Ensuring Data and Information Comparability Using Expert Systems

Larry Keith
Instant Reference Sources, Inc.

Herb Brass - US EPA
Dan Sullivan - USGS

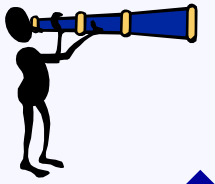
National Monitoring Conference
May 19, 2004
Chattanooga, TN

What is an Expert System?

- An expert system is an interactive computer program that incorporates the knowledge of one or more people into a series of decision trees so that answers (**as advice**) to specific questions are the same ones that a human would give.
- Advantages include:
  - Help and advice when a human expert isn't available
  - Answers are consistent (versus human answers)
  - Ensures that all important factors are considered so that none are forgotten during decision making
  - Get right to answers needed quickly and efficiently

Water Monitoring Expert Systems

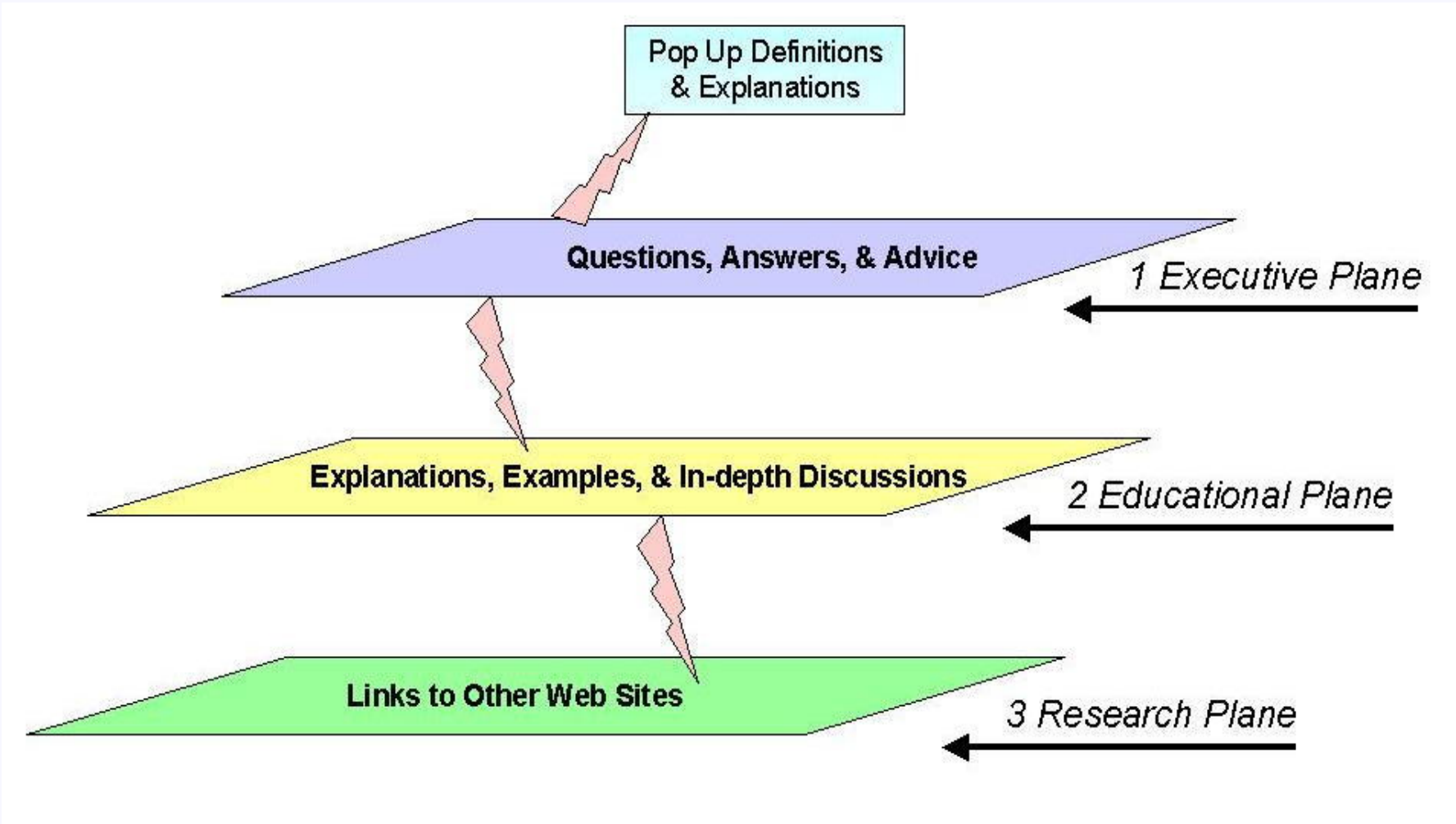
- Two expert systems for water quality monitoring have been produced:
  - Environmental Monitoring and Measurement Advisor (***EMMA***) - produced in 2002 under a NSF SBIR grant.
    - Supports the National Environmental Monitoring Index (***NEMI***)
    - 3 modules: 1 Planning What, When, Where, & How; 2 Selecting best method(s); 3 Calculates numbers of samples needed
    - NSF grant required a commercial product but the second module is free to use at www.EMMA-expertsystem.com
    - EPA and USGS have a CRADA with Instant Reference Sources
  - EPA's *CBR Methods Advisor*
    - Support to NEMI-CBR database of methods for anti-terrorism
    - Response, Planning & Training for threat analysis, site entry, sampling and water analysis



