Environmental Protection Agency

Geospatial Metadata Technical Specification
Version 1.0

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Document Scope and Applicability

The primary purpose of this document is to establish guidelines for publishing geospatial metadata for data sets, applications, and services developed by the Environmental Protection Agency (EPA).

The intent of establishing publishing guidelines for Agency geospatial metadata is two-fold: 1). To ensure that consistent implementation practices are followed for geospatial metadata implementation across the Agency, and 2) To ensure that sufficient information is provided within geospatial metadata published by different Agency authors that will serve multiple Agency needs. Consistency in geospatial metadata publishing and management practices leads to improved discovery and reuse of geospatial data for internal purposes while also improving Agency support for the National Geospatial Data Infrastructure (NSDI).

The guidelines set forth in this document should be applied to the creation of all new geospatial metadata records at EPA. Existing metadata records should be updated to meet EPA requirements in accordance with each organization's records management schedule.

1.2 The EPA Implementation of the CSDGM

EPA's Implementation of the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM) has been developed to provide consistent rules for applying the standard to Agency geospatial metadata. As a content standard, the CSDGM provides a basic framework of elements along with their descriptions that can be used to describe geospatial data. In many cases, elements that comprise the CSDGM are classified as 'free-text', without restrictions on their domain. In order to achieve consistency within EPA there is a need to provide additional guidance and/or restrictions for particular elements of the CSDGM that require common interpretation. This technical specification has been developed to address that need.

In addition to providing specification for particular fields within the CSDGM, the EPA implementation is also designed to provide a single document that will serve the various end-uses that geospatial metadata supports, including minimum FGDC requirements, Agency requirements, and search tool specifications that are used for the practical application of metadata. Utilizing a single EPA Implementation that addresses all needs simultaneously will reduce inefficiencies that result from adhering to metadata requirements individually for different end-uses.

The EPA Implementation is based on the FGDC CSDGM, but augments the standard by providing consistent language for certain metadata elements and by requiring the use of some elements that are not considered mandatory for minimum FGDC validation.   The implementation does not create new elements; rather it provides standard interpretation guidelines for existing elements. Metadata that is compliant with the Agency metadata profile ensures that it is also compliant with minimum FGDC requirements and ESRI search tool requirements. As such, metadata documented according to the EPA implementation may be

shared with the National Spatial Data Infrastructure (NSDI) and Geospatial One Stop (GOS), as well with EPA's central geospatial metadata catalog. The following sections describe the EPA Implementation of the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM) and provide context for interpreting particular geospatial metadata content standard elements.

2.0 METADATA CONTENT GUIDELINES

This section outlines requirements for Agency-specific geospatial metadata, providing guidance on language for specific elements, information on how to make decisions for certain element classification schemes, and the relationship (if any) to Agency standards used or referenced. Each section will highlight which components are required for minimum FGDC validation, which elements are required to address Agency needs, and how users should interpret the use of elements in cases where implementation has been defined for Agency purposes. This document is not intended as a complete explanation of the implementation of the FGDC standard. Rather, it is intended as a reference for guidance only on those elements that are considered important or mandatory for the EPA implementation. Users wishing to obtain additional information about the FGDC CSDGM should visit the FGDC website at http://www.fgdc.gov/metadata/contstan.html.

2.1 Background on the FGDC CSDGM

The FGDC CSDGM is comprised of 7 major sections and 3 supporting sections. The supporting sections (8-10) are used only to provide context for other sections, and are never used alone. The sections are classified as "mandatory", "mandatory if applicable", or "optional". "Mandatory" means that the section must be present in the metadata to adhere to minimum FGDC requirements. "Mandatory if applicable" means that the section must exist if the data set requires it (e.g., data with vertical measures must contain vertical accuracy information). An "Optional" element is only required if the metadata publisher wants to provide additional information supplied by that element. For minimum FGDC requirements, two (2) of the seven (7) major sections are classified as mandatory (see Figure 1). For EPA requirements, five (5) sections are classified as mandatory. A crosswalk showing the commonalities and differences between sections of the standard required for meeting minimum FGDC and EPA implementation requirements is presented below.

Crosswalk: FGDC Metadata Content Standard Requirements and EPA's Metadata Implementation

Minimum FGDC Metadata Sections

1 Identification Information <idinfo>	Basic information about the data set.
2 Data Quality Information <dataqual>	A general assessment of the quality of the data set.
3 Spatial Data Organization <spdoinfo>	The mechanism used to represent spatial information in the data set
4 Spatial Reference Information <spref>	The description of the reference frame for, and the means to encode, coordinates in the data set.
5 Entity and Attribute Information <eainfo>	Details about the information content of the data set, including the entity types, their attributes, and the domains from which attribute values may be assigned.
6 Distribution Information <distinfo>	Information about the distributor of and options for obtaining the data set.
7 Metadata Reference Information <metainfo>	Information on the currency of the metadata information, and the responsible party.

Minimum EPA Implementation Metadata Sections

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LEGEND

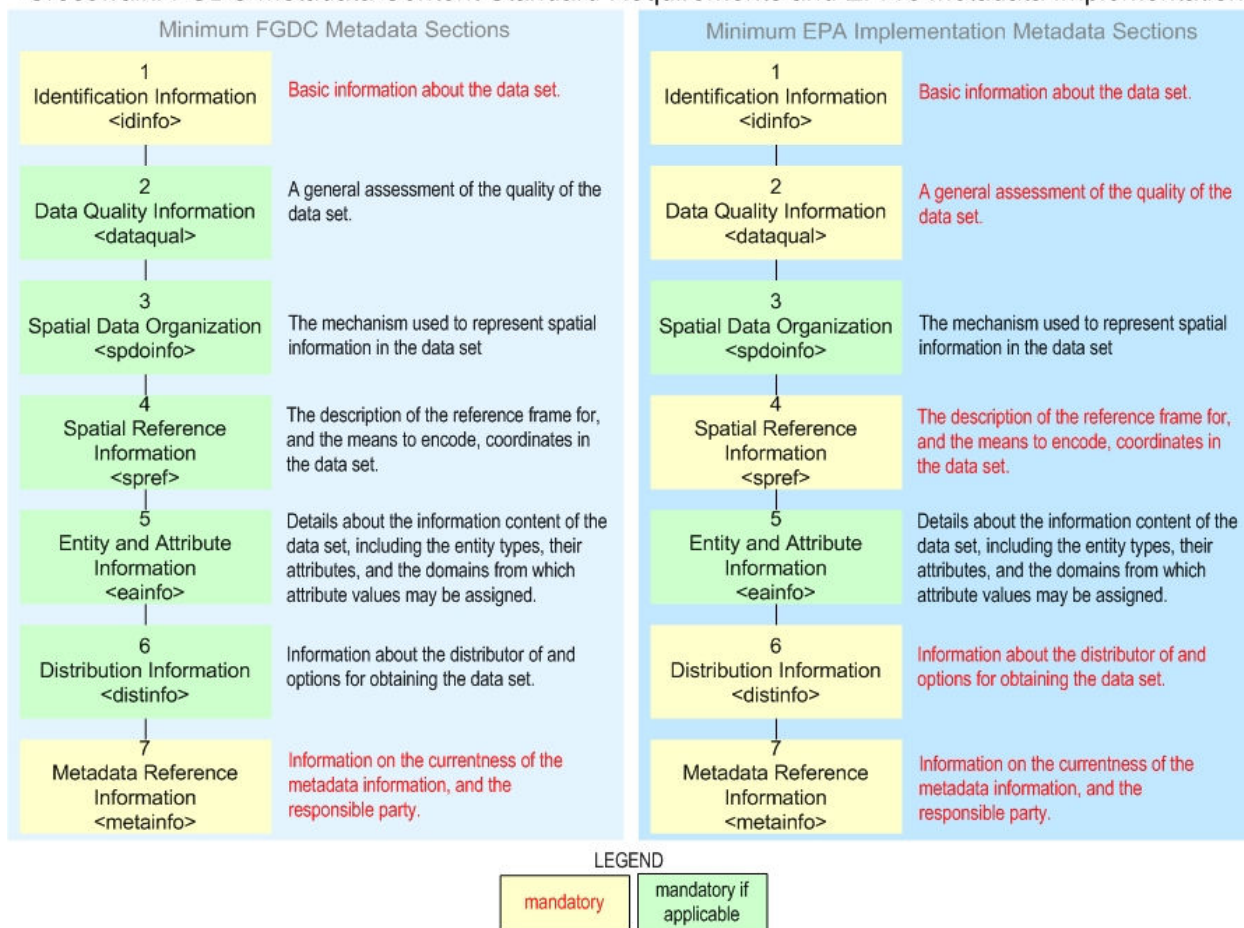mandatory | mandatory if applicable

Figure 1. Sections required by the FGDC CSDGM and the EPA implementation. Yellow = Mandatory Element, Green = Mandatory if applicable element.

