Final Report

Creating a Cultural Resources Metadata Standard for the Western United States

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Federal Geographic Data Committee

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by

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ABSTRACT

The project "Creating a Cultural Resources Metadata Standard for the Western United States" created a set of "best practices" and recommended spatial attributes for archaeological and historical datasets. The recommendations were arrived at during the course of two meetings attended by cultural resource staff from several western State Historic Preservation Offices, federal agency staff, private sector heritage specialists, and information management experts. This report describes the context in which the project took place, the goals of the project, how it was conducted, and the resulting recommendations.

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LIST OF ACRONYMS AND ABBREVIATIONS

BLM – Bureau of Land Management
CRIS – Cultural resource information system
CSDGM – Content Standard for Digital Geospatial Metadata, version 2
DBMS – Database management system
DLG – Digital line graph (vector map data)
DRG – Digital raster graphic (map image)
EDAC – Earth Data Analysis Center, University of New Mexico
ESRI - Environmental Systems Research Institute, a GIS vendor
FGDC - Federal Geographic Data Committee
GIS – Geographic Information System
NHPA - National Historic Preservation Act
NRHP – National Register of Historic Places
NSDI – National Spatial Data Infrastructure
RDBMS – Relational database management system
SCDD - FGDC Subcommittee on Cultural and Demographic Data
SHPO – State Historic Preservation Office
USFS – United States Forest Service
USGS – United States Geological Survey
XML – Extended markup language, a metalanguage of tags

INTRODUCTION

This project, "Creating a Cultural Resources Metadata Standard for the Western United States," outlines a common spatial data model for implementation in associated cultural resources databases. In this model, we have identified individual resources, groupings of resources, and the associated cultural resource projects that locate, identify, research, and evaluate resources as part of this standard. We have developed a minimum data content standard for each entity, along with appropriate spatial representation. Terms used in the standard can be found in **Appendix ?** and are discussed in more detail within this document.

This project is part of the national effort to create and distribute geospatial data called the National Spatial Data Infrastructure (NSDI). The NSDI was established in 1994 by Executive Order 12906; the purposes of the NSDI are to avoid wasteful duplication of effort and to promote effective and economical management of resources by federal, state, local, and tribal governments. NSDI means "the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data."

Standards for certain categories of data or information, insure compatibility between data creators and data users. Spatial data standards and associated metadata documents insure that substantial investments in geospatial data creation have long term utility. Data are more immediately useful and more readily transformed from one management and technological environment to another.

The Federal Geographic Data Committee is established by the Office of Management and Budget Circular No. A-16 ("Coordination of Surveying, Mapping, and related Spatial Data Activities"). The FGDC coordinates the Federal Government's development of the NSDI. The committee also promotes state, local, and tribal government participation in the NSDI. The standards are "intended to be national in scope and go beyond individual agencies and the federal government enterprise. They support national and collective decision making and applications and are developed jointly by federal, state, and local governments and other interested participants. They are only mandatory for federal agencies." (FGDC, March 1996, "Standards Reference Model") This project has been funded as a state effort by the FGDC with participation by federal agencies. Information on the NSDI and FGDC can be found at the FGDC web site(http://www.fgdc.gov).

THE FGDC STANDARDS PROCESS

In January of 1999, the National Park Service hosted a meeting of cultural resource professionals from many state and federal agencies at a meeting in Washington, D.C. A result of this meeting was to create a formal "cultural resources working group" under the FGDC's Subcommittee on Cultural and Demographic Data (SCDD). This group will review the suggested standard and associated metadata as proposed in this document. Should they decide to do so, the working group may then formally propose to develop a standard. This proposal will then follow the FGDC standards approval process (Table 1). Implementation of FGDC standards is mandatory for federal agencies; this work reported here has a long road to travel before becoming a mandatory federal standard.

There are five stages in the FGDC's standards approval process (FGDC 1996).

These stages comprise twelve separate steps. Usually, it takes at least two years to complete the standards development process. The details of the steps are not important (see FGDC 1996 for more information), but the overall stage scheme may be helpful to understanding this project's purpose. Table 1 presents the five stages of FGDC standards development.

Table 1. The FGDC standards development process.

Stage	Description
Proposal	Defines the needs for and benefits of a standard. At the end of this stage, the FGDC recognizes the standard as a project and adds it to the standards' register even though work or funding for the standard may not yet be identified.
Project	Defines the funding and administration for the standard. The development methodology, work groups and members, and development schedule are documented. At the end of this stage, work begins on standards development.
Draft	The standard receives comments and input from as many constituent groups as possible. At the end of this stage, the proposed standard is ready for public review.
Review	The standard receives public comment and official public review. The latter part of the stage is for FGDC internal review of format and integration.
Final	The standard becomes an officially recognized FGDC standard.

This report is a precursor to formal entry into the FGDC standards development process shown in Table 1. This report will be forwarded to the appropriate working group, who may then choose to develop a standards proposal (the first stage described above).

During this project, several of the participating western states have begun to implement these recommendations into their database design and creation of metadata. There is great interest by archives and agencies who maintain cultural resources data to create information in a standard format with commonly needed data elements.

CULTURAL RESOURCES AND INFORMATION SYSTEMS

The focus of this project is upon metadata standards for cultural resources geographic information systems. Of course, many different agencies, organizations, and individuals have created (or will create) geographic databases pertaining to cultural resources. In particular, this project is concerned with geographic data technology in managing large sets of cultural resource information in formal administrative settings. So, the primary focus of this project is data stored in paper and electronic files at Federal and state agencies. Whether on paper, microfiche, or in an electronic framework, the intent of such files is to have an information system pertaining to cultural resources management. Cultural resource management information systems do not exclude research, interpretation, or other kinds of use, but their primary focus is on administrative and managerial needs.

For this project, we have used "cultural resource" as a set of terms defined by the National Park Service (NPS) in several published bulletins relating to the National Register of Historic Places (NRHP). In general, we are defining a standard applicable to historic and

prehistoric resources generally fifty years old or older. These resources range from the Nation's Capitol to faint ruts along the Oregon Trail.

It is important to note that the term "cultural resource" used in this report is *not* a particular instance of what, in USGS mapping terms is called "culture". The USGS mapping term of "cultural" features applies to contemporary man-made objects or places: bridges, roads, cities, houses, etc. A "cultural resource" (as used in this report) is defined by the National Park Service as a property of historical or scientific interest. Because many of the properties in the western U.S. are prehistoric ("historic" in the definition above is meant to include prehistoric too), *cultural resource* is a more appropriate term and is used throughout this report.

In 1966, Congress passed the National Historic Preservation Act, which requires State Historic Preservation Offices (SHPOs) to maintain comprehensive records on archaeological and historical resources and associated literature pertaining to the investigation and eligibility of these resources to the National Register of Historic Places (NRHP). The Act establishes a review process of federally sponsored or permitted projects to ensure state level input and comment. It requires comprehensive inventory and evaluation of cultural resource properties for nomination to the NRHP prior to a federally sanctioned project going forward.

Since the enactment of this legislation, approximately one million archaeological and historic resources have been recorded in the western United States. During the past two decades the census of archaeological and historic inventories has increased many times over. In some western states, the number of recorded resources has doubled and even tripled within the past fifteen years.

Different states utilize different recording formats for cultural resources. The recording forms used for cultural resources vary from one state to another because of regional variation in the archaeological and historical record, differences in administrative histories, and other factors. A few western states have used a common regional format for the past twenty or so years. Nevertheless, differences from one state to another are the rule and not the exception. Yet, there is a core set of observations that cultural resource recording forms attempt to collect from investigators. These core attributes form the basis for the model of cultural resource information systems (or CRIS) presented below.

In general, the resource recordation forms contain written information on the description of the resource and detailed information about the location of the resource. Usually, there is a discussion of the resource's environmental setting. Most resource recordation forms contain details on specific site components, such as the age of the materials observed. Descriptions of artifacts and archaeological features are also usually included in resource records. An important part of most resource records is a site-specific map of the resource and its immediate surrounds. Often, the site-specific map is made with some rough bearing and distance controls, or even just sketched by eye. As well, most states require that a location map be submitted as part of the resource record. The common requirement is that the resource location be depicted on a published USGS topographic map; the 7.5' quadrangle series is often a required base for this map.

Just as there is variation in the recording formats used in different western states, there are variations in the organization of the record archives. While most archives are part of a SHPO office, some are run semi-independently. Information acquisition, storage, query, and

dissemination procedures vary between states; in states with multiple archives there may be variation between them as well. This can be extraordinarily confusing to a cultural resource manager, who not only must decipher different state formats, but may have to pose queries differently within the same state. Arizona, for example, has fourteen different archives, several of them partially overlapping each other in content, some at universities, some in state agency offices, and some in federal offices.

All of the cultural records archives share a common heritage of being (or having been) paper information systems. Each archive maintains a paper file of cultural resource-related documents including reports on archaeological and historic surveys, site and building records, testing and sampling, preventive monitoring during construction, and excavations. The archives also maintain individual recording information (site forms) for each resource.

Each state has developed administrative and staff procedures to respond to requests made by public and private entities as well as by the general public. The users of this information vary, depending upon the sort of development occurring within a state. For example, Colorado county and city officials working on historic preservation planning documents and general land use plans are common users of the cultural records archive system, as are those agencies and industries proposing development on Federal lands. In less urban western states, such as Wyoming, the majority of the requests are related to oil and gas, mining, and industrial activity occurring on Federal lands or requiring Federal permits.

