ITRC has developed a series of fact sheets that summarizes the latest science, engineering, and technologies regarding environmental data management (EDM) best practices. The Geospatial Data Management subgroup created a series of best management practices and guideline fact sheets for management, collection, communication, visualization, and dissemination of environmental data with a geospatial focus. This overview introduces the topics that are discussed in more detail in the related fact sheets. The documents can then be read in any order depending on the needs of the reader.

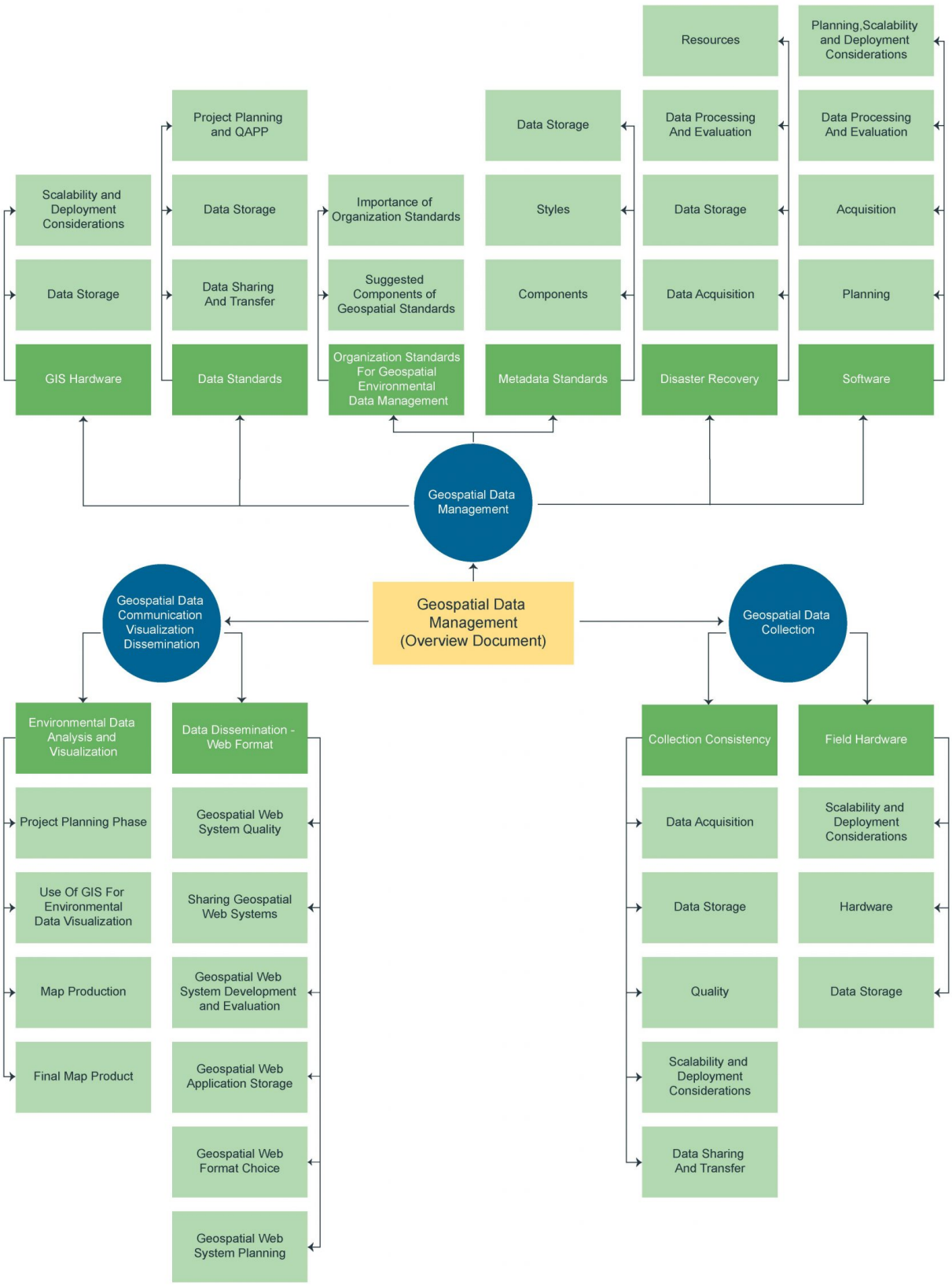
This fact sheet describes items that should be discussed with the GIS professional in your organization, and indeed all stakeholders in the project, to help ensure the environmental data management project buy-in and success. Managers, project managers, program managers, GIS professionals, IT professionals, and interested members of the public may find the information presented here useful for all projects that include geospatial data.