Each major section of the FGDC CSDGM is made up of elements. The same classes as described for sections of the standard also apply to elements within the sections; some are mandatory when the section is used, some are mandatory if applicable, and some are optional. Elements within the metadata content standard may exist as one of two types: data elements, which are comprised of values (text, integer, real), or compound elements, which are composed of other compound or data elements. Some compound elements may be comprised of various levels of nesting of other compound elements, some of which will be required when certain metadata elements are used. This nesting of elements and element types is often shown visually using an image map (illustrated above) to provide clarity. The full image map definition for FGDC metadata developed by the USGS is provided at http://biology.usgs.gov/fgdc.metadata/version2/.

Metadata is generally stored as an xml file, often used in conjunction with a stylesheet for presentation purposes. The examples contained within this section are provided with the corresponding xml elements as required in the metadata document. A list of links to commonly used stylesheets for viewing geospatial metadata stored in XML format is available at http://www.fgdc.gov/metadata/metaxml.html.

The following paragraphs list the elements required for adhering to the EPA implementation of the CSDGM. Those that have been developed with consistent language are described in detail, outlining implementation options and rules for each. Elements that are required by FGDC but do not have consistent language developed by the Agency are shown, but the implementation of these is left to the user (and FGDC). Users wishing to obtain additional information related to the FGDC standard should consult FGDC and USGS resources (FGDC 1998, USGS 1998).

2.2 Relationship to EPA's National Geospatial Data Policy

Compliance with the EPA Geospatial Metadata Technical Specification is required as part of EPA's National Geospatial Data Policy (NGDP). The NGDP identifies five (5) major data life cycle phases, throughout which sections of the EPA Geospatial Metadata Technical Specification become required. This forms a continuum from minimal to full EPA technical specification requirements as a data set is developed, such that information provided within the metadata with is harmonized with that which becomes available as a data set progresses through the life-cycle (e.g., processing steps are not required until the processing and conversion phase of the data life cycle). Full compliance with the EPA Geospatial Metadata Technical Specification is not required until the Data Storage and Access phase. XML templates for each of the life-cycle phases identified below are provided with this technical specification.

The structure for requirements at each life-cycle phase is as follows:

1. **Data Planning Phase:** During the Data Planning Phase, the development of a 'marketplace' record *may* be required. Marketplace requirements include documentation within the metadata record for FGDC Sections 1, 6, and 7. Within Section 1, a marketplace record must have its status set to 'planned'. In section 6, a marketplace record must have its resource description set to 'Geographic Activities'. EPA metadata developers should refer to sections EPA requirements within FGDC sections 1, 6, and 7 to determine documentation requirements during this phase.
2. **Processing and Conversion Phase:** During the Data Processing and Conversion Phase, FGDC Sections 2 and 4 are required in order to document data processing steps and conversion to final coordinate system. The inclusion of these sections completes the sections requirements for the EPA Geospatial Metadata Technical Specification.
3. **Storage and Access Phase:** During the Data Storage and Access Phase, full compliance with the EPA Metadata Technical Specification is required, with the inclusion of updating online linkage within the metadata to provide access to the data set (see Appendix 5.3).

2.3 FGDC Section 1: Identification Information

The identification information section of the CSDGM provides basic information about the data set. This section is required for meeting minimum FGDC requirements. Fourteen (14) elements comprise this section, eight of which are required to meet minimum FGDC requirements. Two additional elements (publication information and security information) are required by the EPA implementation (Figure 2) of the FGDC CSDGM. Context is provided by the EPA implementation for use within the fields: publication information, online linkage, keywords, access constraints, use constraints, and security information.
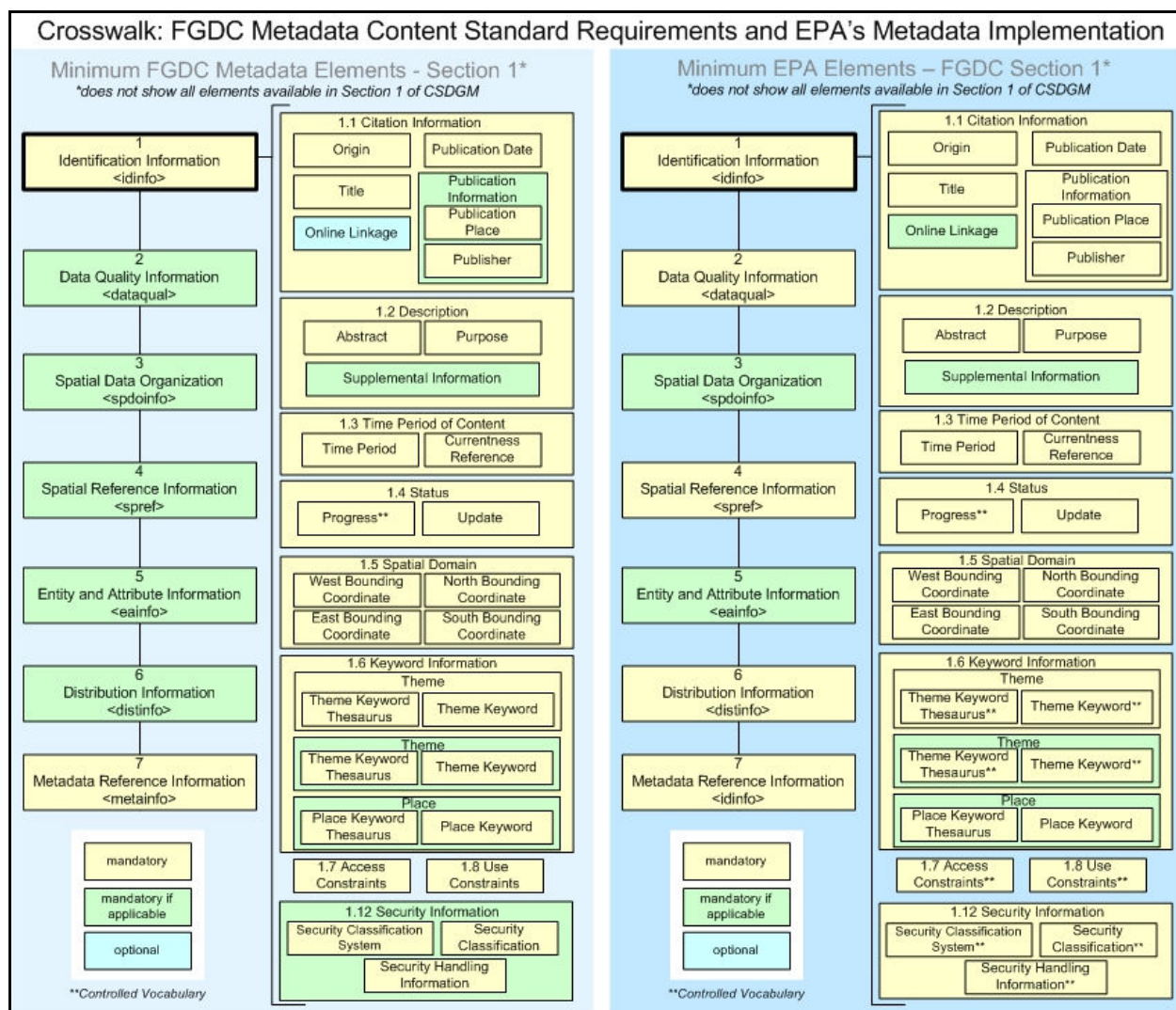
Figure 2. Requirements in Section 1 of the FGDC CSDGM.

2.3.1 Required Elements in FGDC Section 1 (FGDC)

The following elements are required in Section 1 by the FGDC standard:
- 1.1 Citation Information <citation>
- 1.2 Description <descript>
- 1.3 Time Period of Content <timeperd>
- 1.4 Status <status>
- 1.5 Spatial Domain <spdom>
- 1.6 Keywords <keywords>
- 1.7 Access Constraints <acconst>
- 1.8 Use Constrains <useconst>

2.3.2 Additional Required Element(s) in FGDC Section 1 (EPA)

An additional element is required for the EPA Implementation:
- 1.1.8.8 Publication Information <pubinfo>
- 1.12 Security Information <secinfo>

2.3.3 Implementation Specifications for FGDC Section 1 (EPA)

The EPA implementation provides guidance for the following elements:

- 1.1.8.8 Publication Information <pubinfo>
- 1.1.8.10 Online Linkage <onlink>
- 1.6 Keywords <keywords>
- 1.7 Access Constraints <acconst>
- 1.8 Use Constrains <useconst>
- 1.12 Security Information <secinfo>

2.3.4 Specifications for FGDC Element 1.8.8: Publication Information

Publication information is defined by FGDC as "publication details for published data sets". The inclusion of publication information is required to comply with ESRI metadata catalog requirements.

EPA Publication Information Rule: The inclusion of publication information is required to meet ESRI geospatial metadata catalog publishing requirements.