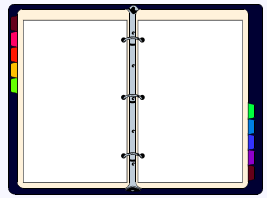
Three “Planes” of Information

- **The top level "Executive/Emergency Plane"**
  - Gives the user advice and answers for his or her specific needs as quickly as possible.
- **The second level "Educational Plane"**
  - Provides explanations and ancillary information to help users to understand what is being asked of them, why it is being asked, and what the consequences of their actions may be.
- **The third level "Research Plane"**
  - Reached by internal and external hyperlinks from the second plane - contains extensive in-depth discussions and links to other web sites such as those of US EPA, USGS, CIA, etc.

Planes of Information Illustrated

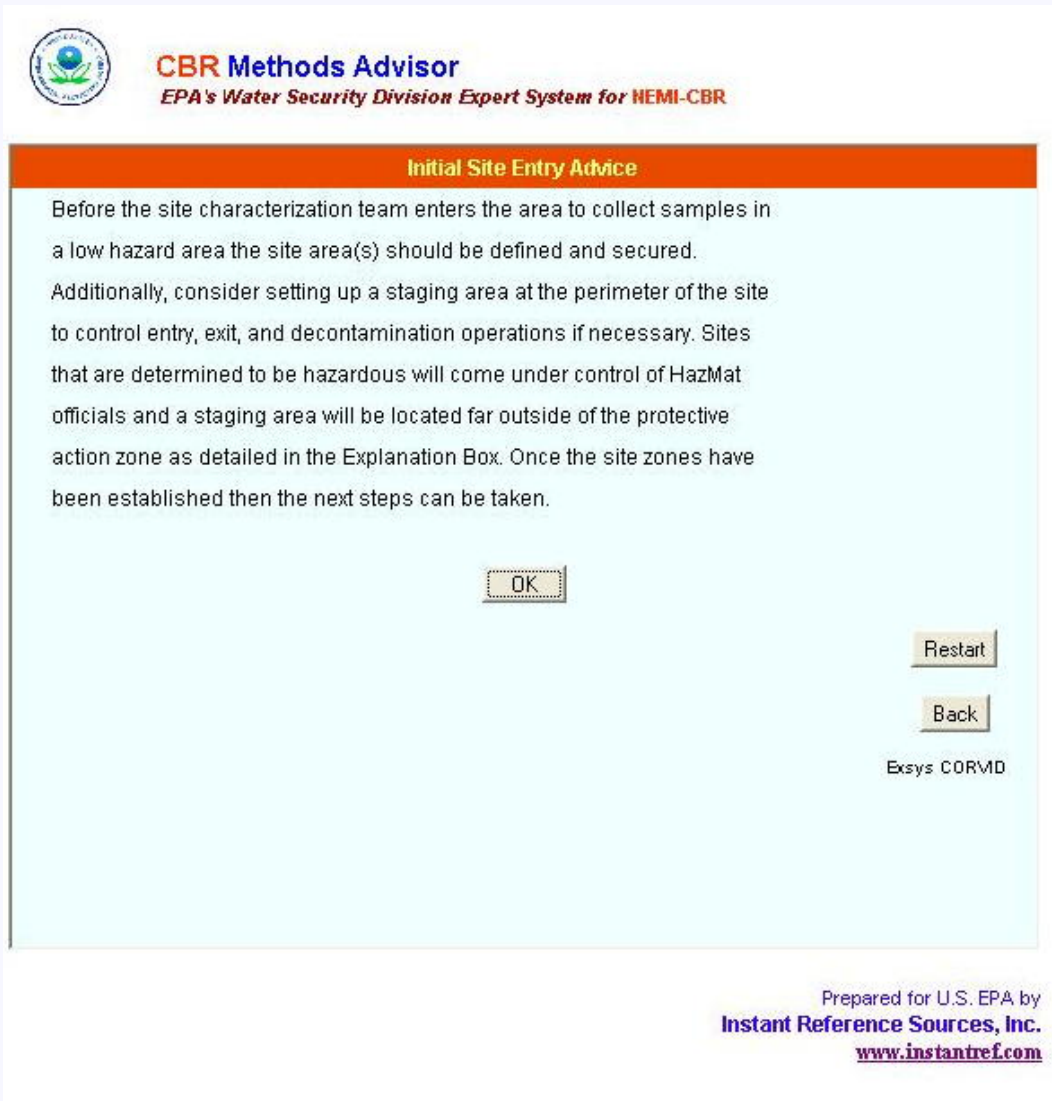


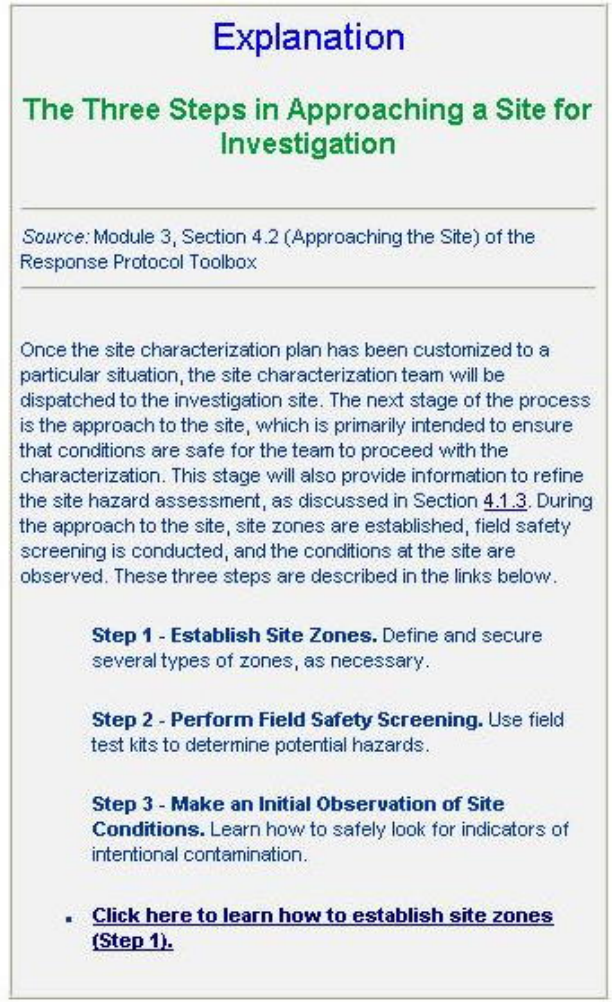
Dual-Screen Viewing



- Special programming is used to provide two "frames" for viewing the expert system.
  - The expert system question and answer software appears in a **left** screen frame.
    - It drives a particular project planning or training session through its questions and "decision trees" that provide advice and answers.
  - Associated with each question is information on what, why, when, where, how, etc. in the **right** screen frame.