Although archives are overwhelmingly paper systems at the moment, every state is moving to digital formats. In the past decade, many archives have created relational databases to manage the attributes, location, and status of cultural resource sites and surveys, though the majority still rely heavily upon paper files for most information, using electronic data as an index to the files. Within the past few years, several western archives have undertaken the development of geographic information systems datasets (GIS). Once again, the creation, design, and maintenance of these information systems has mostly been driven by compliance with Section 106 of the NHPA. Because most Section 106 activities in the western U.S. are dominated by archaeological sites, the automation of archives has had a bias toward archaeological resources.

While the Section 106 need is common for most western SHPO offices each state is following its own pathway into automation. In part, this is due to differences in institutional support: relatively few archives or SHPO offices have even a single full-time computer staff person let alone a database administrator, designer, or systems analyst.

The Cultural Resources Investigation and Evaluation Process

In the western United States most cultural resources investigations and management actions are driven by the Federal permit process shaped by the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). Put simply, projects that involve federal agency approval, use federal funds, or occur on federal property must investigate cultural resources within the area of potential project effect. If cultural resources are found, then they are evaluated relative to the criteria of eligibility to the National Register of Historic Places.

Figure 1 summarizes a typical pathway that a proposed action would follow. Managing the cultural resources in the area of a proposed undertaking involves identifying the resources,

evaluating them, and assessing the effects of the proposed undertaking upon them. The National Register of Historic Places has four basic criteria. Three of these criteria pertain to history primarily. These three criteria recognize the importance of a place due to its association with people, events, and traditions of our history. The fourth criterion, Criterion D, is somewhat different, because it recognizes that a cultural resource may be important for the information about the past that it could yield. Evaluation of cultural resources under National Register Criterion D is based upon the current state of knowledge about the past. So, most evaluation of cultural resources in the western U.S. is dependent upon a pool of scientific knowledge that is available to evaluators.

Cultural resource management also takes place outside of the scope of specific development actions and usually follows a similar overall process. Planning, preservation, and interpretation generally utilize the National Register criteria (and local criteria) in the manner described above. Because no specific threat to resources may be contemplated, the assessment of project effects is not made.

An important *caveat* to all that follows is that the model of cultural resources information created in this project is specific to cultural resource *management*, not necessarily cultural resource *research*. The two are related endeavors, but somewhat different in practice. Management is prescribed by law and policy, research has no such restrictions. Thus, it would be difficult to model a cultural resources *research* information system comprehensively.

As Figure 1 makes clear, an information system that will be effective for cultural resource management of a given area needs to convey the following:

- where resources have been sought in the area;
- what resources have been found in the area;
- the regulatory status of resources in the area;
- information sources for contextual background.

The last need is more difficult to define than the first three. As described above, the regulatory evaluation of resources may depend upon identification of relevant research trends. An effective information system needs to allow the manager some ability to gauge the current pool of knowledge about an area's past, i.e., convey contextual background or guide the manager to it.

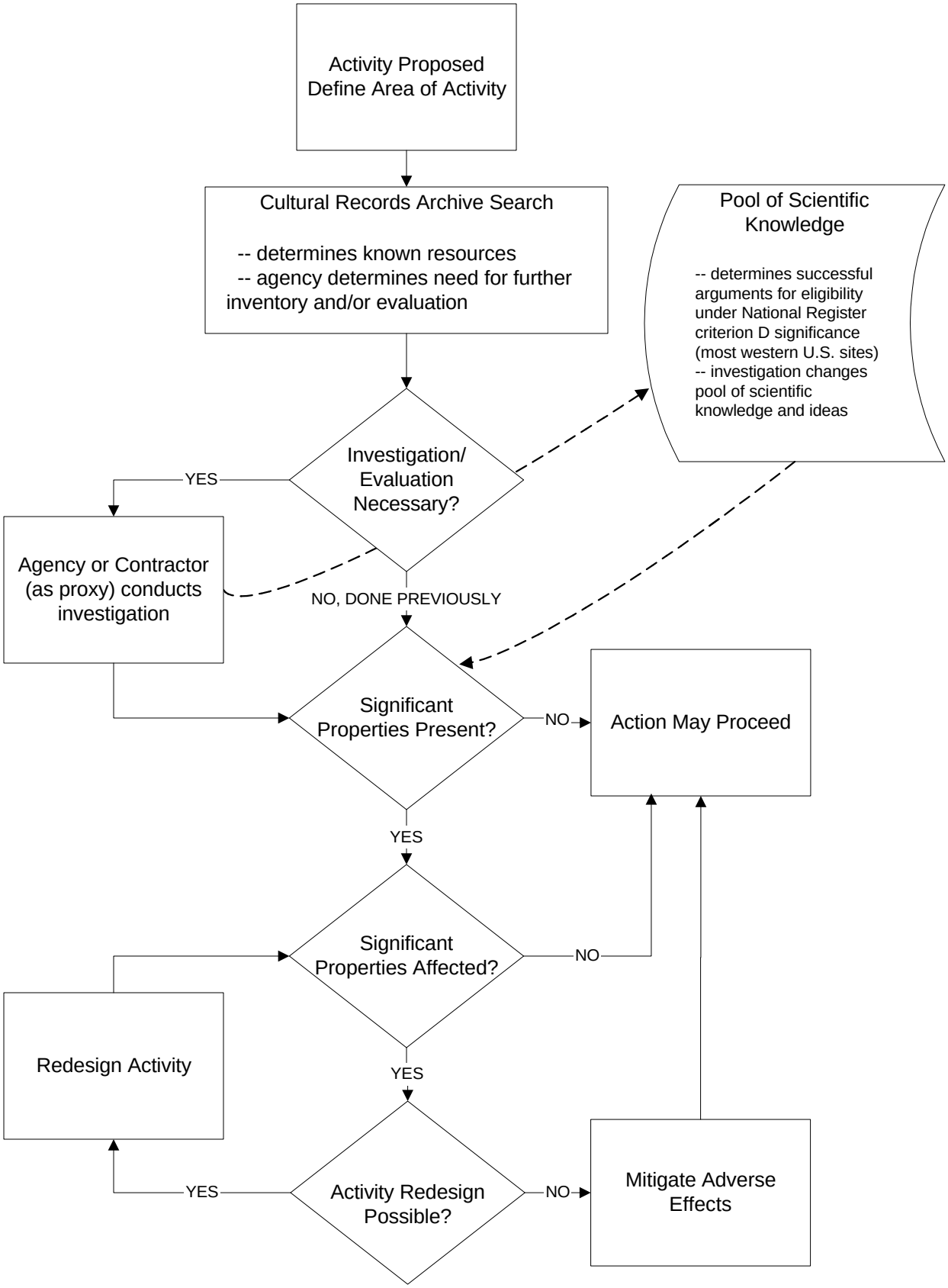


Figure 1. Overview of the cultural resources management process under Section 106 of the NHPA.

The attributes of an information system described above pertain to its content. There are also operational parameters. Any information system used for cultural resource management must be relatively time-efficient, because the pace of proposed actions that may require cultural resources review is rapid. Timeliness in response to queries is important. A related factor in many states is the speed with which new observations (site records, reports, determinations of regulatory status) are available. For example, in oil and gas fields cultural resource investigations may occur nearly side by side within the same week – knowing about on-going nearby investigations and resources is important in this situation.

In general, the SHPO offices or their cooperating in-state partners in the western U.S. maintain information systems for cultural resources that meet many of the needs described above. However, not all are electronic information systems. In many states, paper systems are still the source used to answer the queries described above. Often, these are hybrid systems in which electronic data serve as an index to a paper archive. The electronic data typically contain some of the commonly needed information, but one must then examine paper records for other needed facts. Paper records can be expensive due to the time and travel expense of using records at an archive or the cost of paying archive staff to send copies. Additional costs and liabilities to the archives are the fragile nature of the records (many are artifacts themselves), the cost of archival reproduction, storage space, and the need to retain and collate multiple paper copies arriving at an archive from different sources (e.g., from a SHPO review office, from field archaeologists, and from managing agencies). For these reasons, all western United States SHPO's are moving more of the primary information systems to digital formats.

PROJECT GOALS AND METHODS

The brief overview of current cultural resource information systems highlights the need for standards. In information systems, standards have many benefits:

- lower design costs by specifying minimum criteria of adequacy;
- make feasible and enhance exchange of information between systems;
- allow query tools and user interfaces to be designed at economies of scale.

For cultural resources studies, one might think of standards as existing at two distinct levels:

- mandatory standards that dictate procedure and content of information systems;
- best practices standards that serve as guidelines about procedure and content of information systems.

Cultural resources management already follows mandated dictates about procedure and content of inventories -- these are specified in the National Historic Preservation Act and in subsequent legislation. For example, the status categories of the National Register of Historic Places are fixed by regulation and there is a standard format for nominations to the National Register itself. So too, the FGDC "Content Standard for Digital and Geospatial Metadata" is a documentation standard required of every federal agency creating spatial datasets. *Best practices* standards are less clearly defined. Best practices are recommended procedures or guidelines. They may be nearly prescriptive but they do not carry the force of regulation: "should" instead of "shall".

Cultural resources have complicated sets of attributes. This is one reason why there is local variation in recording procedures. Nonetheless, the process of cultural resource management is not highly variable (especially in the western U.S.). So, the information that is part of the management process is relatively similar from one place to another. So, at a managerial level *minimum information standards* are possible.