Implementation: The publication information element is a compound element comprised of publisher name, publisher place, and other citation details. Publisher name and publisher place are required elements. This is implemented as follows:

<pubinfo>
    <pubplace>Washington, DC</pubplace>
    <publish>U.S. Environmental Protection Agency</publish>
</pubinfo>

2.3.5 Specifications for FGDC Element 1.8.10: Online Linkage

Online linkage is defined by FGDC as "the name of an online computer resource that contains the data set. Entries should follow the Uniform Resource Locator convention of the Internet".   Online linkage is considered mandatory if applicable for the EPA Implementation of the FGDC CSDGM, but its use is strongly recommended to promote direct access to data sets and services.   Documentation of online linkage should be provided using the nomenclature that reflects the specifics of the asset (data, service, application) being documented. For additional information regarding the online linkage element, see Appendix 4.5.

EPA Publication Information Rule: Online linkage is considered mandatory if applicable, but is strongly recommended to promote direct access to data sets and services.

Implementation: The online linkage element is implemented as follows:

<onlink>http://www.epa.gov/ </onlink>

2.3.6

2.3.7 Specifications for FGDC Element 1.6: Keywords

Keywords are defined by FGDC as "words or phrases summarizing an aspect of the data set". A single theme keyword is required to meet minimum FGDC standards. Contributions to GOS require the inclusion of at least one ISO-keyword provided by the ISO19115 keyword thesaurus. The ISO19115 keyword thesaurus provides a general classification scheme for GIS data layers, and should be used for general classification purposes (see Section 6.2). For Agency data, a second (optional) keyword list is provided to complement the ISO keyword for Agency-specific geospatial data (i.e., monitoring locations, facilities, or other sites). For implementation purposes, the following rules are used for keywords:

EPA Keyword Rule: At least one ISO theme keyword is minimally required for Agency metadata. Publishers must choose 1 theme keyword from the ISO19115 keyword thesaurus for each data set (Section 6.2). A second EPA Keyword is considered mandatory if applicable, and should be used for EPA-specific data sets to augment classification of data with respect to EPA business areas. See Section 6.2 for the complete listing of both ISO and EPA keywords.

Implementation: The keywords element is a compound element comprised of keywords related to theme, place, stratum, and temporal aspects of the data set. This implementation demonstrates the use of the theme keyword element. The theme keyword element is comprised of a theme keyword thesaurus and 1 or more theme keywords. This is implemented as follows:

```
<keywords>
<theme>
<themekt>ISO 19115 Topic Category</themekt>
<themekey>environment</themekey>
<themekey>007</themekey>
</theme>
            <theme>
                <themekt> EPA GIS Keyword Thesaurus</themekt>
                <themekey>Hazards</themekey>
                <themekey>Waste</themekey>
                <themekey>Cleanup</themekey>
                <themekey>Facilities</themekey>
            </theme>
</keywords>
```

Users may choose to also implement place, temporal, or stratum keywords, but specific EPA usage for these categories is not defined within this guidance document.

2.3.8 Specifications for FGDC Element 1.7: Access Constraints

FGDC Defines the Access Constraints element as "Restrictions and legal prerequisites for accessing the data set. These include any access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the data set." The access constraints element is required to meet minimum FGDC

standards. It should be used to provide additional detail to the security classification chosen (described in Section 3.2.7).

EPA Access Constraints Rule: Provide information that describes the decision made for applying security restrictions. This element should be used to provide an explanation for the security level applied.

Types of Data that may have access constraints applied to them:
- Sensitive Habitats
- Draft Data
- High-resolution orthophotography
- Certain internal data (sensitive facilities)
- Data protected by license agreements that may not be redistributed.
- Data showing detailed information regarding public water supplies.

Implementation: The specific language used to implement the access constraints element may vary from one data set to the next, depending on the nature of the data. Some data sets will be restricted due to sensitivity, whereas others may be considered draft, and are not ready for distribution. If there are no known use constraints for the data set, use the term "None".

An example of language that may be used to describe a data set that is considered "sensitive" is shown below:

<acconst>Data have restricted access due to the sensitive nature of the locational information presented.</acconst>

2.3.9 Specifications for FGDC Element 1.8: Use Constraints

FGDC defines the Use Constraints element as 'Restrictions and legal prerequisites for using the data set after access is granted. These include any use constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on using the data set.' Use constraints are data set specific and should be used to describe the known limitations of individual data sets. Some data that are accessed from external sources may have use constraints documented by external agencies that should be retained in the metadata. Data developed internally to EPA should have any limitations known to the data set documented within the metadata.

EPA Use Constraints Rule: For data developed by other parties, retain use constraints information, and add the EPA General Statement. For data developed in-house, determine scale, accuracy, and other limitations related to using the data. If there are no known use constraints for the data set, use the term "None" and provide the EPA General Use Constraints Statement.

Types of constraints that may apply to particular data sets:
- Scale Constraints: Data should not be used at scales greater than 1:24,000.
- Accuracy: Data are only considered accurate to 5 meters.
- Currentness: Data are considered current to the date of the original source material.
- Acknowledgement: Acknowledgement of the EPA when used would be appreciated.

<u>EPA General Use Constraints Statement:</u> Please check sources, scale, accuracy, currentness and other available information. Please confirm that you are using the most recent copy of both data and metadata.

<useconst>Data are considered current to the date of the original source material. Please check sources, scale, accuracy, currentness and other available information. Please confirm that you are using the most recent copy of both data and metadata.</useconst>

2.3.10 Specifications for FGDC Element 1.12: Security Information

FGDC defines the Security Information element as "Handling restrictions imposed on the data set because of national security, privacy, or other concerns." The security information element is used to document a formal security classification system, and will be used by the Agency to make determinations about which data are made available to public, external partners, or internal Agency staff. The security classification tags should be used to provide distinct classifications for data that can be interpreted by humans or computers to make determinations about the availability of data sets. This element is used together with Access constraints.   Access constraints can be used to describe more completely the security restrictions that are applied within this element.

<u>EPA Security Information Rule</u>: The use of the security information element is required by the EPA implementation. Geospatial data owners should refer to FIPS Pub 199 and the EPA Information Security Manual for information on security concerns for EPA data. Use no, medium, and high confidentiality to classify data sets.

Classification System Rules
<u>No Confidentiality</u>: Data are publicly available.
<u>Medium Confidentiality</u>: Can be shared with state partners.
    Internal practices
    'Draft' data sets
    Geophysical or public water supply data
    Other Sensitive Data
<u>High Confidentiality</u> Can only be used internally.
    Confidential Business Information
    Confidential Agency Information
    FOIA Exempt information

Implementing Security Information
Security Information is a compound element that is made up of three data elements. These include:
<u>Security System</u>:<secsys> Name of the classification system.
<u>Security Classification:</u><seclass> Name of the handling restrictions on the data set.
<u>Security Handling Restrictions:</u><sechandl> Additional information about the restrictions on handling the data set.

These are implemented as follows:
Security System: FIPS Pub 199
<u>Security Classification:</u> No Confidentiality, Medium Confidentiality, or High Confidentiality
Security Handling Restrictions: Standard Technical Controls

```
<secsys>FIPS Pub 199</secsys>
<secclass>High Confidentiality</secclass>
<sechandl>Standard Technical Controls</sechandl>
</secinfo>
```

2.4   FGDC Section 2: Data Quality Information

The data quality information section of the CSDGM provides a general assessment of the quality of the data set (attribute accuracy information, completeness of the information, processing steps completed on the data set). This section is not required to meet minimum FGDC requirements. This section is required by the EPA profile to ensure documentation of horizontal positional accuracy. When used, this section maintains six elements, three of which are considered mandatory for minimum FGDC requirements (Figure 3). The EPA profile requires the use of four of the elements in this section. Of the four elements required for the EPA profile, guidance on implementation for is provided for only positional accuracy. The remaining elements can be interpreted according to FGDC specifications.

2.4.1   Required Elements in FGDC Section 2 (FGDC)
- 2.2 Logical Consistency Report <logic>
- 2.3 Completeness Report <complete>
- 2.5 Lineage <lineage>

2.4.2   Additional Required Elements in FGDC Section 2 (EPA)

- 2.4 Positional Accuracy <posacc>

2.4.3   Implementation Specifications for FGDC Section 2 (EPA)

The EPA implementation provides guidance for:

- 2.4 Positional Accuracy <posacc>
- 2.4.1 Horizontal Positional Accuracy <horizpa>
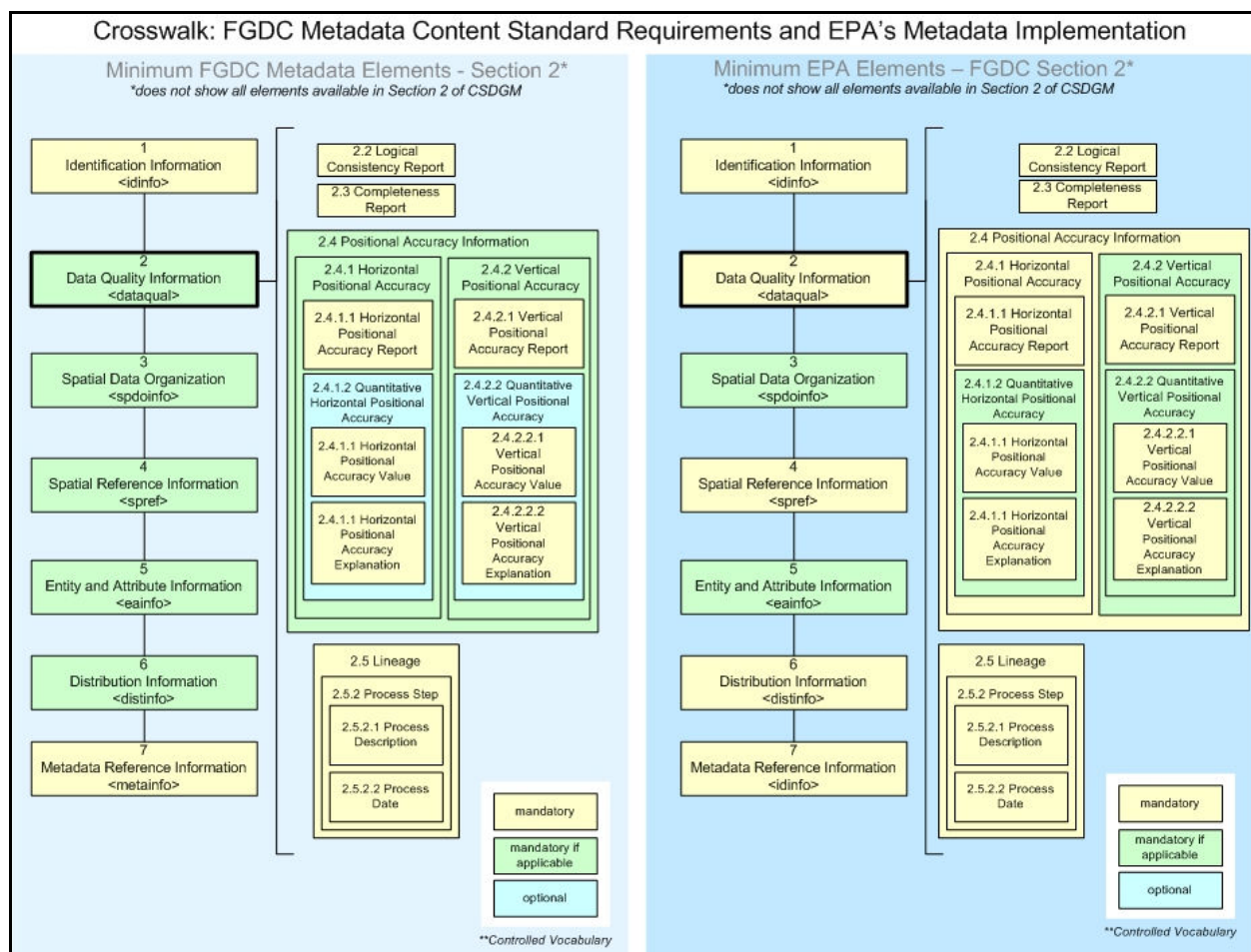   - 2.4.2 Vertical Positional Accuracy <vertacc>

Figure 3. Element Requirements for Section 2 of the CSDGM.

2.4.4 Specifications for FGDC Element 2.4: Positional Accuracy

The FGDC defines the Positional Accuracy element as "an assessment of the accuracy of the positions of spatial objects". This element is not required by minimum FGDC standards, but is required by the EPA implementation. The positional accuracy element is comprised of both horizontal positional accuracy and vertical positional accuracy. For EPA profile requirements, only horizontal positional accuracy is considered mandatory. Vertical positional accuracy is considered mandatory if applicable. Determining and documenting accuracy is a complex and varied process. Different geospatial data sets may be collected and/or developed via numerous different methods, each of which contributes to the accuracy of the data set as a whole. It is important to determine how the methods used to develop the data set affect the resultant accuracy statements and quantitative estimates.

Positional accuracy may be documented using qualitative statements only, or by developing a numerical estimate for the data set using statistical methods. Due to the complex nature of this field, the implementation for this element requires greater detail on methodology than that presented above. Examples of different implementation options given the nature of the data set are provided as guidance on documenting accuracy, and should be used as a basis from which to develop statements and/or estimates for particular data sets. Templates for calculating accuracy estimates using different standard methods are provided in Section 6.3.

EPA Horizontal Positional Accuracy Rule: Geospatial data developed at the Agency shall include horizontal positional accuracy information for all data sets. The use of vertical positional accuracy is required when the data set maintains vertical position information. Positional accuracy reports should be developed using one, or a combination of, the following techniques:

1. Use standard tests (NSSDA, ASPRS for large scale maps) for developing an accuracy estimate at a given confidence level.
2. Record accuracy information while collecting data (GPS, survey).
3. Develop estimates based on data compilation activities (photo/map interpretation errors).
4. Reference default accuracy tier ranges being developed as part of the National Geospatial Data Policy.
5. Develop a composite accuracy assessment for data that have been developed using a 'hybrid' method (i.e., data were collected using a recreational grade GPS, but were also compared with digital orthophotos to evaluate the data against a source of known accuracy.

Data received from an external source that that is delivered with accuracy statements and/or estimates should retain the information delivered with the data set. Data received from external sources without accuracy information may use the term 'Unknown' to document accuracy; however it is strongly recommended that geospatial data obtained from external sources be tested and documented for accuracy.

The following four methods are provided by the Spatial Data Transfer Standard (SDTS) as standard techniques for determining spatial accuracy:

- Deductive Estimate: Any deductive statement based on knowledge of errors in each production step shall include reference to complete calibration tests and shall also describe assumptions concerning error propagation. Results from deductive estimates shall distinguish from results of other tests.

- Internal Evidence: Federal Geodetic Control Committee procedures will be used for tests based on repeated measurement and redundancy such as closure of traverse or residuals from an adjustment.

- Comparison to Source: When using graphic inspection of results ('check plots'), the geometric tolerances applied shall be reported and the method of registration shall also be described. Use of check plots shall be included in the lineage portion.

- Independent Source of Higher Accuracy: The preferred test for positional accuracy is a comparison to an independent source of higher accuracy. The test shall be conducted using the rules prescribed in the 'ASPRS Accuracy Standards for Large Scale Maps' (see section 1.3.3. of SDTS). When the dates of testing and source material differ, the report shall describe the procedures used to ensure that the results relate to positional error and not to temporal effects. The numerical results in ground units, as well as the number and location of the test points, shall be reported. A statement of compliance to a particular threshold is not adequate in itself. This test may only be applicable to well-defined points.

Of these, the _independent source of higher accuracy_ is the method preferred by FGDC for determining data set accuracy.

For Agency purposes, if data are collected at EPA using GPS, surveying, or other methods that provide positional errors and offsets, information should be obtained during data collection and should be used for developing accuracy assessments. If data are developed manually (map/photo interpretation), then error information should be retained to develop a quantitative accuracy assessment and procedures should be reported in the qualitative accuracy statement. If data are produced using a method that does not readily provide information to document accuracy (e.g., computing site centroids) then users can default to the accuracy ranges provided in the National Geospatial Data Policy for different collection techniques (see Section 6.4). If data are collected from external sources, then users should check the data set's metadata to retain original accuracy information (if it exists), and should perform tests (NSSDA) to develop an accuracy assessment. If accuracy information is lacking from the data set and accuracy estimates cannot be performed, then the term 'Unknown' can be used for documenting the accuracy of data developed by others. See Figure 4 (below) for additional reference information regarding accuracy reporting.

Implementation Examples

Horizontal Positional Accuracy is made up of 3 elements, a horizontal positional accuracy report (<horizpar>), a horizontal positional accuracy value (<horizpav>), and a horizontal positional accuracy explanation (<horizpae>). Of these, only the horizontal positional accuracy report is considered mandatory. Descriptions of each of these elements are shown below:

- **Horizpar:** an explanation of the accuracy of the horizontal coordinate measurements and a description of the tests used.
- **Horizpav:** An estimate of the accuracy of the horizontal coordinate measurements in the data set expressed in (ground) meters.
- **Horizpae:** The identification of the test that yielded the Horizontal Positional Accuracy Value.
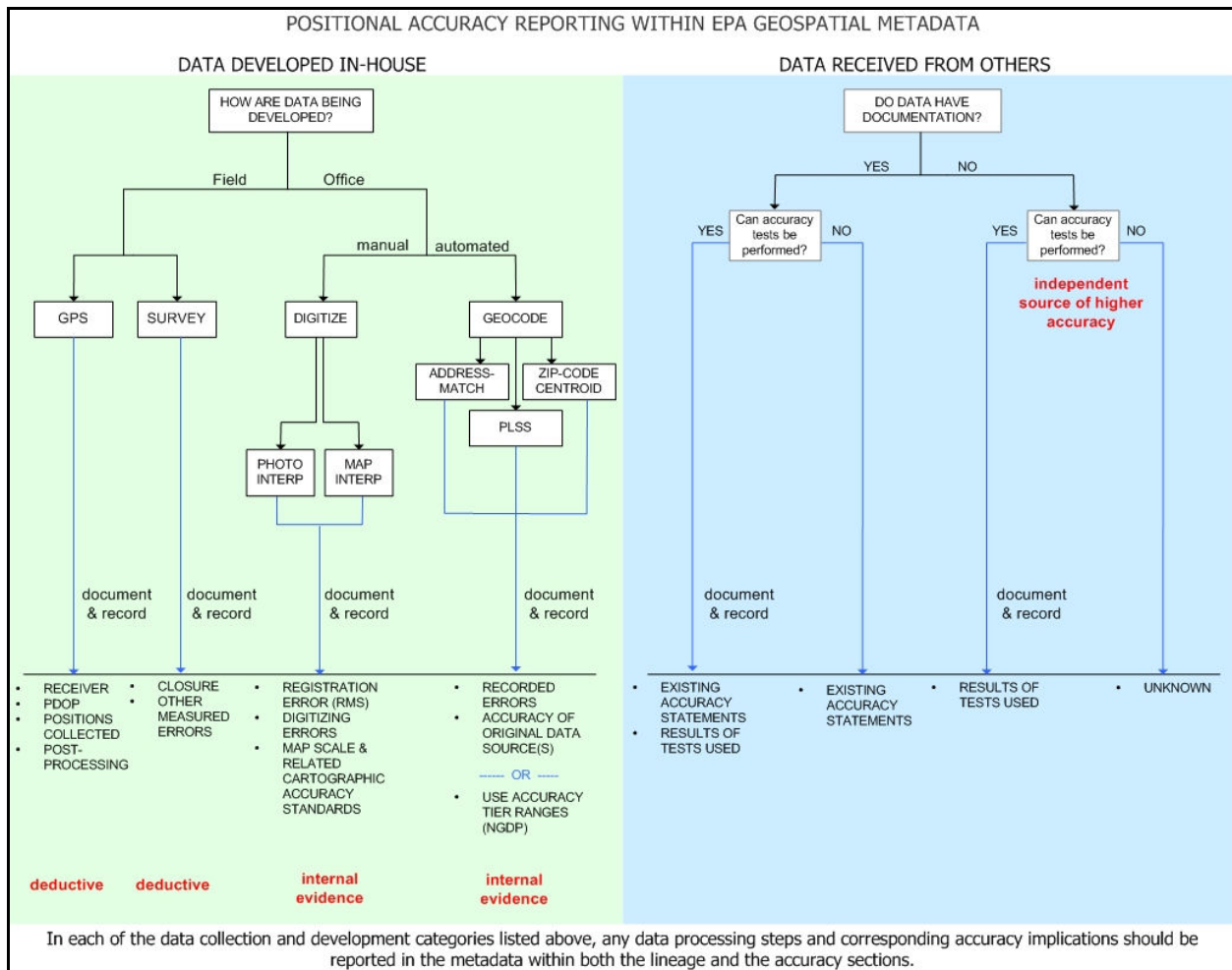
Figure 4. Positional Accuracy Estimate Development

Methods:

1. <u>Testing (independent source of higher accuracy)</u>: Using testing as a method for developing a positional accuracy assessment generally results in a quantitative estimate of positional accuracy at a given confidence interval. A quantitative estimate is developed by comparing a selected number of well-defined points against those of known higher quality. When a quantitative accuracy value is estimated, the tests used for developing the estimate should be identified. The standard test for determining digital data accuracy is to use the National Standard for Spatial Data Accuracy (NSSDA). The NSSDA is one in a suite of standards dealing with the accuracy of geographic datasets, and is one of the most recent standards to be issued by the Federal Geographic Data Committee (LMIC 1999). It implements a statistical and testing methodology for estimating the positional accuracy of points on maps and in digital geospatial data, with respect to georeferenced ground positions of higher accuracy. It was approved in 1998 to address the growing need for quality spatial data and to provide a common language for reporting accuracy.

There are generally six steps used in applying the NSSDA to develop an accuracy estimate:

1. Determine if the test involves horizontal accuracy, vertical accuracy, or both

2. Select a set of test points from the dataset to be evaluated (these should be 'well-defined' locations, such as fence corners, manholes, or existing benchmarks)
3. Select an independent dataset of higher accuracy that corresponds to the dataset being tested
4. Collect measurements from identical points within each of these two sources.
5. Calculate a positional accuracy statistic using either the horizontal or vertical accuracy statistic worksheet (Section 6.3).
6. Prepare an accuracy statement in a standardized report form (shown below) in the metadata.

At least twenty points are required to conduct a statistically significant accuracy evaluation at the 95% confidence level. Coordinate values for both test points of both the test dataset and the independent dataset are collected and statistics are computed for each pair of points (See Section 6.3):

- The sum of the set of squared differences
- The average of the sum by dividing the sum by the number of test points
- The root mean square error (RMSE) which is simply the square root of the average
- The NSSDA statistic, determined by multiplying the RMSE by a value that represents the standard error of the mean at the 95% confidence level: 1.7308 for horizontal accuracy and 1.9600 for vertical accuracy.

After applying the NSSDA to a dataset an accuracy statement such as the following should be used: "Tested 0.55 meters horizontal accuracy at 95% confidence interval using the NSSDA." In the horizontal positional accuracy section of the metadata, it is also important to describe the independent dataset used for comparison, its source(s) and associated accuracy. For more information about using the NSSDA, see LMIC 1999.

An independent source of higher accuracy will be obtained from different sources, depending on the nature of the data. Positions of highly accurate geodetic control network locations collected by the National Geodetic survey (NGS) are available on-line at http://www.ngs.noaa.gov/cgi-bin/datasheet.prl. In some cases, independent datasets of higher accuracy are not available to perform NSSDA accuracy calculations. If funds are available, additional data may be collected for accuracy assessment, involving field work and/or GPS collection. The Minnesota Planning Land Management Information Center (LMIC) website provides an exceptional handbook for implementing this standard, using 5 real-world examples to show methods of implementation of the NSSDA for determining accuracy. It can be downloaded from the LMIC website: http://www.mnplan.state.mn.us/resource.html?Id=1852.

Implementation Example:
<posacc>
> <horizpar>Tested 5.32 meters horizontal accuracy at 95% confidence level using the National Standard for Spatial Data Accuracy. Twenty well-defined points from were selected from the data set to compare with geodetic control stations. Positional offsets were recorded and the Root Mean Square Statistic was calculated according to NSSDA specifications.<horizpar>
> <qhorizpa>
> > <horizpav>5.32</horizpav>

<horizpae>The NSSDA statistic uses a Root Mean Square calculation of at least 20 well-defined points for determination of positional accuracy at the 95% confidence interval. </horizpae>
    </qhorizpa>
</posacc>

2. <u>Deductive Estimate (GPS Collection):</u> For data collected using GPS, accuracy information can be collected to document the limitations of the unit itself, the accuracy for a given collection, and other steps involved in data processing. The following information should be reported in the metadata: type of GPS equipment, data collection methodologies and settings, inherent GPS errors, and post-processing techniques. A listing of accuracy ranges reported for some common GPS units is shown in Section 6.5.

Implementation Example:
<posacc>
<horizpar> A Trimble Pro XL receiver was used that maintains accuracy standards of approximately one to two meters after applying post-processing techniques. All recommended settings were followed in configuring the receiver, including the number of positions collected for each source, the logging interval of the positions, the number of satellites available, and the Position Dilution of Precision (PDOP). 30 positions were logged at one second intervals for each point collected. Additionally, at no time could the PDOP exceed six. All positions were collected using the 3-D setting with no less than four satellites being used. POST-PROCESSING: Once data were downloaded, they were differentially corrected using the XX base station along with Trimble's PFINDER software. The MCORR400 algorithm was applied for all collected data. Finally, all corrected positions were averaged to produce a single latitude and longitude for each source. </horizpar>
<qhorizpa>
    <horizpav>5</horizpav>
    <horizpae>Points were tested using a root mean square estimate of the errors associated with the collection method.</horizpae>
</qhorizpa>
</posacc>

3. <u>Deductive Estimate (Map/Photo Interpretation):</u> For data developed through the use of digitizing, the following information should be reported in the metadata:

    a. RMS error of the spatial registration process
    b. Resolution and type of the original the source material (scanned map or photo),
    c. Scale of the source material,
    d. Inherent errors associated with the source (where applicable),
    e. Type of source material,
    f. Other internal checks made to validate the positional accuracy of the data set.

