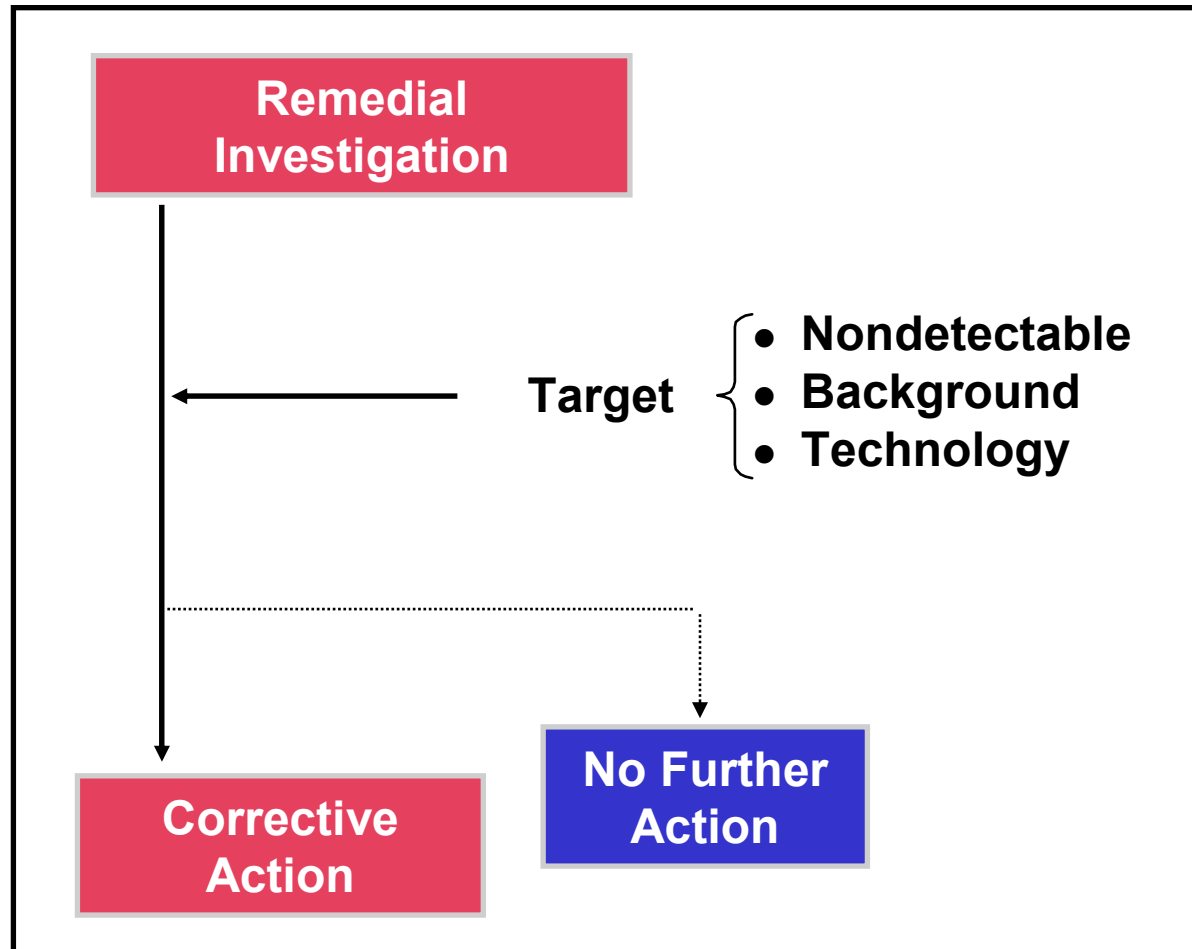
Applications of Risk Assessment

- In the context of our remediation program, both human health and ecological risk are used
- Prioritizing among multiple sites
- For a given site:
 - *Setting site strategy*
 - *Developing work plans*
 - *Setting priorities among different areas*
 - *Setting cleanup goals*
 - *Selecting a remedy*