Minimum standards are not only possible, they are highly desirable, as a brief example makes clear. Rivers form the boundaries between several states. Since different states use different cultural resource recording formats, the same sort of cultural resource may appear different . Because of different recording formats, two archaeological sites that are truly similar but on different river banks may seem very different in the archival and electronic data of each state. Effective management requires the same baseline data on the cultural resources of both river banks. This is the role of a standard, to ensure consistency across administrative boundaries.

There is a temptation to consider "spatial" data about cultural resources as wholly distinct from other attributes of the cultural resource management process. In practice, it is nearly impossible to separate spatial information from other kinds of information in cultural resources. There really is no clear division between spatial and aspatial data except the technology one chooses to manage it. So any discussion of standards will have to consider all kinds of information used in the management process. Returning to the river bank example

above, the cultural resource manager would still want to know the location of an archaeological site on the river bank, its spatial extent, and how clearly its boundary is defined. Any of these "attributes" of the cultural resource could be in a table, an automated map tool or GIS, or both.

This project was started to develop documentation standards for cultural resources geographic information systems. We soon found that defining documentation standards meant defining what was being documented in the first place. Necessarily, then, the project participants had to achieve a consensus about the content of cultural resources datasets (spatial or aspatial). How one must *describe* datasets is primarily a mandatory standards issue, so that other data users know how to use your data effectively. There are also recommended practices for such descriptions. Conversely, the *content* of datasets is more of a best practices issue, with some avenues for mandatory standards (e.g., NRHP categories).

PROJECT GOALS

A metadata standard, as a supplement to the existing FGDC standard for "Cultural and Demographic Data," is important for cultural resources. The relevance of the project to the NSDI is that it addresses an identified need within federal, state, and local agencies to better manage and interpret cultural resources for the public good.

Two project goals can be distinguished. The long-term goal of the project is to create a foundation for the development of spatial information regarding cultural resources in the western United States, allowing more effective research and management. The short-term project goal is to produce and encourage the development of standards in data collection, documentation, transfer, and query within particular information systems. In this regard, the project goal is to assist information system managers who are developing spatial data in two ways: by clarifying federal infrastructure standards and by recommending best practices for spatial and attribute data. Above, we have made clear that these standards take two forms: recommendations for *mandatory* requirements and recommendations about *best practices*.

PROJECT METHODS

The creation of professional information systems shared by multiple users is necessarily a collaborative effort. To be successful, any information system requires:

- people who know and use the information itself ("content experts");
- experts in the logic of information systems (data modelers);
- experts in the creation of information systems (system administrators and designers);
- technology experts (system managers and technicians) who can manipulate technology to meet the needs of content experts.

We assembled experts in each of these four categories to achieve the project goals. Polling multiple perspectives on the same information phenomena helped to determine the business models in actual use within cultural resource records, the spatial attributes that are or will be important, and the relationship between spatial data and other categories of information.

In January of 1998, we convened a two-part workshop held in Albuquerque and Glorieta, New Mexico. We invited professionals with backgrounds in cultural resources,

database modeling and design, and geographic information systems. Of the sixty-four invitees, forty-three people attended the workshop.

To meet the goals outlined above, we thought that the four day workshop should cover the following subjects:

- Introduce the concept of NSDI and the current metadata standard to participants by having the Earth Data Analysis Center (EDAC) conduct formal training;
- Identify basic spatial entities and realtionships involved in CRM, outline options for representing spatial entites,and define appropriate metadata;
- Identify basic categories of non-spatial attributes for each spatial entity appropriate to management concerns;
- Classify spatial representations and non-spatial attributes into three basic levels --
  "mandatory" or "required" -- the bare minimum required to meet data sharing standards
  "optional" or "mandatory, if applicable" -- a highly desirable spatial representation or attribute for all CRM databases
  "recommended"-- highly desirable representation or attribute that, owing to the level of detail or data collection effort required, may not be appropriate for all CRM databases

The workshop lasted four days. The first part of the workshop consisted of an intensive 1.5 day seminar in metadata, the FGDC metadata standard, and metadata tools. This brought all participants up to the same basic knowledge level about metadata. We were extremely fortunate to have as our partner for this activity the Earth Data Analysis Center (EDAC). EDAC itself had an FGDC grant to undertake metadata training, so our projects dovetailed perfectly.

After metadata training in Albuquerque the workshop moved to the Glorieta Baptist Conference Center outside of Santa Fe. This isolated location enhanced the collaboration between professionals from different disciplines. Here, the workshop participants defined a basic model of cultural resources information, sifted through best practices and mandatory attributes and processes and considered real-world implementation and feasibility issues.

The scope of the workshop was narrow, purposely. Many elements go into the creation of an information system, and we recognized that a restricted focus was necessary. For example, "standards" in information systems comprises a broad topic, ranging from specification of detailed content and procedures to general agreement about appropriate sorts of information to track and maintain, to ways in which users, hardware, software, and data interact. In general, our work proceeded from the following perspectives:

- National data standards are realistic -- a national database is NOT;
- Get the ball rolling quickly – start a dialog instead of trying to prescribe anything or to suggest that there is a single best way to do things;

An open collaborative project sponsored by, but not limited to, the western states.
National participation is the logical ultimate goal, but this will not be achieved

immediately because (in some ways) the resources and management processes *are* different geographically;

- Make the process of standards development as open as possible, so that those who must use them have opportunities for review and comment. Hence, publish workshop results on the Internet, take comments, and only then create a draft standard for submission to the FGDC working group;
- Given the perspective on information system development outlined above, have diverse professionals (not just archaeologists) create a common set of concepts and a language useful to everyone involved with cultural resource management.

A preliminary report from the 1998 conference was made available to all interested parties. It was also distributed through a web site location.

A follow-up workshop occurred in February of 1999, in Denver, Colorado. At the follow-up meeting, we reviewed and revised the model, the minimum content recommendations, and other issues addressed at the Glorieta conference. The follow-up meeting group also delved further into particular implementation issues and ideas for exchanging information across administrative boundaries. In particular, we changed the categorization of attributes and metadata from mandatory, optional or mandatory if applicable, recommended to a simple two tier scheme of mandatory or mandatory if applicable, optional.

Spatial information metadata proved to be the least controversial topic of the meetings. Consequently, delineation of spatial metadata elements for cultural resources information systems was relatively easy. The consensus was that, the current FGDC "Content Standard for Digital Geospatial Metadata" (CSDGM; version 2), provided a sound basis for most spatial *dataset* description. Since cultural resource datasets accumulate over time, the problem with the CSDGM is that it does not capture sufficient metadata about individual spatial features. Furthermore, before one can agree how to document a dataset (or the spatial features it contains), one has to agree upon what a "dataset" and a "spatial feature of a dataset" are. In short, reaching this consensus required agreement on the *content* of cultural resource information systems.

Part of the content definition necessitated subscription to an overall model of cultural resource information systems. Thus, this report first discusses the overall model of cultural resource information systems, then content of information systems, and last ways to describe the spatial data portion of the information spectrum.

A Model of Cultural Resources Information Systems For Cultural Resource Management

Cultural resource investigations and management are information-driven actions. The goal of cultural resources investigations is not to gather physical materials, it is to collect information about the past. Cultural resource management uses these observations of cultural resources to determine what resources to preserve. In a sense, information systems *are* cultural resources management, for it is the "importance" of the past that is managed. In turn, "importance" is based (in part) on what information is already known about the past and what can be learned about it.

The rest of this section discusses a model for cultural resources information systems. The model defines major entities, minor entities, and relationships between them. The original discussion of this was made in an affiliated report to this one (Seaman 1999).

The Basic Model: Entity Definitions and Relationships

To minimize confusion, we have adopted National Register of Historic Places (NRHP) terms and definitions for historic property types:

> "The National Register of Historic Places includes significant properties, classified as buildings, sites, districts, structures, or objects" (NRHP Bulletin 15: p. 4).

Definitions for these five categories of historic properties are fully described in National Register Bulletin #15 and will not be repeated here. Subsequent NRHP Bulletins have discussed Historic and Cultural Landscapes (Bulletins 18, 30) and Traditional Cultural Properties (Bulletin 38), but these property types still fall within the original definitions provided in Bulletin 15.

To build a logical model it was necessary to focus on how historic property types are related to each other. The NRHP is not concerned with such relationships at a logical level. For example, buildings, sites, districts, structures, and objects are all considered as historic properties but districts had to be separated out from the other four historic property types to recognize and preserve the complex relationships that exist between districts and their constituent properties. Districts consist of multiple resources, and consequently are part of a more general entity entitled a *resource aggregation*. As the name implies, a resource aggregation is an entity that exists only by virtue of containing one or more members. Other sorts of resource aggregations aside from districts (which are defined by regulation) could consist of resources that share a given theme (e.g., all resources related to the Oregon Trail).