1. OVERVIEW

Broadly speaking, most if not all environmental data include a geospatial component: the where of the environmental data. The “where” of environmental data management can include many considerations, as shown in Figure 1. If your environmental data will be published, analyzed, or otherwise displayed on either a paper or web-based map, it is best practice to include your organization’s GIS professional in the environmental data management discussions from the beginning. Fact sheets prepared by the Geospatial Data Management subgroup address common concerns and offer suggestions for not only the GIS professional, but also their managers, project managers, other IT professionals, and field personnel. There may be different requirements for a geographic analysis of environmental data that these fact sheets can help the non-GIS professional become acquainted with. See the Environmental Data Management Systems (EDMS) White Paper for using a GIS as an EDMS.

As illustrated in Figure 1, there are many aspects of geospatial data management. Within this graphic, blue circles represent subcategories within geospatial data management and darker green boxes correspond to fact sheet topics. Light green boxes represent subjects covered within a fact sheet. Some topics, such as data storage, are discussed in multiple fact sheets.

Figure 1. Graphical depiction of geospatial data considerations and their interrelationship.


Geospatial Data Management (Overview Document)
Geospatial Data Management
Geospatial Data Communication Visualization Dissemination
Geospatial Data Collection
Project Planning and QAPP
Data Storage
Data Sharing And Transfer
Data Standards
Scalability and Deployment Considerations
Data Storage
GIS Hardware
Importance of Organization Standards
Suggested Components of Geospatial Standards
Organization Standards For Geospatial Environmental Data Management
Data Storage
Styles
Components
Metadata Standards
Resources
Data Processing And Evaluation
Data Storage
Data Acquisition
Disaster Recovery
Planning,Scalability and Deployment Considerations
Data Processing And Evaluation
Acquisition
Planning
Software
Environmental Data Analysis and Visualization
Project Planning Phase
Use Of GIS For Environmental Data Visualization
Map Production
Final Map Product
Data Dissemination - Web Format
Geospatial Web System Quality
Sharing Geospatial Web Systems
Geospatial Web System Development and Evaluation
Geospatial Web Application Storage
Geospatial Web Format Choice
Geospatial Web System Planning
Collection Consistency
Data Acquisition
Data Storage
Quality
Scalability and Deployment Considerations
Data Sharing And Transfer
Field Hardware
Scalability and Deployment Considerations
Hardware
Data Storage

2. WHO IS THE AUDIENCE?

Each fact sheet about environmental geographic data has an intended audience. The audience may include any of the following:

- **GIS professionals:** GIS professionals are the people in an organization who may coordinate the geospatial program and write or assist in writing standards and strategies and developing workflows for the geospatial analysis. These individuals may oversee purchasing and budgets related to GIS software and hardware. They typically use GIS software on a regular basis.
- **Project managers:** Typically, project managers are the scientists or engineers in an organization who are the primary contact and lead for a particular project that has a set beginning and end point.
- **Program managers:** Typically, program managers are a scientist or engineer who may manage multiple staff working on multiple projects within an organization. Program managers may have budgetary authority over the projects they manage as well as a stake in the quality assurance components of the projects. Programs may refer to a designated regulatory authority, such as the National Pollutant Discharge Elimination System (NPDES) program manager for an organization.
- **Field personnel/technicians:** These are an organization's staff members who are directly responsible for collecting environmental samples.
- **Stakeholders:** For the purposes of these geospatial fact sheets, stakeholders are any entities that have a direct interest in a project or program. Stakeholders may be within or outside the data-originating organization, and may include environmental professionals or members of the public that interact with the environmental data.

3. GEOSPATIAL DATA MANAGEMENT: INITIAL PROJECT PLANNING STAGE

Initial project planning assumes that you are starting a new project. However, you may have historical data that you'd like to incorporate into an existing project. The data may have either been collected for a previous project or originated from another source and have been georeferenced. Historical data may also be incorporated into a completely new project. Special considerations about incorporating historical geospatial data are noted below.