Implementation Example:
<posacc>
<horizpar>USGS Topographic Sheet T-6580 (1:20,000 scale) served as the source material for the data developed. The paper map was scanned at 600 dpi. The registration error reported was 6 ft. 10 geodetic control points identified on the registered map were compared with positions at the National Geodetic Survey website:

http://www.ngs.noaa.gov/cgi-bin/datasheet.prl. The maximum offset observed was 12 ft.
The average offset of all control points was 5.2 ft.</horizpar>
</posacc>

4. Internal Evidence (Reliance on NGDP Standard): The ranges used for the NGDP can
    be used in the absence of other information.
    <posacc>
    <horizpar> Data were originally digitized from USGS 1:24,000 Topographic Maps, which
    require at least 90 percent of horizontal points tested to be accurate to within one-fiftieth
    of an inch on the map (40 feet on the ground). The registration error of the original
    scanned image is unknown. As such, the accuracy estimate for this data set is
    estimated based on EPA National Geospatial Data Policy ranges to be 26-100
    meters.<horizpar>
    </posacc>

2.5   FGDC Section 4: Spatial Reference Information

The spatial reference information section of the CSDGM provides the description of the
reference frame for, and the means to encode, coordinates in the data set. This section is
not mandatory to meet minimum FGDC requirements, but it is required by the EPA
implementation to ensure that horizontal coordinate system information is documented
appropriately. When used, this section requires the inclusion of one of three spatial
reference encoding options (geographic, planar, or local) depending on the nature of the
data set. The implementation of the spatial reference option chosen can be interpreted
according to FGDC specifications.

2.5.1   Required Elements in FGDC Section 4 (FGDC)

None of the elements in Section 4 are mandatory to meet minimum FGDC requirements
when this section is used

2.5.2   Additional Required Elements in FGDC Section 4 (EPA)

The following elements are mandatory within this section to meet EPA Implementation
requirements:

- 4.1 Horizontal Coordinate System Definition <horizsys>
- 4.1.4 Geodetic Model <geodetic>
- 4.1.4.1 Horizontal Datum Name <horizdn>
- 4.1.4.2 Ellipsoid Name <ellips>
- 4.1.4.3 Semi-Major Axis <semiaxis>
- 4.1.4.4 Denominator of Flattening Ratio <denflat>

The <horizsys> element provides three options for specifying the horizontal coordinate
system, including geographic, planar, and local. Each of these options maintains different
requirements for its use. Users should follow FGDC specifications for encoding the
horizontal coordinate system information as applicable to the data set. The <horizsys>
element also includes geodetic model <geodetic> as a "mandatory if applicable" element.

This element is considered mandatory for EPA implementation, as it is essential for documenting geospatial positional information. Finally, the Horizontal Datum Name <horizdn>, although considered by FGDC a "mandatory if applicable" element within the geodetic model description, is considered mandatory for meeting EPA specifications due to its importance in providing a full description of a data set's frame of reference (Figure 5).

2.5.3 Implementation Specifications for FGDC Section 4 (EPA)

The EPA implementation leaves the specification for all of these elements to the FGDC.

EPA Horizontal Coordinate System Rule: EPA Geospatial Metadata shall include the horizontal coordinate system information. Additionally, the geodetic model, along with the horizontal datum name shall be used to document the datum used for the data set. The vertical coordinate system definition shall be used where applicable. The Agency is requiring the use of these elements but is not providing explicit EPA language for their implementation. Users should refer to the FGDC website at http://www.fgdc.gov/metadata/contstan.html or the USGS image map website that shows the standard graphically at http://biology.usgs.gov/fgdc.metadata/version2 for proper implementation guidance.
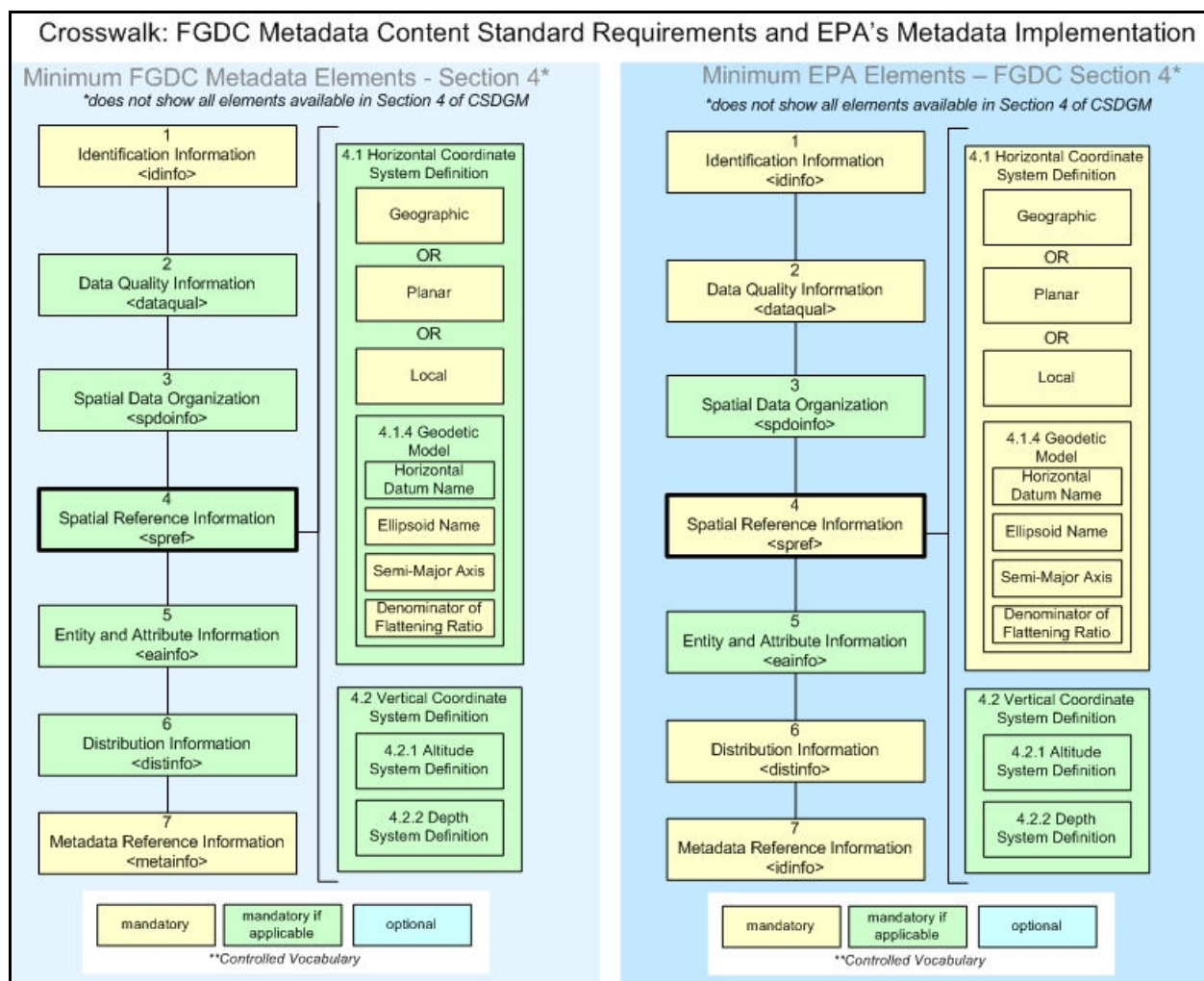
Figure 5. Element Requirements for Section 4 of the CSDGM.

2.6 FGDC Section 6: Distribution Information

The distribution information section maintains information about the distributor of and options for obtaining the data set. This section is not required to meet minimum FGDC standards. This section is required by EPA to ensure inclusion of the resource description element (used by Geospatial One Stop and ESRI search tools) and to ensure proper documentation of distribution liability.

When used, this section maintains seven elements, two of which are considered mandatory for minimum FGDC requirements (Figure 6). The EPA profile requires the use of three elements in this section. Of the three elements required for the EPA profile, guidance on implementation for is provided only for resource description and distribution liability. The remaining elements can be interpreted according to FGDC specifications.

2.6.1 Required Elements in FGDC Section 6 (FGDC)

The following elements are mandatory in Section 6 for minimum FGDC requirements:
- 6.1 Distribution Information <distrib>
- 6.3 Distribution Liability <distliab>

2.6.2 Additional Required Elements in FGDC Section 6 (EPA)

An additional element is mandatory according to the EPA Implementation:
- 6.2 Resource Description <resdesc>

2.6.3 Implementation Specifications for FGDC Section 6 (EPA)

The EPA implementation provides guidance for:

- 6.2 Resource Description <resdesc>
- 6.3 Distribution Liability <distliab>
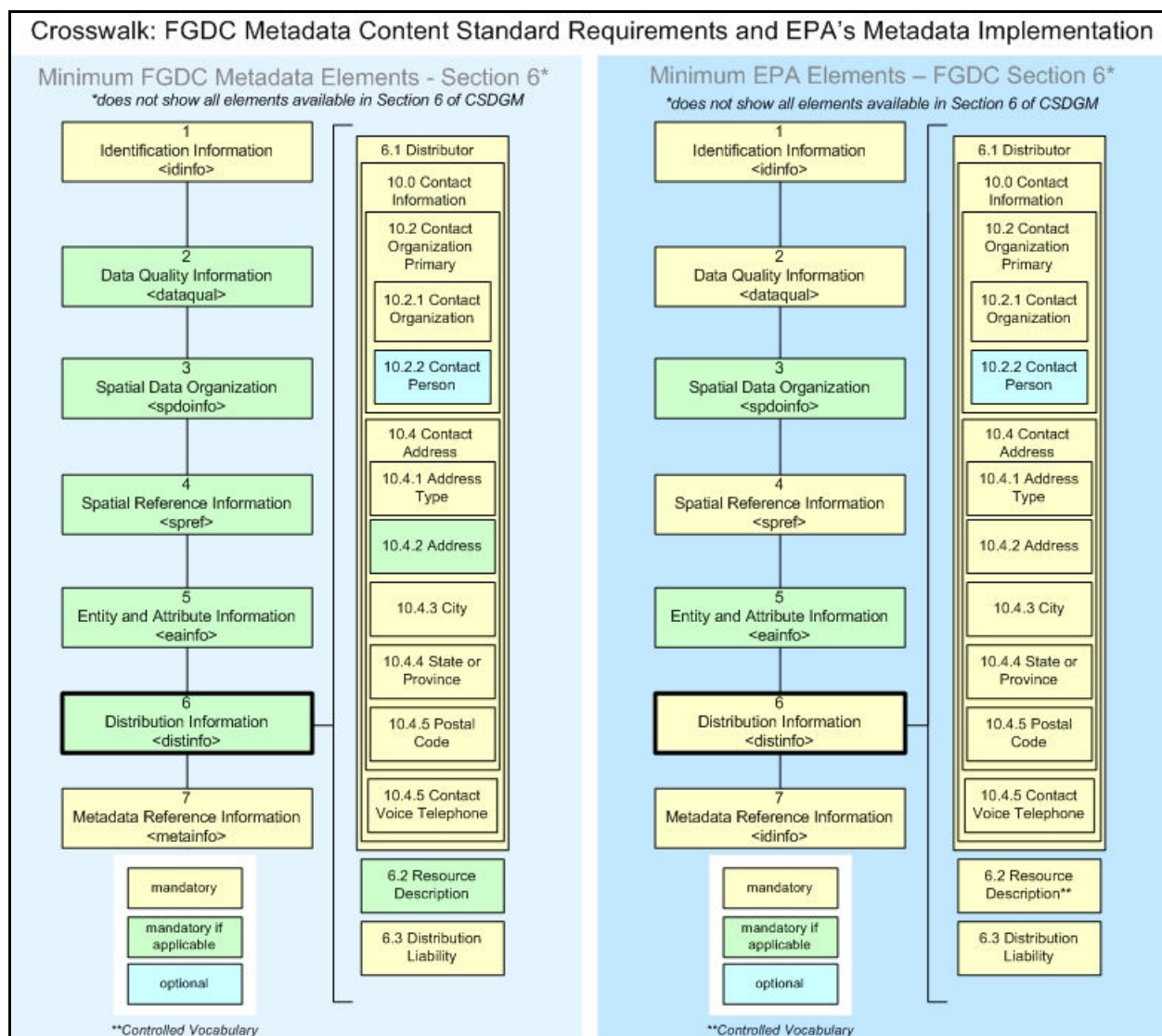
Figure 6. Element Requirements for Section 6 of the CSDGM.

2.6.4 Specifications for FGDC Element 6.2: Resource Description

The FGDC defines the Resource Description as "The identifier by which the distributor knows the data set." The resource description implementation should follow the options provided by Environmental Systems Research Institute (ESRI) so that metadata searched by GOS or other search tools adhere to this common classification system. The categories available using the ESRI classification system are listed below.

- Live Data and Maps
- Downloadable Data
- Offline Data
- Map Files
- Static Map Images
- Other Documents
- Applications
- Geographic Services: **Marketplace Record Designation**

- Clearinghouses
- Geographic Activities

Implementation Example:
<resdesc> Live Data and Maps</resdesc>

2.6.5 Specifications for FGDC Element 6.3: Distribution Liability

The FGDC defines the Distribution Liability element as "The statement of liability assumed by the distributor". For EPA purposes there are two types of distribution liability statements: those reflecting data that are not subject to license agreements and those that are subject to license agreements. As such, two options are available.

EPA Distribution Liability Rule: EPA shall require the use of the distribution liability tag, using 1 of 2 versions depending on the nature of the data set: freely available, or restricted by license agreements.

Unrestricted Data (Not Restricted by license agreements)
Although these data have been processed successfully on a computer system at the Environmental Protection Agency, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. It is also strongly recommended that careful attention be paid to the contents of the metadata file associated with these data to evaluate data set limitations, restrictions or intended use. The U.S. Environmental Protection Agency shall not be held liable for improper or incorrect use of the data described and/or contained herein.

Restricted Data (Not freely available to the public due to license agreements)
This is a licensed product by <insert licensor here> for use within the U.S. EPA. No third party copy or use of this product will be permitted.

Implementation Example:
<distliab> Although these data have been processed successfully on a computer system at the Environmental Protection Agency, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. It is also strongly recommended that careful attention be paid to the contents of the metadata file associated with these data to evaluate data set limitations, restrictions or intended use. The U.S. Environmental Protection Agency shall not be held liable for improper or incorrect use of the data described and/or contained herein.</distliab>

2.7 FGDC Section 7: Metadata Reference Information

The metadata reference information section maintains information on the currency of the metadata information, and the responsible party. This section is mandatory for meeting minimum FGDC requirements. There are eleven elements that comprise this section, four of which are considered mandatory for meeting minimum FGDC requirements (Figure 7).

2.7.1 Required Elements in FGDC Section 7 (FGDC)

The following elements are mandatory in FGDC Section 7 according to minimum FGDC requirements:
- 7.1 Citation Information <metdate>
- 7.4 Metadata Contact <metc>
- 7.5 Metadata Standard Name <metstdn>
- 7.5 Metadata Standard Version <metstdv>

2.7.2 Additional Required Elements in FGDC Section 7 (EPA)
An additional element is mandatory for meeting EPA Implementation requirements
- 7.3 Metadata Future Review Date <metfrd>

2.7.3 Implementation Specifications for FGDC Section 7 (EPA)

The EPA implementation provides guidance for:

- 7.3 Metadata Future Review Date <metfrd>
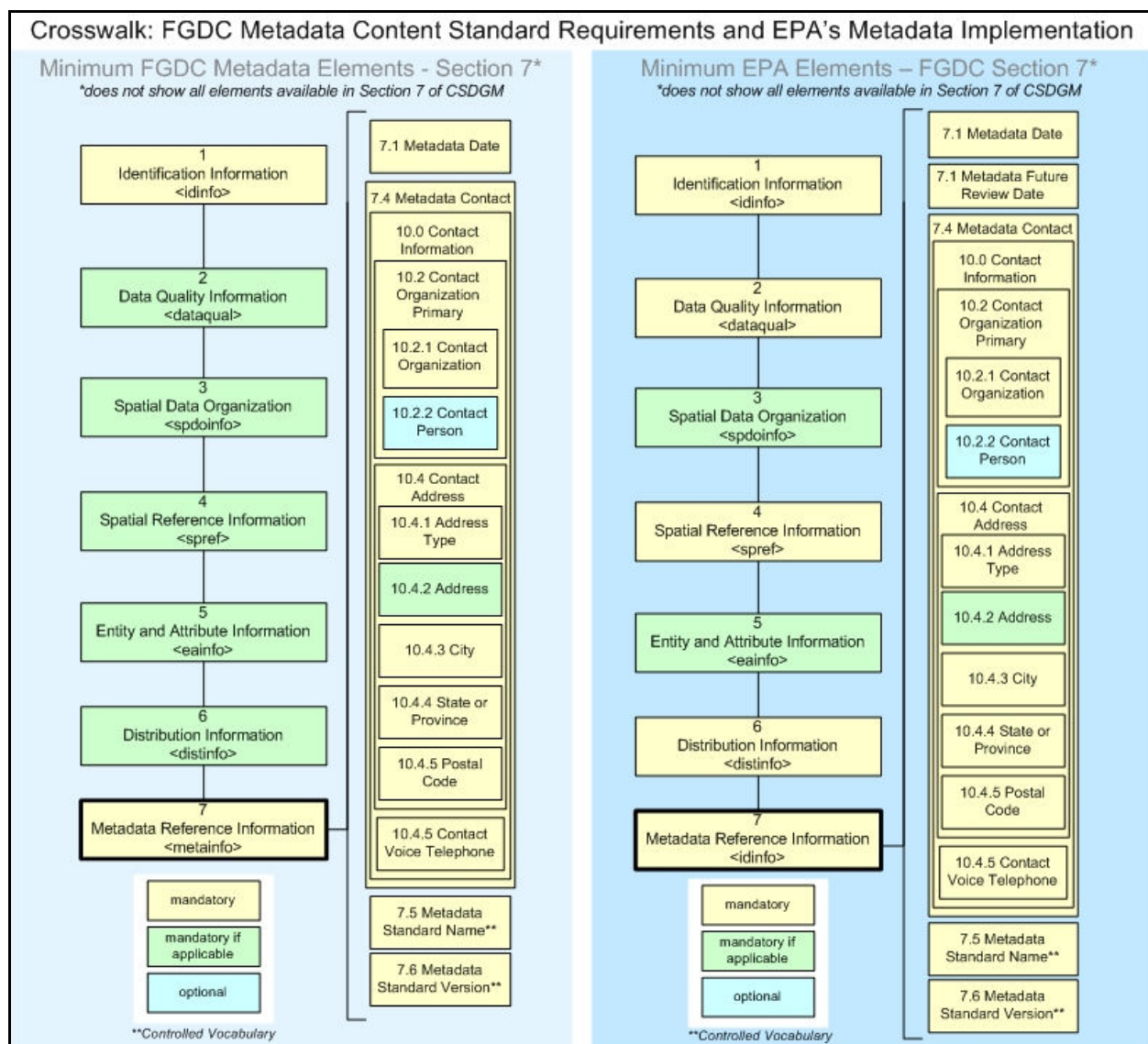
Figure 7. Element Requirements for Section 7 of the CSDGM.