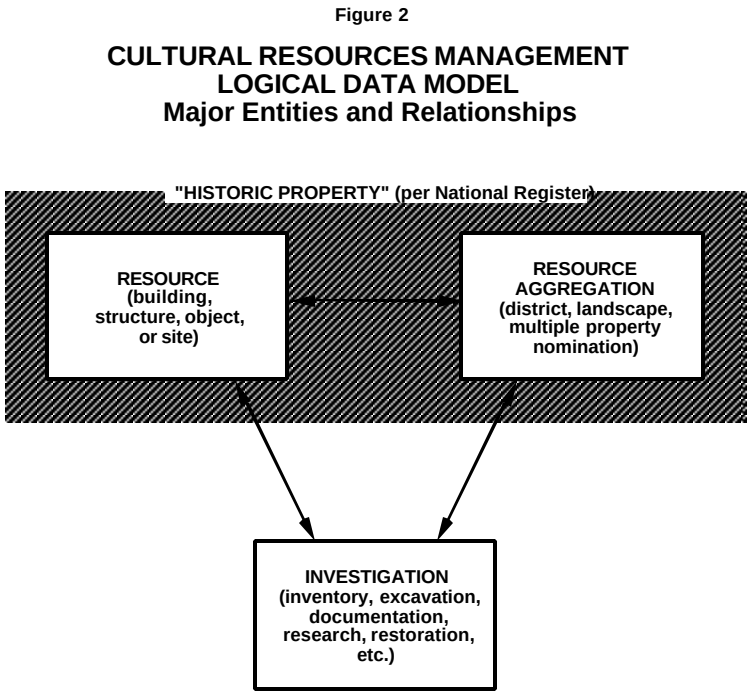
Figure 2 shows these relationships schematically in a first order data model. Only one additional major entity (Investigations) had to be added to the model to create a logical data model for cultural resource management. So, the model is built around three major data entities that have geospatial properties:

- **Resource**: an individual building, structure, object, or site. A historic property constituting the smallest unit of management considered by the NRHP.

• **Resource Aggregation**: a defined historic property consisting of a collection of two or more Resources related by proximity and/or a common theme. An area, referred to as a district or landscape by NRHP, created to manage Resources contained within an explicitly defined area, or a set of dispersed but thematically related Resources; Resource aggregations may also be related to each other in a parent-child fashion, for example to link together historic districts associated with a common theme.

• **Investigation**: an event or activity resulting in the identification, documentation, restoration, rehabilitation or preservation of historic properties. Investigations may, or may not (in the case of "negative" identification efforts), relate to one or more historic properties. Common examples of investigations include inventory, excavation, documentation, and restoration activities.

Figure 2. Major entities



Several minor entities relating to Investigations were also defined during the workshop (see Figure 3):

• **Visit**: the observational record relating a specific Investigation with a specific Resource or Resource Aggregation. When linked to a Visit, date-stamped observations on resource condition, status, and boundary definitions allow long-term maintenance of property "histories." Visits relate properties to investigations in a many-to-many fashion: a property may be the focus of more than one investigation, and a single

investigation may involve multiple historic properties. Visits insure that the integrity of these relationships are maintained.

• **Investigation Aggregation**: a collection of two or more Investigations related through a common, usually management-related, undertaking. This entity provides a reliable means of relating multiple investigation events or phases (e.g., overview, inventory, data recovery, etc.) with a larger undertaking (e.g., a federal project or permit, a long-term research project). Undertakings may also be linked to other undertakings through a parent-child relationship.

• **Publication**: a report or other document describing a single investigation. This was determined to be a one-to-many relationship: an investigation may produce multiple publications (or none), but a publication may describe only one investigation.

These three entities are considered minor because they are secondary to the primary entities and they are not necessary to model the corpus of data. In actual practice these entities may be very important. For example, most cultural resource managers work with publications and not with investigations although the former are a tangible product of the latter.

One interesting logical complexity in the model is created by the data being a set of observations. Cultural resource information systems differ from systems that tally and track attributes of tangible items. Cultural resource investigations generally make observations of resources, and it is these observations that are tracked within a cultural resource information system. Because different observers may have different perceptions of the same resource or because the resource itself changes through time (e.g., due to erosion), one could argue that each new observation of a resource (i.e., a Visit instance) is independent of all prior observations. The consequence in the data model is that there may be a logical dependency of resource table rows upon investigation and visit table rows -- each re-observation of a resource (through a new visit or investigation) creates a "new" resource record. Conceptually, this is the same as saying that each new investigation of a particular place should be considered another Investigation instance.

Figure 3

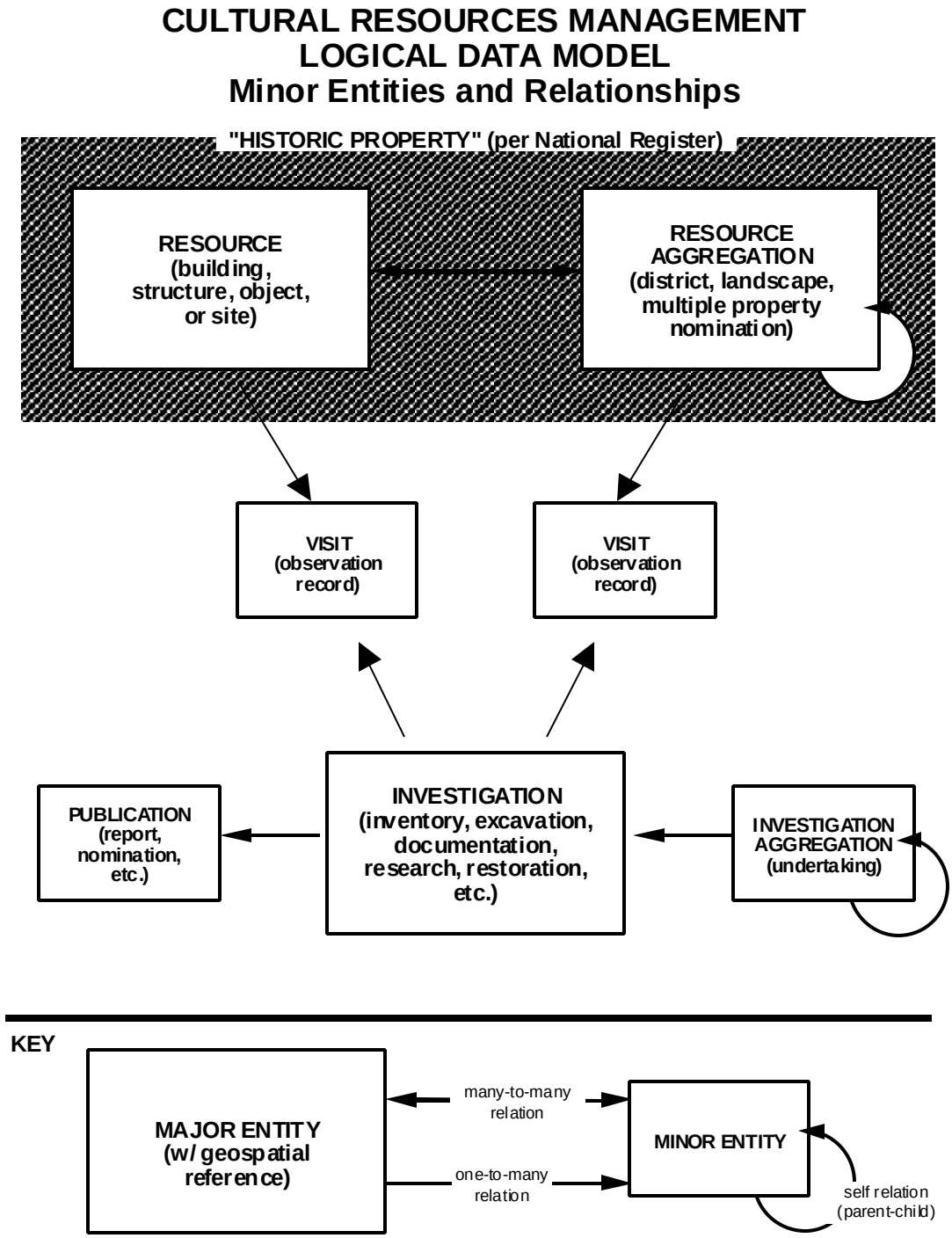


Figure 3. Major and minor entities.

GEOSPATIAL COMPONENTS OF THE BASIC MODEL

Five of the six entities in the cultural resource information system model have spatial definition. The Publication entity is probably not relevant spatially except in light of its parent Investigation entity instances. In general, the two most "atomic" entities of Resources and Investigations share spatial characteristics:

- They have definable spatial boundaries ("edges") even if a particular entity instance boundary may be unknown;
- A single entity instance may have multiple boundaries defined for it, perhaps because different observers record the boundary differently or the observable boundary changes through time;
- A single entity instance may have different types of boundaries defined for it (e.g., a National Register boundary definition *and* a boundary defined by field observation);
- A single cultural resource or investigation may consist of multiple discrete spatial instances. For instance, a single cultural resource may occur in patches or segments that are not contiguous;
- Resources may overlap spatially, as may Investigations;
- Resources and Investigations occur in three spatial dimensions. If one chooses to implement a "visit"-based model of data, then Resources and Investigations occur in four dimensions because every observation is bound to a particular time;
- The spatial extent entity itself is of interest, not the space that it occupies. That is, we seek to describe the entity as a geographic feature, not to describe the geographic space that contains the feature. The latter may be captured with reference to some other spatial data (e.g., a spatial dataset of hydrologic units might be used to describe the location of cultural resources).

Resource Aggregation instances and the minor entities of Visits and Investigation Aggregations inherit the boundary characteristics of the other two entities, so they share the characteristics described above.