Stakeholder involvement. The storage, display, and analysis of geographic data pose some unique problems that can be alleviated if a GIS professional is brought into the project discussions at an early stage. If a new database is being developed from scratch, the best practice is to engage proper stakeholders early in the process. All the potential internal stakeholders listed below play a role in the end use of an environmental database. Knowing the unique role of each stakeholder and what they may be asked to do with the data at both the beginning and end of a project can help ensure success. An organization's project stakeholders can include, but are not limited to:

- Project manager, who may have had the initial project idea and be a key player in developing the project scope, purpose, and budget. The project manager needs to be able to communicate in plain language why this information is important and what they wish to do with the results, including potentially putting the project information on a map for either display or analysis.
- Field technicians, who collect the information that populates the database. They can provide information about the sample equipment that may be required to achieve the desired coordinate accuracy results.
- Data manager, who develops and maintains the data systems. Very often the data manager is also responsible for quality analysis/quality control (QA/QC) and later, after the database is built, building queries and reports based on the data. The data manager's role in incorporating historical data is particularly important, as they have the potentially difficult task of migrating historical data to the new geospatial data. They may, at times, need to create special tables or queries to relate historical data to newly obtained data, for example.
- GIS professionals, who are asked to display, analyze, or verify data, or make a map of the data after they have been collected and entered into the database. Engaging the GIS professionals early in the project ensures the database fields are formatted correctly for geospatial analysis, display, or distribution, if that is a desired project outcome. GIS professionals can also evaluate historical data to determine its usefulness for mapping applications or in spatial analyses.
- Public information officer or communications specialist, who may be asked to communicate the importance of

the data or actions based on the results to other members of the agency, other government entities, or the general public.

Project scoping. Determine the scope of the geospatial project and end use of environmental data. Determine the required data elements that may (or may not) be displayed in the final map and determine the data quality required. Asking questions specifically about the geospatial component of the data in the project planning stage can save time, money, and effort as the project progresses:

- How are you going to use the geospatial data? Will the data be used to display sample results on either a web-map or printed map? Will you be conducting geospatial analysis of the data? (In other words, will you be using GIS software to analyze sample concentrations over an area?) Will geospatial data be used to direct people to a particular location?
- Will you be sampling at the same physical location multiple times over the course of the project, or over the course of years? There are innovative ways to show results over time at a sample location on a map. See the Geospatial Data Dissemination: Web Format subtopic sheet and Geospatial Visualization of Environmental Data subtopic sheet for further discussion.
- Do you have an elevation established and documented for the sample locations?
- What attribute information will be collected at each location? Consider that in a geospatial database, the attribute information can be used to symbolize, sort, analyze, or query a map of the data. For example, you may have a geospatial data set of groundwater wells with arsenic concentrations greater than 10 µg/L. The minimum number of attributes needed to create a meaningful map of arsenic concentrations must include location of the well, date sampled, and arsenic concentration for that sample date. Best practices for collecting and managing attribute tables can be found in the Geospatial Data Standards subtopic sheet.
- Will the location for the sample collection point be professionally surveyed? What are the accuracy requirements of the coordinate and elevation data of sample locations? These considerations are discussed in more detail in the Geospatial Data Collection Consistency subtopic sheet.
- If the data are historical data, it is important to have some coordinate or locational information about the sample location if it is to be mapped or analyzed spatially. Additional details are in the Geospatial Data Collection Consistency subtopic sheet and Geospatial Data Dissemination: Web Format subtopic sheet.
- How will you be disseminating the data? Will you be providing a map handout at a public meeting, tables of data or a data download, or interactive online map? Best practices for disseminating data can be found in the Geospatial Data Dissemination: Web Format subtopic sheet.
- Who will be using the data? Students? Professionals? The public? Consider plain language descriptions and headings for the data and attribute fields.

Geospatial data management. Consider data management practices that have an impact on legitimacy, authority, and transparency of the project for the public.

- Organizations should maintain an inventory of geospatial data sets. The inventory should identify every geospatial data set and include an identifier, a description of the content and purpose, location within the data storage system (file name, directory, database, and table), the format (geodatabase, shapefile, or other file format), the source, date of origination of data set, and if the data have been superseded by another data source. An up-to-date inventory of geospatial data sets can also help the data manager maintain their organization’s record retention schedule. Processes should be in place to ensure that the inventory is kept current.
- Consider the GIS software and GIS hardware that may be required for the project. Will there be special hardware required for data transfer? Examples of hardware would be a digitizing table or special GPS collection device. See the Geospatial Data Software subtopic sheet and Geospatial Data: GIS Hardware subtopic sheet for additional information.
- Consider data collection quality standards, by the agency, organization, or specifically for the project. See the Geospatial Data Collection Consistency subtopic sheet for additional information on this topic.
- Consider the locational accuracy requirements needed for the type of work. Do the sample locations need to be professionally surveyed? The geodatabase must maintain locational accuracy measurements in the database and when using and displaying the surveyed data in a GIS. In all cases, professionally surveyed or not, it is best