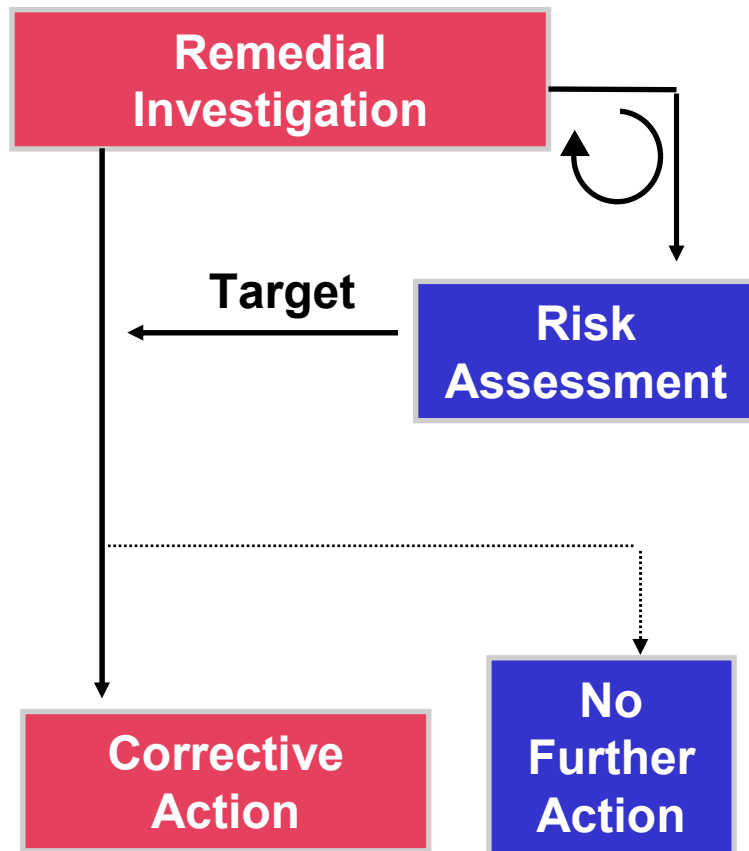
Topics

- Introduction: use of risk in remediation
- General risk assessment principles
- Application of risk assessment
- Risk-based decision making (RBDM)
- Using risk in remedial decisions
- Key risk-based remediation messages

Traditional Remediation Process



Risk-Based Decision Making (RBDM)



Characteristics

- Science-based
- Health protective
- Reflects contaminant / receptor
 - Toxicity
 - Exposure
- “Acceptable risk”
- Progresses from Screening to Site-specific

Benefits

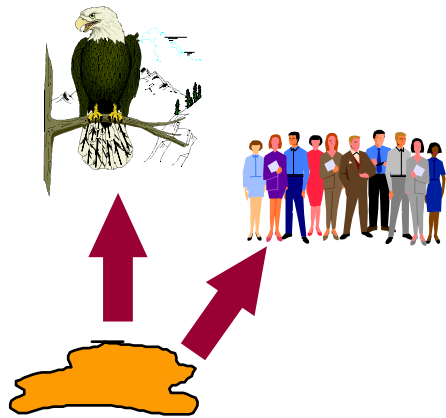
- Sound basis for decision making
- Effort consistent with site risk
- Flexible management options
- Cost-effective

The Concept of Tiers

- Use a stepwise, iterative approach
 - Data collection
 - Initial biasing of sample locations
 - Assessments
 - Screening (typically generic evaluation, simple but tends to overestimate risk)
 - Site-specific (typically more realistic evaluation but more complex, more time, and higher cost)

Conceptual Site Model (CSM)

Important tool in assessing risk and guiding data collection



- An inventory of sources, transport mechanisms, and receptors
- Pathway analysis
 - Focus on complete pathways
 - Current and reasonably foreseeable future land and water use
- Material characteristics (toxicity and physical/chemical)

Decision Making

- Use the weight of evidence
 - Start by evaluating all available information (chemistry, toxicology, geology, habitat, land use)
 - Focus effort on being as site-specific as possible
 - Collect additional data, if needed
 - Reduce uncertainty
 - Refine decision

Uncertainty

- What we do not know or areas where we are unsure (not the same as error or variability)
- Example - Extrapolations:
 - Laboratory to field
 - Surrogate species
 - Literature information vs. site-specific information
 - Individual effects to population and to community

Uncertainty Analysis

- Describes the unknowns
- Details extrapolations and assumptions
- Indicates impacts to the risk estimate
- May lead to further data collection
- Significantly impacts risk management decisions

Topics

- Introduction: use of risk in remediation
- General risk assessment principles
- Application of risk assessment
- Risk-based decision making (RBDM)
- **Using risk in remedial decisions**
- Key risk-based remediation messages

Remedy Selection

- Remedies should:
 - Be protective of human health and the environment
 - Not pose a greater risk than the current situation
 - Have a net environmental benefit