ENTITY ATTRIBUTES AND FEATURE REPRESENTATION BEST PRACTICE RECOMMENDATIONS

What attributes and spatial feature representations comprise acceptable description of the model's data entities and the relationships between them? This section examines the content of cultural resource information systems as best practice recommendations. These recommendations can be seen as minimum standards for cultural resource information system content. They were distilled from many possible attributes and feature representations discussed by the participants at the two workshops and in subsequent review and correspondence with colleagues.

Some terminology definitions will be useful in reading this section. *Attributes* means properties of an entity instance that could be represented in text or numeric symbols. *Spatial features* are properties of an entity that are represented as graphic symbols on some sort of map. This terminology is preferred because an attribute may be "spatial" data even though it is not displayed in graphical form on a map (e.g., the x-y coordinate location of an entity). A

domain is the set of possible values that an attribute may have. One can also conceive that spatial features have possible configurations too, or *spatial domains* comprising the set of allowed spatial representations of an entity instance.

Two sorts of best practices recommendations follow from the above. First, attributes or spatial features themselves may be distinguished. For example, a recommendation might be that all cultural resources have an attribute of National Register of Historic Places status or that all cultural resource inventories have spatial features representing their location on a map. An attribute or spatial feature may also have a recommended domain. For instance, a National Register status attribute might have a domain of "unknown, eligible, not eligible, other" or a spatial feature might have a domain of "point on map, area on map".

The entity attributes are intended to promote comparability of information and the sharing of data. For existing information systems (electronic, paper, or both) the recommended attributes provide a set of classes against which any given system can be arrayed for comparison. This has two benefits. First, someone unfamiliar with a particular system has a guide to finding commonly useful information. Second, mapping two systems into the same categories makes clear how to share information from both.

The content attribute discussion follows the discussion of spatial representation practices. The representation of cultural resources entities in spatial form is almost always a compromise between accuracy (cost) and need. The recommendations consist of a series of options, each conveying more information than the other. Whether this information is *useful* given its cost is a decision each information system must make on its own.

ENTITY SPATIAL REPRESENTATION

The major cultural resource entities in the model have spatial presence too. The graphic objects representing these entities may be on paper maps, in CAD files, or in GIS systems. Although the line between spatial and aspatial data is gray and broad, here we discuss the representation of cultural resource entities as map features. Unlike the attributes discussed above, best practices for spatial data run a range of options from minimal (essentially mandatory if a phenomenon is to be mapped at all) to best.

Spatial representation best practices have to consider legacy data, as well as the creation of new data. Legacy data is particularly problematic in maps and spatial data. Older records often contain rather inaccurate maps. Improvements in maps themselves and in mapping technologies like the Global Positioning System, make contemporary data ever more accurate. Nevertheless, many historic resources may never be relocated or re-mapped, but still must be included in an information system. Metadata about the source(s) of individual spatial entities becomes very important in this information environment. We discuss this after considering appropriate graphical/spatial entities.

Much of the following discussion is paraphrased from our sister project and report "Advancing State Historic Preservation Office Geographic Information Systems in the Western United States" (Seaman 1999) in which these practices were implemented.

Recommendations for spatial feature representation in mapping systems are:

- **Minimal: centroids or line segments.** This option is most appropriate for legacy data where information on size and/or shape is either unknown or unreliable. Also appropriate for very small cultural resources that cannot be represented accurately at the scale of the source graphics (e.g., largest resource dimension is less than National Map Accuracy Standards);

- **Better: buffered points or lines.** Resource and investigation boundaries are "calculated" by buffering a centroid or line segment with some estimate of resource size (e.g., area, length, width);

- **Even Better: minimum bounding rectangle.** Boundaries are roughly approximated by a rectangle;

- **Best: boundary polygon.** Resource or inventory boundaries accurately represented by a polygon of the observed boundary.

Best practices also indicate the need for a great deal of flexibility in how cultural resources are represented. To wit:

- cultural resources may overlap spatially;

- a single cultural resource entity may have multiple boundaries definitions relating to separate investigation events (e.g., redefinitions of archeological site boundaries).
- a single cultural resource entity may be represented as the union of multiple objects and object types (i.e., points, lines, or polygons; e.g., an archeological inventory of an oil well pad and associated access road, a historic trail and associated buildings).
- a single cultural resource entity may have different types of boundaries (e.g., National Register vs. State Register boundaries; legal vs. traditional boundaries.

The most important decisions one must make concern how the spatial information will be used. For spatial/map data, this is often an issue of "useful" map display scale. For example, a national database of National Register Properties can probably rely on simple point and line locations at a fairly gross scale but a local government CRIS may need accurate resource boundaries to overlay on large scale base maps. The latter may be critical to make many planning decisions (e.g., "is this trench going to affect the county courthouse?").

Entity Attributes

The draft report for this project presented the entity attributes in tabular format. Attributes were grouped by entity type, and by general category. Relatively little attention was paid to the relationship between attributes. For example, in the original draft report, the attribute category of "Identification" for the Resource entity contained three actual attributes of identifying number, name, and ownership. These three attributes were simply listed, without specifying whether they are co-dependent (if one is present the others must be), may repeat (e.g., a

resource may have multiple identification numbers), suggested data formats for interchange with other systems, and value domains. This presentation worked to generate discussion of the attributes and provided a basic framework.

Subsequent work has elaborated upon the draft attribute set. The most important change in this presentation is showing the relationship between attributes (Appendix B, Tables B1 to B3). For each of the major entities (resource, investigation, resource aggregation), attributes are presented in tabular format. Attributes are described in terms of recommended data type, attribute domain, and whether the attribute repeats for a given entity instance. Where possible, the domain of the attribute is indicated, along with recommended data type, and whether its presence is mandatory or optional, as in the FGDC CSDGM, there is also a category of "mandatory if applicable".

The tables in Appendix B provide a simple (if lengthy) guide to the best practice attributes. Participants in all of the workshops felt that while no system may contain all of the attributes shown, the recommended attributes provide a structure for exchanging information. Toward this end, we have attempted to phrase the tables in a fashion that allows them to be turned into XML schemas or physical databases.

METADATA RECOMMENDATIONS

Ultimately, what goes into a cultural resource information system must inevitably be drawn from a wide variety of observers. Once in an electronic format other than an image of the original record, the heritage of an observation is very difficult to determine. Metadata provides an assessment, a guide, and an index to information heritage, and so, to information utility.

Metadata are particularly useful in cultural resources management, for how the historic and archaeological record is observed actually changes through time. Research trends change as do field and laboratory methods. Thus, one observation of an archaeological site may be quite different from another though both are equally valid and accurate. Whether one chooses to model each observational event as an independent data entity or have just one "master" record for each entity is a decision that must be made early in the creation of a cultural resource information system (and documented).

Too, the physical landscape in which cultural resources are exposed changes through time. The boundaries of a resource at one time may differ from the same resource boundary ten years later. This is particularly common in sand dunes, which sequentially expose and re-cover parts of archaeological sites over time.

In this section we discuss best practices recommendations for spatial entity metadata, for aspatial attributes (also see Appendix B), for simple spatial datasets as a whole, and for complex datasets that involve spatial data and extensive sets of aspatial attributes. The tables in Appendix B provide much of the detail on aspatial and spatial entity metadata. We have not included the FGDC Content Standard for Digital Geospatial Metadata as an appendix, as it is available on-line (www.fgdc.gov).

SPATIAL FEATURE METADATA

Accuracy and cost are probably the two most important factors in deciding which kind(s) of spatial entities will be used in the spatial data of a cultural resources information system. Whatever level of accuracy is appropriate and regardless of the strategic decisions involving cost, the need for comprehensive spatial metadata is critical. When legacy data are involved, data should be maintained at the level of the individual feature (e.g., "cultural resource X was located using GPS -- its location is accurate to within 10 meters"). Because SHPO archives are cumulative, legacy data is the rule. In these CRIS's, metadata about the source of an entity's spatial location is critical. Appendix B reflects this need, mandating that one record spatial data source. This can vary from survey grade GPS to 1:500,000 poor quality xerox maps.

Also in Appendix B, we suggest that the spatial data themselves be some sort of electronic format. We suggest the shapefile format (cf. ESRI) because it is common. SDTS format files, other vendor formats, or the older DLG formats may also be appropriate. Here, our recommendations are not prescriptive.

In Appendix B we indicate that the CSDGM 2.0, section 2.4 be used to describe horizontal and vertical positional accuracy for individual entities. This section of the CSDGM contains the following elements:

2.4 Positional Accuracy -- an assessment of the accuracy of the positions of spatial objects.

(compound)

2.4.1 Horizontal Positional Accuracy -- an estimate of accuracy of the horizontal positions of the spatial objects. (compound)

2.4.1.1 Horizontal Positional Accuracy Report -- an explanation of the accuracy of the horizontal coordinate measurements and a description of the tests used. (Text)

2.4.1.2 Quantitative Horizontal Positional Accuracy Assessment -- numeric value assigned to summarize the accuracy of the horizontal coordinate measurements and the identification of the test that yielded the value. (Compound)

2.4.1.2.1 Horizontal Positional Accuracy Value -- an estimate of the accuracy of the horizontal coordinate measurements in the data set expressed in (ground) meters.