practice to include location accuracy statements in the metadata. See the Geospatial Metadata subtopic sheet and Geospatial Data Standards subtopic sheet for information on documenting location information.
- Closely related to the locational accuracy requirements, is the coordinate reference system(s) to be used for storage, analysis, and display. These systems should be considered and specified. The coordinate reference systems used by data sources should also be identified.
- Make sure you understand your agency geospatial standards or any regulations that your organization follows. See the Organization Standards for Geospatial Environmental Data Management subtopic sheet for additional information.
- Will these data be linked or shared between other systems? If so, make sure that the systems can “speak” to each other or make sure the requirements are met so they can be linked. More information can be found in the Geospatial Data Standards subtopic sheet.
- Ensure that the GIS professional has a means of accessing the authoritative database, either via stored queries or some other means to display the data directly from the database in the GIS software?
- Include device standards and map scale requirements. More information can be found in the Geospatial Data Software subtopic sheet and Geospatial Data: GIS Hardware subtopic sheet.
- If the data are historical data, consider how these data will be incorporated into existing data management systems or used in conjunction with existing geospatial data.
- Does the organization have a disaster recovery plan or backup plan in place? If not, consider having one for at least the project, and encourage the organization to develop an overall disaster recovery plan. See the Data Disaster Recovery Fact Sheet for additional information on this topic.
- Are all staff trained on the proper use of hardware and software needed to collect, store and manage the necessary geographic data? Consider establishing a training program and regular audits of data collection methods to ensure data is being collected correctly and according to your carefully established protocols.

4. GEOGRAPHIC METADATA

Metadata is information about the data. If the database includes geospatial attribute fields such as coordinate information, it should also include additional fields indicating the quality and accuracy of the locations. Geospatial metadata can be included in not only the data dictionary of the database, but also within the geospatial data file itself as an .xml file. When completing metadata for geospatial data, consider the following:

- Does your agency or organization have metadata standards?
- Does your state have metadata standards?
- Don’t have organization or state standards? There are Federal Geospatial Data Committee (FGDC Undated) standards and other international standards you can use for guidance.

See the Geospatial Metadata subtopic sheet for additional information.

5. COMMUNICATION, DISSEMINATION, AND VISUALIZATION

Communication of geospatial information begins in the project planning phase so that the information that needs to be visualized on a map is properly collected and maintained from the inception of the project. It is also important to consider the audience and intention of the final map product during the project planning and execution phases. Some general best practice considerations for planning communication, dissemination, and visualization of geospatial data include:

- Privacy requirements of geospatial data must be determined. There might be legal and ethical reasons to not disseminate the locations of all the information that you collect in the field to the public. For example, there are ways within a GIS to obscure the exact sample location without disclosing the location of the sample collection site. This can be done if the data contain protected health information, sensitive cultural sites, or other sites containing protected information.
- Traditional ecological knowledge (TEK) or local ecological knowledge (LEK) may have other location considerations that preclude it from classic XYZ coordinate and elevation mapping. For example, consider using polygons or other area representations when displaying and communicating TEK or LEK.
- Include general map elements such as legend, scale, map notes, source, etc. The Geospatial Visualization of

Environmental Data subtopic sheet has tips for basic map elements to include on your map.
- Determine if you need static or dynamic map dissemination, and if the map will be printed or available online.
- Both paper and digital maps have been historically inaccessible to individuals with low vision, visual impairment, or blindness. Recently, tools have been created to make both types of map products more accessible to those individuals.
- If the web-based map does not contain well-established user interfaces, it's best practice to provide an explanation of how to use the map.

The Geospatial Data Dissemination: Web Format and Geospatial Visualization of Environmental Data subtopic sheets provide in-depth discussion of communication, dissemination, and visualization of geospatial data.

6. REFERENCES AND ACRONYMS

The references cited in this fact sheet, and the other ITRC EDM Best Practices fact sheets, are included in one combined list that is available on the ITRC web site. The combined acronyms list is also available on the ITRC web site.