Controlling Exposure Manages Risk

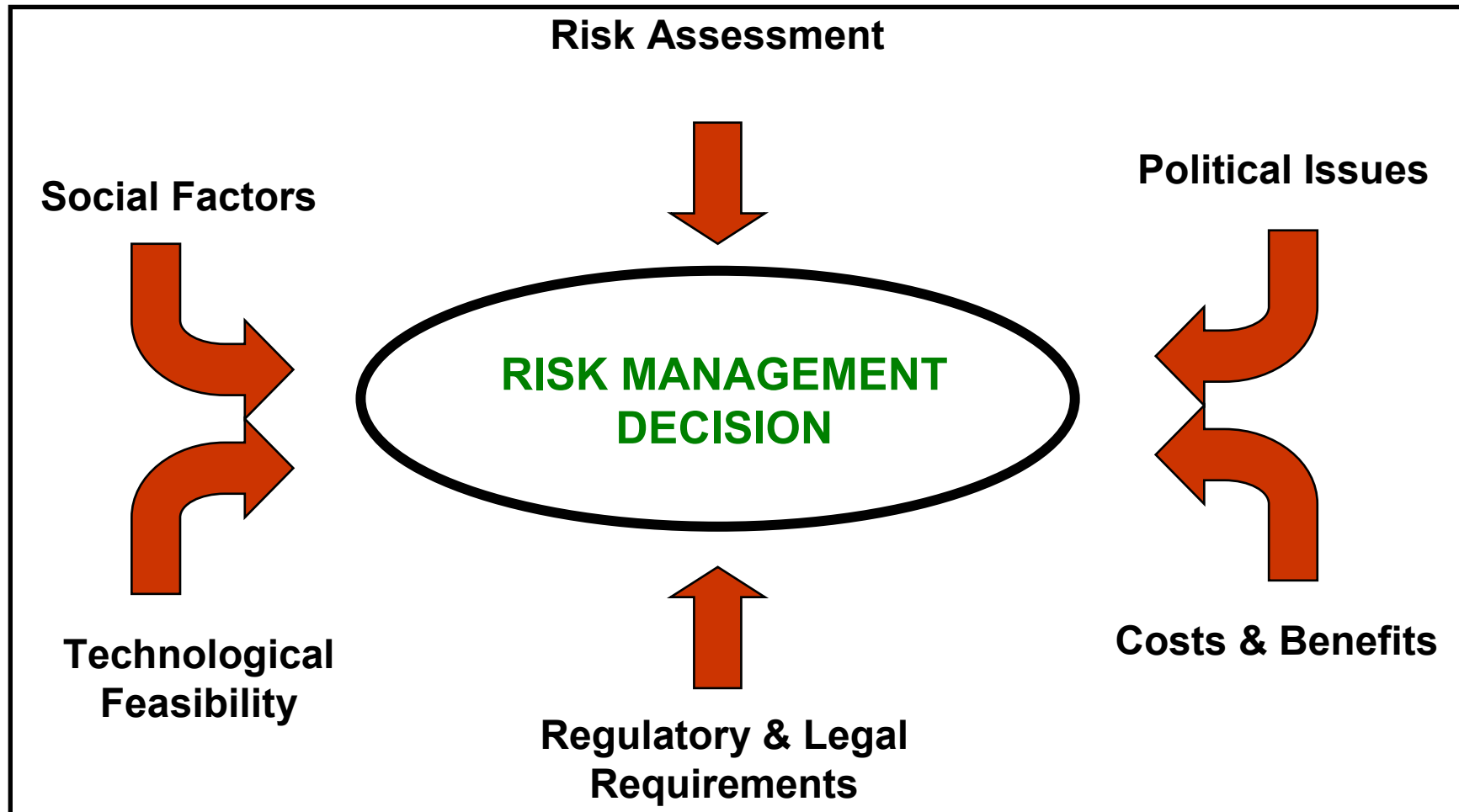


- Controlling exposure manages risk
 - Removal/Treatment: remediate source
 - Containment: prevent transport
 - Institutional controls: control exposure activity

Net Environmental Benefit Concept

- Risk management actions should result in a net improvement to the environment
- Do not destroy viable habitats and ecosystems to clean them up

Inputs to a Typical Risk Management Decision



Key Risk-Based Remediation Messages

- Risk assessment should serve as a key element in remediation decision making.
- Risk characterization should be based on site-specific exposure conditions rather than on hypothetical assumptions.
- When justified, probabilistic methods should be used to calculate risks and establish risk management levels.
- Remedy selection must consider actual and reasonably foreseeable future land use.
- Spending should be prioritized based on achieving the greatest degree of risk reduction.
- The risk assessment should be an open process that provides for observation by and input from local stakeholders.

If you remember anything from this presentation, please remember this...

- Risk = f (hazard/stress, exposure)
- Risk assessment is an imperfect science that has to be tempered with sound judgment
- Your results are only as good as your ability to communicate them



The miracles of science®