2.4.1.2.2 Horizontal Positional Accuracy Explanation -- the identification of the test that yielded the Horizontal Positional Accuracy Value. (Text)

2.4.2 Vertical Positional Accuracy -- an estimate of accuracy of the vertical positions in the data set. (Compound)

2.4.2.1 Vertical Positional Accuracy Report -- an explanation of the accuracy of the vertical coordinate measurements and a description of the tests used. (Text)

2.4.2.2 Quantitative Vertical Positional Accuracy Assessment -- numeric value assigned to summarize the accuracy of vertical coordinate measurements and the identification of the test that yielded the value. (Compound)

2.4.2.2.1 Vertical Positional Accuracy Value -- an estimate of the accuracy of the vertical coordinate measurements in the data set expressed in (ground) meters. (numeric)

2.4.2.2.2 Vertical Positional Accuracy Explanation -- the identification of the test that yielded the Vertical Positional Accuracy Value. (Text)

For an individual spatial feature, the CSDGM basically asks for an estimate of accuracy in metric terms, (2.4.1.2.1, 2.4.2.2.1) and a narrative explanation of how one knows the accuracy in metric term (2.4.1.2.2 and 2.4.2.2.2). In our opinion, for individual spatial entities in a CRIS one could use narrative terms with equal effect (essentially just 2.4.1.1 and 2.4.2.1). Recommended locational methods and associated metadata are as follows:

- **Minimal: map-derived coordinates** based on UTM or State Plane coordinates, Latitude/Longitude, etc. Metadata: source map identification, scale, date; Coordinate system zone, datum. (Note: the Public Land Survey System (PLSS) is not a locational system, but some institutions use "Township/Range/Section/Aliquot units" to locate cultural resources -- this is not recommended, but it is better than nothing! The PLSS Meridian must be included if this system is used).

- **Better: Global Positioning System (GPS)-derived coordinates** based on UTM or State Plane coordinates, Latitude/Longitude, etc. Metadata: estimate of positional accuracy (e.g., typical standard deviation values for tool and method used, such as ± >100m, 10-100m, 1-10m, <1m); **Street address geocoding** is also recommended in urban situations. Metadata: base map or geospatial dataset series, scale, name date, etc.

- **Best: Cadastral survey or parcel map coordinates** (for historic resources) based on UTM or State Plane coordinates, Latitude/Longitude, etc. Typically locational

data of this sort is created by professional surveyors. Metadata: estimate of positional accuracy, and for resources located with reference to legally recorded property maps, the file reference to the recorded map (typically held at a government office).

The recommendations are not difficult to implement at a practical level. For instance, we routinely record source map scale for legacy entries, and use a fixed value as the estimate for horizontal accuracy. Vertical accuracy, where vertical location is known, is often derived from looking at the contour lines around a map plot, and so would be encompassed by source map scale and contour interval. In essence, the national mapping standards carry much of the information about the greatest level of accuracy that could be expected for a legacy entity. Metadata positional accuracy descriptions then take on sets of default values based upon the map source scale. One can gloss all of this into a single field (e.g., SPATIAL DATA SOURCE = USGS 1:24,000 MAP PLOT) or separate values into CSDGM Section 2.4 fields.

Spatial Dataset Metadata

As mentioned above, the workshop attendees agreed that the current CSDGM should be used as the documentation for an entire spatial dataset. In general, Section 5.1 of the CSDGM provides a structure for describing attributes in the spatial dataset at a high level of detail. This level of detail appears to exceed the needs of current data creators, according to most of the workshop participants. There was general agreement that Section 5.2 (narrative descriptions of attributes present) should be used in all cultural resources spatial dataset-level metadata documents.

Although only CSDGM Section 5.2 was recommended by the participants, we urge all spatial dataset creators to examine CSDGM carefully. The framework provided by CSDGM Section 5.1 is useful in designing spatial datasets, and if followed one generates CSDGM Section 5.1 entries anyway.

Entity Non-Spatial Attributes

Most professional data systems incorporate data dictionaries that contain the domains of all columns in every table and that document relationships between tables. Internal documentation of this sort is essential to system maintenance and functions. One could simply cite the appropriate internal data dictionary as the metadata for a table entry about a resource, investigation, or resource aggregation. Allowable values (domains) for attributes change in most data systems, so it is important to cite the data dictionary version or date used to create the table row.

Appendix B can also serve as a framework for reporting values in a way that allows comparison between data systems. We have not attempted this exercise as part of this project, but are creating XML schemas for several CRIS's using the tables in the appendix. To date, the attribute framework of Appendix B has proved useful.

Dataset and System Metadata

Many data systems operate without a comprehensive list of attribute domains, relationships between tables, and other such data dictionary and RDBMS models. In essence,

these systems are self-defeating – one still has to rely upon an expert to interpret their data. We strongly advocate formal system documentation, and making this available to users of the information itself.

Data system design always involves some tactical compromise between data models and the physical data design. Again, very few systems tell users how records are updated and what the relationship is between the records received at an archive and the data table rows (in general terms). For example, whether one chooses to treat each observation of a resource as a new table row (or set of table rows) or instead has a single "master record" for each resource is important for users to know.

This level of system documentation need not be onerous. Most users do not wish to read a true data dictionary that specifies bit formats, triggers and null rules, and other such facts. Rather, overviews of domain values and descriptions of procedures is sufficient. The FGDC CSDGM section 5 can serve as a useful descriptive structure for attributes.

CONCLUSIONS

This project set out to determine whether it was feasible to derive metadata standards for western U.S. cultural resources spatial datasets and to recommend those standards. Along the way, we found that workshop participants had an appetite to review their business models, evaluate the information content of their work processes, and agree upon some common minimum standards for spatial and aspatial data. We think this result is as important as the metadata discussion for spatial data. As well, approximately forty workshop participants received formal training in the FGDC CSDGM.

Indeed, it is feasible and highly desirable to employ documentation standards in cultural resources information systems. For datasets, the standards follow the CSDGM fairly closely. We call particular attention to CSDGM Sections 2.4 and 5 for consideration by large scale CRIS's. Individual spatial features are somewhat different. These are essential to the role of most cultural resources specialists, so will be scrutinized, relied upon, and form the basis of decisions. Because of this, spatial metadata at the level of individual map features that represent cultural resource entities is very important. Our recommendations are straightforward – document spatial data source for each feature.

At the system level, many CRIS's have different policies about information management. For example, how a record for a resource is updated varies by archive. Some CRIS's attempt to have a single data record for each resource that summarizes everything observed, though there may be multiple observation events (e.g., a site that has been recorded four times in twenty years). This requires someone in the CRIS office to make judgements about what belongs in the comprehensive record. Other CRIS's create a new data record for each observation of a resource. The differences in policy lie in different views of the record, the business process, and in practical training. As many western CRIS's add GIS to their information management systems, similar policy decisions about spatial data will need to be made. There is no "correct" policy for operating a CRIS. Yet, the users of CRIS records need to know the operating procedures that each CRIS uses. This level of metadata is very difficult to find at present.

In the long-term, the need to collate information from different sources will only increase, not decrease. Standards allow this interchange to occur with a higher degree of reliability. We hope that this project can make a modest contribution toward information sharing.

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APPENDIX A. WORKSHOP PARTICIPANTS

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APPENDIX B. ATTRIBUTE AND METADATA RECOMMENDATIONS

Table B.1. Resources. page 1
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
Identification						Resource identification information	
	Identifier					Identification label	
		Datasource	(*enumeration list*)			source of information	"Idaho SHPO", "NPS NHL Database"
		ID	(*free text*)			identification number	"48CR122", "Devil's Tower National Monument"
	Name		(*free text*)		optional	resource name(s); may include other resource identifiers (e.g., a temporary field number)	"Monticello", "CrNV-61-1234", "Old Mill Bridge"
	Ownstatus		(unknown | *free text*)			General ownership category (not specific owner)	“Federal”, “State”, “Private”, “Public and Private”
	Owner		(unknown | *free text*)			Specific ownership information or name	“USFS Humboldt N.F.”, “Tom Jones”, “Arizona State Lands”
Location						Basic coordinates, descriptive location, and some sort of spatial data format (to be defined)	
	Horizontal location					Horizontal (x-y) spatial description and source	
		Shape	GIS data (format to be defined or variable)		may be optional or in addition to horizontal coordinate pair(s)	May be complex or simple spatial feature.	Possible candidates include ArcView shapefile format, SDTS.
		HcoordsXY	x-y pairs	can repeat	may be optional or in addition to SHAPE	Horizontal coordinate pair(s) representing resource location	“1234.36, 567.8”
		Hcoordtype	(*enumeration list* | free text)	can repeat, paired to	may be optional or in addition to	How horizontal coordinate relates to	“Point on boundary”, “Centerpoint”

Table B.1. Resources. page 2
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
				HcoordsXY	shape, mandatory if HcoordsXY given	resource spatial position	
		Source	(*enumeration list* | free text)	does not repeat		Spatial data source, typically the series of map from which location was taken or verified but could be GPS method used.	"USGS 1:24,000", "USGS 1:100,000", "GPS w/<2m error", "UncorrectedGPS", "Map calculation"
		Horizontal Positional Accuracy	compound element, see FGDC Content Standard for Digital Geospatial Metadata 2.0 section 2.4				see FGDC CSDGM 2.0
	Vertical location				optional	Vertical location(s)	
		Elevation	integer (feet)	can repeat	optional	One or more elevation values, in feet to match published sources	"5280", "4567", "12300"
		Source	(*enumeration list* | free text)	does not repeat		Spatial data source, typically the series of map from which location was taken or verified but could be GPS method used.	"USGS 1:24,000", "USGS 1:100,000", "GPS w/<2m error", "Uncorrected GPS"
		Vertical Positional Accuracy	compound element, see FGDC Content Standard for Digital Geospatial Metadata 2.0 section 2.4				see FGDC CSDGM 2.0
	Location Description		free text	can repeat	optional	text describing location of resource	"U.S. 50, Storey Cty. postmile 2.3", "foot of ridge"
Access						Availability of physical and data records	