Example of Dual Screen Use

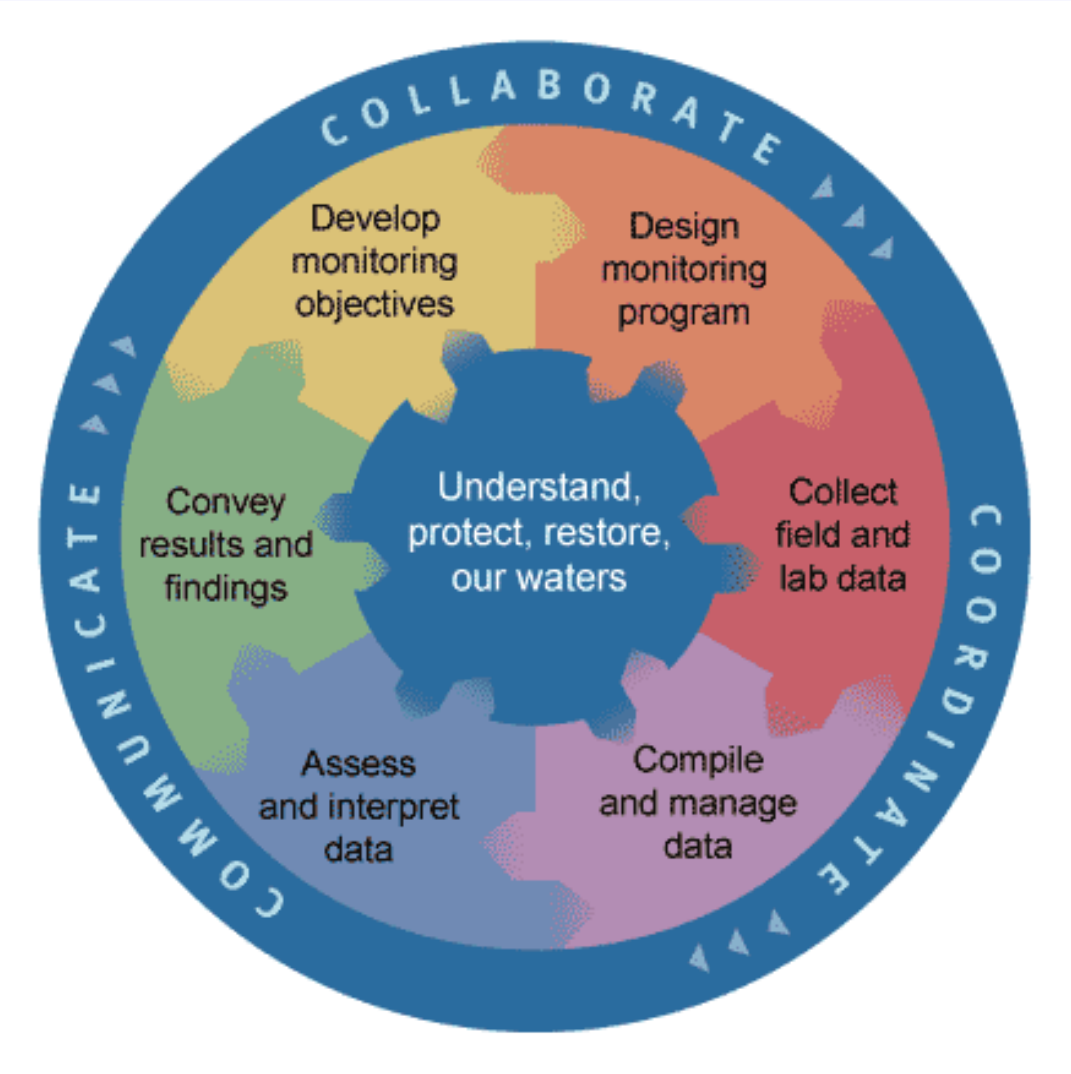




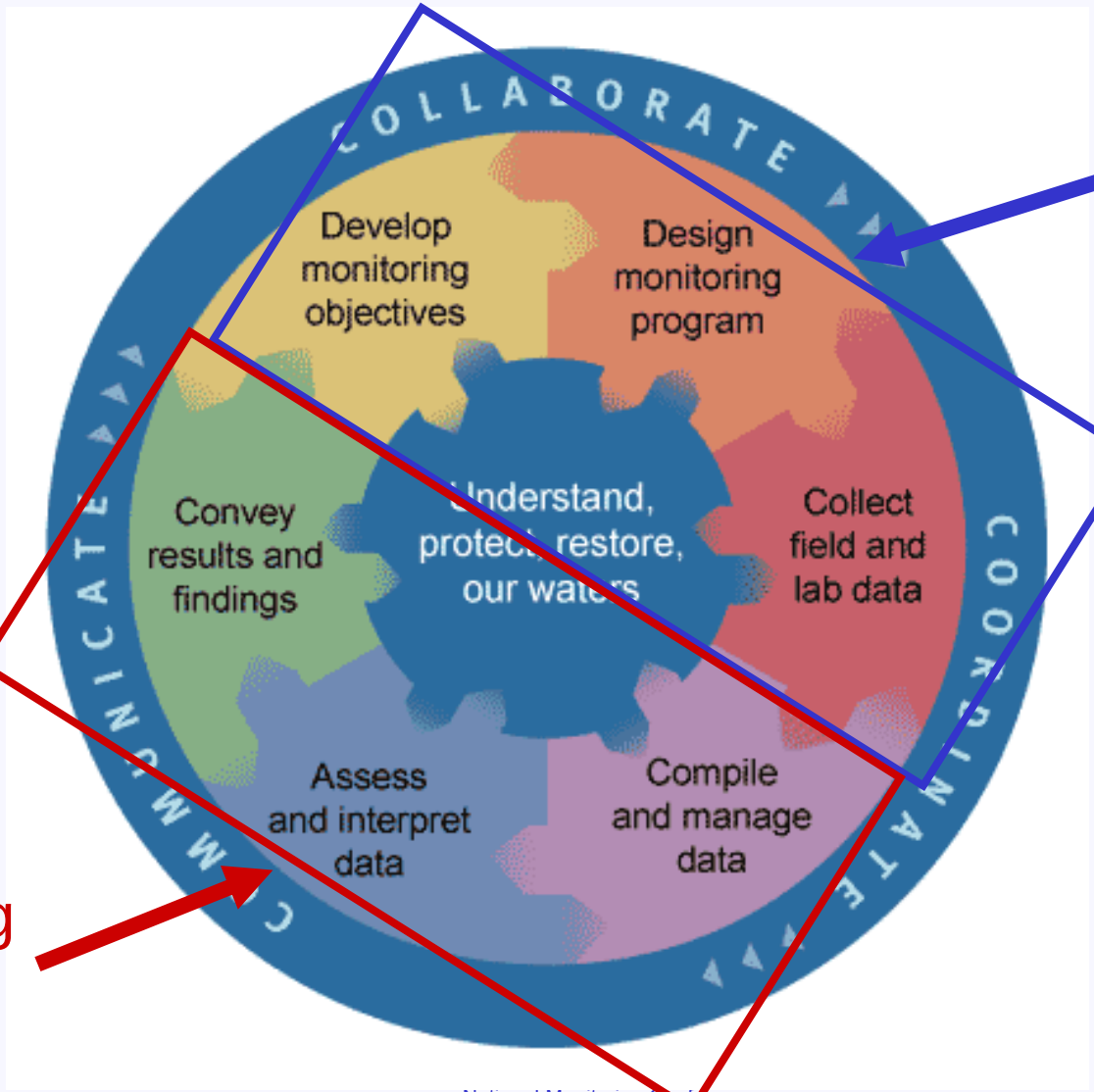
Expert System Side

Explanation Box Side

National Council's Monitoring Framework



Expert Systems for Monitoring Framework Areas



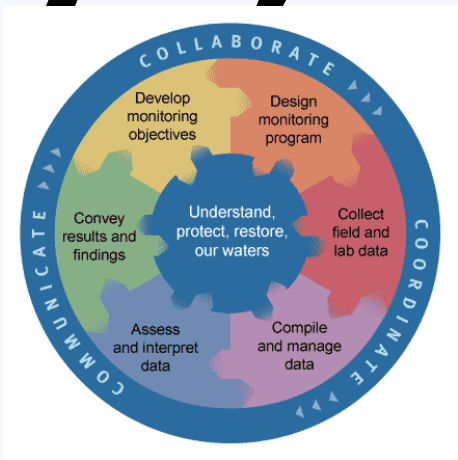
Areas Currently Partly Covered by ***EMMA*** and/or ***CBR Methods Advisor***

Areas Remaining to be Covered

How Expert Systems Could Support Water Monitoring

- Incorporate the algorithms already developed from NSF and EPA funding into a comprehensive expert system used for planning, training, and execution of water monitoring projects.
  - Special features would include dual screen viewing and multi-level depth of information given as a user desires
  - Development would incorporate knowledge of experts versed in many areas for multi analytes and organisms
  - Product would cover all areas of the Water Quality Monitoring Framework
  - Tools for entering and sharing data, statistical analysis, modeling, preparing reports, etc. would be launched from the appropriate modules that direct the Monitoring Framework.

Conceptual Model



Expert System

Monitoring Framework

Data Management

What an Expert System Would Do

1. Develop Monitoring Objectives
   - Type of objective, regulatory requirements, DQOs, resources
2. Design Monitoring Program
   - Determine what, when, where, frequency, type of sampling, QA/QC
3. Collect Field and Lab Data
   - Select sampling & analytical methods (DL, interferences, False + / -)
4. Compile and Manage Data
   - Data entry, preservation, search, retrieval, and metadata
5. Assess and Interpret Data
   - Statistical analysis, models, comparisons, trends, patterns
6. Convey Results and Findings
   - Reports, formats, diagrams, summaries, tables, graphs, plots

Advantages of Developing an Expert System for Water Monitoring Projects

- Could be freely available from an Internet site
- Would facilitate consistant and comparable data quality across many different organizations and programs
- Updates and information expansion easily accomodated
- All important factors in planning and executing a project would be considered and documented
- More cost-effective project plans would result
- Project plans would **always** fit available budgets
- Help would be available when experts are not
- Training would be facilitated using built-in links and forms