Table B.1. Resources. page 3
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
	Physical Access		unknown | yes | no			Whether physical records are available at source (cf. DATASOURCE)	“Unknown”, “Yes”, “No”
	Data Access		unknown | yes | no			Whether data records are available at source (cf. DATASOURCE)	“Unknown”, “Yes”, “No”
Description						Specific characteristics of resource	
	Resource Type		enumeration list (per National Register: Building, Structure, Object, Property, Landscape)	can repeat		Category of resource as defined by National Register criteria	“Building”, “Structure”, “Site”
	Historic function		none | unknown | free text	can repeat		Historic uses or functions	“Mill site”, “Residence”, “Railroad”
	Current function		none | unknown | free text	can repeat		Current functions or uses	“residence”, “office”, “vacant”
	Linear dimensions				optional, if applicable	Linear dimensions of resource	
		Maximum	numeric			Maximum length	22
		Minimum	numeric			Minimum crossing dimension	5
		Linear units	enumerated list (feet, meters, etc.)			Units of measure	“meters”
	Area dimensions				if applicable	Area dimensions	
		Area	numeric			Area in square units	1542
		Area units	enumerated list			Units used for area measure	“feet”
	Depth dimensions					Depth below surface of resource	
		Depth below	numeric		if applicable	Depth below surface	1.25

Table B.1. Resources. page 4
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		surface				(distance)	
		Depth units	enumerated list			Area used for depth	"meters"
	Boundary completeness		unknown | yes | no			Is boundary of resource completely defined or observed?	"No" [meaning boundary is not fully known]
	Age			can repeat		Compound element describing the general age(s) or periods of time of the resource	
		Period	historic | prehistoric | free text			text describing general age of resource, could be descriptive time periods	"historic", "Civil War"
		Period begin date	date			starting date for period	1860
		Period end date	date			ending date for period	1865
	Dates			can repeat		Compund element describing dates derived by observation and analysis of the resource	
		Begin date	date			Observed date, older bracket, years B.P.	5200 before present
		End date	date			Observed date, younger bracket, years B.P.	4800 before present
		Date basis	enumerated list			One from enumerated list of dating methods	"Radiocarbon", "Archaeomagnetism"
	Culture or cultural association		free text | unknown | not specified	can repeat		Associated archaeological, historic, or contemporary culture	"Paleoindian", "Mormon"
	Artifacts present/absent		yes | no | unknown			Whether artifacts are present at resource	"Yes"

Table B.1. Resources. page 5
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
	Artifact list		enumeration list	can repeat		Short artifact description list	“Cans”, “Bottles”, “Bifaces”
	Features present		yes | no | unknown			Whether features are present at resource	“Yes”
	Feature list		enumeration list or free text list	can repeat		Short feature description	“Hearth”, “Cesspit”
	Structures present		Yes | no | unknown			Whether structures and buildings are present	“Yes”
	Structure list		enumeration list or free text list	can repeat		Short structure description	“House”, “Barn”, “Bridge”
Architecture						Attributes of architectural resources	
	Style		none | free text	can repeat		Building style(s)	"Victorian"
	Description		free text			Description of building or resource	
Evaluation						National Register and/or other regulatory status of resource	
	Current status					Compound element describing regulatory status	
		Status	listed | eligible | not determined | not eligible | unknown			National Register status	“Eligible”
		Criteria	a | b | c | d | none	can repeat	if applicable	criteria of NRHP significance	“a”, “b”
		Integrity	enumerated list	can repeat	if applicable	keywords for National Register integrity properties of resource	“Setting”, “craftsmanship”
		Significant persons	free text	can repeat	if applicable	names of significant historical figures associated with resource	“George Washington”

Table B.1. Resources. page 6
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Period of significance – begin date	date		if applicable	Start of period of significance	1900
		Period of significance – end date	date		if applicable	End of period of significance	1925
	Theme		free text	can repeat	if applicable	Theme defining significance of resource	“Territorial Expansion”
	District status				if applicable	Compund element describing whether resource is part of an historic district aggregation	
		District	free text			Name or identifier of district	“Carson City Historic District”
		Contributes yes/no	yes | no | unknown			Resource is a significant contributor to district?	“No”
	Other status		National Monument | National Historic Landmark | World Heritage Site | free text		if applicable	Resource has status as one of listed values; enumerated list could include local and state values	“California State Historical Landmark”
	Management status		free text		optional	current management status	“BLM Pinedale Office”
Condition				entire element can repeat		compound element describing the physical condition of the resource	
	Observation date		date			Date condition observation was made	
	Disturbance						
		Disturbance	free text	can repeat,		Short descriptive term	"construction"

Table B.1. Resources. page 7
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Source		with amount affected		for source of disturbance to resource, paired with disturbance - amount	
		Disturbance Amount	free text	can repeat, with disturbance source		Short summary (preferably quantitative)	"15%"
		Threatened	yes | no | unknown			site is threatened with imminent destruction	"No"
Documentation						Compound element for Reporting, collections, records, citations	
	Investigations					Compound element describing the investigative history	
		Description	free text			Description of investigation, could include fieldwork id, etc.	"Project 88-123"; "Preliminary fieldwork"
		Investigation ID	free text			identifier string for investigation event	IMR 88-133
		Data source	enumerated list			type of investigation, from simple list	"Survey"
		Investigation Date	date			date that investigation event occurred	"3/2/99"
		Investigator	free text			name of investigator	"John Smith"
	Collections		yes | no | unknown			whether collections of materials or samples exist	
	Repository (ies)		free text	can repeat	if applicable	where materials or samples are stored	"Idaho State Museum", "Smithsonian Institution"
	Records		forms | maps | photos | free text	can repeat	if applicable	types of records stored at one or more of the	"Forms" "Maps"

Table B.1. Resources. page 8
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
						repositories	
	Citation		free text		if applicable	Bibliographic citation of any formal works regarding this resource; could be own compound element following National Archaeological Database format	
Record metadata						Description of currency of record	
	Record DB Status		verified | pending verification | unknown | free text			Summarizes whether record is known to be correct	"Verified"
	Record date		Date			Date record was last modified	

Table B.2. Resource aggregations. page 1
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
Identification						Resource identification information	
	Identifier					Identification label	
		Datasource	(*enumeration list*)	does not repeat		source of information	"Idaho SHPO", "NPS NHL Database"
		ID	(*free text*)	does not repeat		identification number	"26OR12"
	Name		(*free text*)	does not repeat	optional	aggregation name(s); may include other resource identifiers (e.g., a temporary field number)	"Carson City Historic District"
	Type		National Register District | free text |	does not repeat		type of resource aggregation, could be thematic	"Natl. Register District", "Santa Fe Railroad"
Location						Basic coordinates, descriptive location, and some sort of spatial data format (to be defined)	
	Boundary defined		yes | no |unknown			Whether the aggregation has a definable boundary	"no" (e.g., aggregation is all sites older than 5000 years)
	Horizontal location					Horizontal (x-y) spatial description and source	
		Shape	GIS data (format to be defined or variable)		may be optional or in addition to horizontal coordinate pair(s)	May be complex or simple spatial feature.	Possible candidates include ArcView shapefile format, SDTS.
		HcoordsXY	x-y pairs	can repeat	may be	Horizontal coordinate pair(s)	“1234.36, 567.8”

Table B.2. Resource aggregations. page 2
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
					optional or in addition to SHAPE	representing resource location	
		Hcoordtype	(*enumeration list* | free text)	can repeat, paired to HcoordsXY	may be optional or in addition to shape, mandatory if HcoordsXY given	How horizontal coordinate relates to resource spatial position	"Point on boundary", "Centerpoint"
		Source	(*enumeration list* | free text)	does not repeat		Spatial data source, typically the series of map from which location was taken or verified but could be GPS method used.	"USGS 1:24,000", "USGS 1:100,000", "GPS w/<2m error", "UncorrectedGPS", "Map calculation"
		Horizontal Positional Accuracy	compound element, see FGDC Content Standard for Digital Geospatial Metadata 2.0 section 2.4				see FGDC CSDGM 2.0
	Vertical location				optional	Vertical location(s)	
		Elevation	integer (feet)	can repeat	optional	One or more elevation values, in feet to match published sources	"5280", "4567", "12300"
		Source	(*enumeration list* | free text)	does not repeat		Spatial data source, typically the series of map from which location was taken or verified but could be GPS method used.	"USGS 1:24,000", "USGS 1:100,000", "GPS w/<2m error", "UncorrectedGPS"
		Vertical Positional	compound element, see FGDC Content				see FGDC CSDGM 2.0

Table B.2. Resource aggregations. page 3
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Accuracy	Standard for Digital Geospatial Metadata 2.0 section 2.4				
	Location Description		free text	can repeat	optional	text describing location of resource	“central Virginia City”
Description						Specific characteristics of resource	
	Aggregation description		free text			narrative description of resource aggregation	"Comstock Mining District and associated towns"
	Historic function		none | unknown | free text	can repeat		Historic uses or functions	“Mill site”, “Residence”, “Railroad”
	Current function		none | unknown | free text	can repeat		Current functions or uses	“residence”, “office”, “vacant”
	Area dimensions				if applicable	Area dimensions	
		Area	numeric			Area in square units, maximum area	1542
		Area units	enumerated list			Units used for area measure	"miles"
	Contributing resources *n* dimensions		number			number of resources that are considered "contributing" to aggregation	
	Non-contributing resources *n* dimensions		number			number of resources that are considered not "contributing" to aggregation but are members	
	Member resources			can repeat		Compund element of ID strings (links to RESOURCES attributes and status viz. aggregation	
		Resource ID	ID String			Resource ID string, links to RESOURCE attribute	26CH12", "Helm Building"

Table B.2. Resource aggregations. page 4
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Resource Contributes	yes | no |unknown			whether the resource is a contributing element of the aggregation (legal or thematic)	
	Age			can repeat		Compound element describing the general age(s) or periods of time of the resource	
		Period	historic | prehistoric | free text			text describing general age of resource, could be descriptive time periods	"historic", "Civil War"
		Period begin date	date			starting date for period	1860
		Period end date	date			ending date for period	1865
	Dates			can repeat		Compund element describing dates derived by observation and analysis of the resource	
		Begin date	date			Observed date, older bracket, years B.P.	5200 before present
		End date	date			Observed date, younger bracket, years B.P.	4800 before present
		Date basis	enumerated list			One from enumerated list of dating methods	"Radiocarbon", "Archaeomagnetism"
	Culture or cultural association		free text | unknown | not specified	can repeat		Associated archaeological, historic, or contemporary culture	"Paleoindian", "Mormon"
Evaluation						National Register and/or other regulatory status of resource	
	Current status					Compound element describing regulatory status	
		Status	listed | eligible | not determined | not eligible | unknown			National Register status	"Eligible"
		Criteria	a | b | c | d | none	can repeat	if applicable	criteria of NRHP significance	"a", "b"

Table B.2. Resource aggregations. page 5
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Integrity	enumerated list	can repeat	if applicable	keywords for National Register integrity properties of resource	“Setting”, “craftsmanship”
		Significant persons	free text	can repeat	if applicable	names of significant historical figures associated with resource	“George Washington”
		Period of significance – begin date	date		if applicable	Start of period of significance	1900
		Period of significance – end date	date		if applicable	End of period of significance	1925
	Theme		free text	can repeat	if applicable	Theme defining significance of resource	“Territorial Expansion”
	Other status		National Monument | National Historic Landmark | World Heritage Site | free text		if applicable	Resource has status as one of listed values; enumerated list could include local and state values	“California State Historical Landmark”
	Management status		free text		optional	current management status	“BLM Pinedale Office”
Documentation						Compound element for Reporting, collections, records, citations	
	Investigations			can repeat		Compound element describing the investigative history	
		Description	free text			Description of investigation, could include fieldwork id, etc.	"Project 88-123"; "Preliminary fieldwork"
		Investigation ID	free text			identifier string for investigation event	IMR 88-133
		Data source	enumerated list			type of investigation, from simple list	"Survey"
		Investigation	date			date that investigation event	"3/2/99"

Table B.2. Resource aggregations. page 6
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Date				occurred	
		Investigator	free text			name of investigator	"John Smith"
	Collections		yes | no | unknown			whether collections of materials or samples exist	
	Repository (ies)		free text	can repeat	if applicable	where materials or samples are stored	"Idaho State Museum", "Smithsonian Institution"
	Records		forms | maps | photos | free text	can repeat	if applicable	types of records stored at one or more of the repositories	"Forms" "Maps"
	Citation		free text	can repeat	if applicable	Bibliographic citation of any formal works regarding this resource; could be own compound element following National Archaeological Database format	
Record metadata						Description of currency of record	
	Record DB Status		verified | pending verification | unknown | free text			Summarizes whether record is known to be correct	"Verified"
	Record date		Date			Date record was last modified	

Table B.3. Investigations. page 1
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
Identification						Compound element of Investigation identification information	
	Identifier					Identification label	
		Datasource	(*enumeration list*)	does not repeat		source of information	"Idaho SHPO", "NPS NHL Database"
		ID	(*free text*)	does not repeat		identification number (often the filing number)	"88-132"
	Name		(*free text*)	does not repeat	optional	investigation name(s); may include other resource identifiers (e.g., a temporary field number)	"Architectural Survey of the Carson City Historic District"
	Investigator		free text		optional	compound element specifying lead investigator	
		Investigator name	free text		optional	name of lead investigator	“Tom Smith”
		Affiliation	free text			organizational affiliation of lead investigator	“UC Berkeley”, “none”
	Lead Agency		free text		optional	name of lead reviewing agency for investigation	“USFS Ashley N.F.”
	Begin Date		date		optional	date investigation began	“3/1/95”
	End Date		date		optional	date investigation ended	“314/95”
Location						Basic coordinates, descriptive location, and some sort of spatial data format (to be defined)	
	Boundary defined		yes | no |unknown			Whether the investigation has a definable boundary	"no" (e.g., investigation has no definable bound
	Horizontal location					Horizontal (x-y) spatial description and source	
		Shape	GIS data (format to be defined or		may be optional or in	May be complex or simple spatial feature.	Possible candidates include ArcView

Table B.3. Investigations. page 2
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
			variable)		addition to horizontal coordinate pair(s)		shapefile format, SDTS.
		HcoordsXY	x-y pairs	can repeat	may be optional or in addition to SHAPE	Horizontal coordinate pair(s) representing resource location	"1234.36, 567.8"
		Hcoordtype	(*enumeration list* | free text)	can repeat, paired to HcoordsXY	may be optional or in addition to shape, mandatory if HcoordsXY given	How horizontal coordinate relates to resource spatial position	"Point on boundary", "Centerpoint"
		Source	(*enumeration list* | free text)	does not repeat		Spatial data source, typically the series of map from which location was taken or verified but could be GPS method used.	"USGS 1:24,000", "USGS 1:100,000", "GPS w/<2m error", "UncorrectedGPS", "Map calculation"
		Horizontal Positional Accuracy	compound element, see FGDC Content Standard for Digital Geospatial Metadata 2.0 section 2.4				see FGDC CSDGM 2.0
	Location Description		free text	can repeat	optional	text describing location of resource	"central Virginia City"
Description						Compound element describing investigation	
	Investigation type		enumerated list | free text	can repeat		short description of investigation, from appropriate list of values or	"Architectural survey", "Excavation"

Table B.3. Investigations. page 3
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
						free text	
	Undertaking		free text		optional	Description of undertaking that provoked investigation	“Downtown parking structure”, “Oil and gas exploration”
	Land/ownership status		free text | unknown	can repeat	optional	Compound optional repeating element of ownership of area/places investigated	
		Owner	free text			Name of owner or managing agency	“Joe Smith”, USDI-BLM”
		Area	numeric			Area in square units, maximum area for this owner	1200
		Area units	enumerated list			Units used for area measure	"acres"
	Total Investigation Area				if applicable	Area dimensions of entire investigation	
		Area	numeric			Area in square units, maximum area	2400
		Area units	enumerated list			Units used for area measure	"acres"
Methods						Compound element describing investigation methods.	
	Intensity		free text			Intensity or level of investigation	"Class III", "Windshield survey"
	Configuration		free text			Description of general "geometry" of investigation	"Block excavation", "Linear inventory"
	Bias/scope		free text			whether investigation looked at all historical materials or selected ones	"Historic buildings", "Prehistoric rock art only"
	Interval		free text		if applicable	for survey, survey interval and method	"30m spacing", "10m spacing, rake every

Table B.3. Investigations. page 4
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
							100m"
	Crew Size		free text		if applicable (optional)	Number of persons in investigation	"5-25", "1"
	Field Time		free text		optional	estimated amount of time expended (person-hours)	"2000 person hours"
	Subsurface		free text		optional	if subsurface investigations, what sort	"shovel probes", "trenches and 1m test units"
	Surface		free text		optional	kinds of surface investigation or recording done	"Detailed mapping", "Check for vandalism only"
	Visibility		free text		optional	For surveys only, the approximate ground visibility conditions	"Poor - high grass", "Variable - patchy snow"
Documentation						Compund element describing any reports, associated resources or aggregations, collections	5200 before present
	Total resources		number		optional	total number of resources investigated or present	
	Associated Resources			can repeat		Compound element enumerating resources and/or rows of resource table associated with investigation	
		Data source	enumerated list			Source of information for the resource	
		ResourceID	free text			Resource identifier (could be key to resource table row)	"26CH1"
	Associated aggregations					Compound element describing associated aggregations	

Table B.3. Investigations. page 5
Note that compound elements are shown in indented fashion.

Category	Attribute	Child attribute	Domain	Repeats?	Optional?	Brief description	Example
		Data source	enumerated list			Source of information for the resource	
		ResourceID	free text			Resource identifier (could be key to resource table row)	"Downtown Laramie Historic District"
	Collections		yes | no | unknown			whether collections of materials or samples exist	
	Repository (ies)		free text	can repeat	if applicable	where materials or samples are stored	"Idaho State Museum", "Smithsonian Institution"
	Records		forms | maps | photos | free text	can repeat	if applicable	types of records stored at one or more of the repositories	"Forms" "Maps"
	Citation		NADB format citation		if applicable	National Archaeological Database format citation (may be compound)	
Record metadata						Description of currency of record	
	Record DB Status		verified | pending verification | unknown | free text			Summarizes whether record is known to be correct	"Verified"
	Record date		Date			Date record was last modified	