2.7.4 Specifications for FGDC Element 7.3: Metadata Future Review Date

FGDC defines the Metadata Future Review Date element as "The date by which the metadata entry should be reviewed". For Agency purposes, the metadata future review date will be used to track which data sets require review/recertification according to the Agency geospatial metadata update schedule (described in greater detail in Section 5). According to Agency specifications for metadata recertification and review, each metadata record and corresponding data set shall be reviewed at least once every four years using a staggered-cyclical schedule. The metadata future review date field will be used to provide the proper scheduling for and querying of data that need to be reviewed each year.

EPA Metadata Future Review Date Rule: The use of the future review date element shall be required to track metadata review and recertification cycles. Geospatial data and metadata shall be reviewed at least once every four years, and shall have information regarding the next scheduled update stored in the metadata future review date field. When metadata and

data are updated, the metadata date field should be changed to reflect the most recent update, and the metadata future review date should be scheduled for no later than four years from the date of the last update.

Implementation Example
The metadata future review date element is a "free date" field, which should use the *yyyymmdd* format.
<metfrd>20090617</metfrd>

3.0 REFERENCES

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Environmental Protection Agency (EPA), 2005, National Geospatial Data Policy.

Federal Geographic Data Committee (FGDC), Content Standard for Digital Geospatial Metadata (CSDGM)
Version 2 - FGDC-STD-001-1998 http://www.fgdc.gov/metadata/contstan.html

Federal Geographic Data Committee (FGDC), Metadata Presentation via XML and XSL
http://www.fgdc.gov/metadata/metaxml.html

Minnesota Land Management Information Center (LMIC) 1999. Positional Accuracy Handbook: Using the National Standard for Spatial Data Accuracy to measure and report geographic data quality.
http://www.mnplan.state.mn.us/resource.html?Id=1852

National Institute of Standards and Technology (NIST) 2004a. Federal Information Processing Standards Publication Standards for Security Categorization of Federal Information and Information Systems (FIPS 199) http://www.csrc.nist.gov/publications/fips/fips199/FIPS-PUB-199-final.pdf

National Institute of Standards and Technology (NIST) 2004b. Federal Information Processing Standards Publications (FIPS Pubs) http://www.itl.nist.gov/fipspubs/geninfo.htm

Schweitzer, Peter, 1995, Metaparser http://geo-nsdi.er.usgs.gov/validate.php

U.S. EPA Controlled Vocabulary of Subject Terms http://www.epa.gov/webguide/metadata/

U.S. Geological Survey (USGS), An Image Map of the Content Standard for Digital Geospatial Metadata. http://geology.usgs.gov/tools/metadata/

4.0 APPENDICES

4.1 Key Terms and Definitions

Content Standard for Digital Geospatial Metadata (CSDGM): The Content Standard for Digital Geospatial Metadata provides a common set of terminology and definitions for the documentation of digital geospatial data. It establishes the names of elements to be used for documenting geospatial data, the definitions of these elements, and information about the values that are to be provided for the data elements. Federal agencies are required to use the CSDGM to document geospatial metadata. The CSDGM is the basis from which the EPA implementation has been developed. http://www.fgdc.gov/metadata/contstan.html

Environmental Information Management System (EIMS):
The environmental information management system (EIMS) is one of eight registries in the EPA's System of Registries (SoR). EIMS was developed by the Office of Research and Development (ORD) to store, manage, and deliver descriptive information (metadata) for data sets, databases, documents, models, multimedia, projects, and spatial information. The EIMS database provides the storage location for geospatial metadata, and also serves as EPA's node on the National Spatial Data Infrastructure (NSDI). The EIMS database may be accessed with standard Web browsers by EPA staff and others with Internet access. http://www.epa.gov/eims/index.html

Federal Geographic Data Committee (FGDC): The FGDC is a 19 member interagency committee composed of representatives from Federal and independent agencies. It is developing the National Spatial Data Infrastructure (NSDI), which encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data. The FGDC develops geospatial data standards for the NSDI when there are no externally developed standards appropriate for Federal use. Federal agencies are required to use FGDC standards. The EPA metadata content profile is built on the Content Standard for Digital Geospatial Metadata developed by the FGDC http://www.fgdc.gov/

GeoData Gateway: The GeoData Gateway is EPA's central geospatial portal. It is an application used to manage, search for and access existing and planned geospatial assets. It can be accessed by internal EPA staff members at http://geogateway.epa.gov/Portal.

Harvesting: Harvesting is a method used to collect, aggregate and exchange metadata from distributed sets of metadata catalog.

International Standards Organization (ISO): ISO is a network of the national standards institutes of 151 countries. The ISO creates international, voluntary standards for which there is a market demand. The ISO has developed a content standard for describing geographic information and services, known as ISO 19115. Efforts are being made within the FGDC to attempt to harmonize the ISO19115 with the FGDC CSDGM. Currently, the only component of the ISO19115 standard that impacts the EPA profile is the ISO 19115 Topic Category (theme keywords) section. http://www.iso.org/

National Institute for Standards and Technology (NIST): NIST is a non-regulatory federal agency within the U.S. Commerce Department's Technology Administration that is focused on

the development and promotion of measurement, standards, and technology. Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards and guidelines that are developed by the NIST for Federal computer systems. These standards and guidelines are issued by NIST as Federal Information Processing Standards (FIPS) for use government-wide. NIST develops FIPS when there are compelling Federal government requirements such as for security and interoperability and there are no acceptable industry standards or solutions (NIST 2004b). For the EPA geospatial Metadata Content Implementation FIPS Pub 199 (NIST 2004a) is used to apply security classification information. http://www.nist.gov/

Open Geospatial Consortium: The Open Geospatial Consortium, Inc. (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. Through member-driven consensus programs, OGC works with government, private industry, and academia to create open and extensible software application programming interfaces for geographic information systems (GIS) and other mainstream technologies. The OGC provides specifications that support interoperable solutions that "geo-enable" the Web, wireless and location-based services. http://www.opengeospatial.org/

4.2   EPA Geospatial Metadata Profile Templates

4.2.1 Marketplace Record Template

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<metadata>
<!-- ============================================================ -->
<!-- Part 1 - Identification Information: Minimum FGDC Required  -->
<!-- ============================================================ -->
<idinfo>
<citation>
<citeinfo>
<!-- Should reflect office requesting the information-->
<origin>United States Environmental Protection Agency, Office of Environmental Information</origin>

<!-- Date the record was posted -->
<pubdate>20060801</pubdate>

<!-- Title of Requested Data -->
<title>Generic EPA Geospatial Metadata Template for Planned Acquisitions (Marketplace
Records)</title>

<!-- Publisher of the Data/Record (this element is required to put this record in the GDG Catalog -->
<pubinfo>
<pubplace>Washington, DC</pubplace>
<publish>U.S. Environmental Protection Agency</publish>
</pubinfo>
<!-- This should be the correct nomenclature for your services or data if you have them -->
<onlink>http://geogateway.epa.gov/Portal/download/EPA_templates_ALL.zip</onlink>
<onlink>http://www.epa.gov</onlink>
</citeinfo>
</citation>

<descript>
<!-- Overview of the data being requested -->
```

```
<abstract>This data set is needed for_____. It should contain_____.
</abstract>

<!--  What will the data be needed for? -->
<purpose>The purpose of this data set is to _____. </purpose>
<!-- Change to your data specific needs -->
</descript>

<!--  What time period is needed? -->
<timeperd>
<timeinfo>
<sngdate>
<caldate>20060801</caldate>
</sngdate>
</timeinfo>
<current>publication date</current>
</timeperd>

<!--  Status must be 'planned' in order to identify this as a marketplace record. -->
<status>
<progress>Planned</progress>
<update>As needed</update>
</status>

<spdom>
<!-- This is the entire US -->
<bounding>
<westbc>-173.129822</westbc>
<eastbc>-67.434525</eastbc>
<northbc>71.490303</northbc>
<southbc>17.305182</southbc>
</bounding>
</spdom>

<keywords>
<theme>
<!-- One ISO Keyword is required; change category your data specific needs -->
<themekt>ISO 19115 Topic Category</themekt>
<themekey>environment</themekey>
</theme>

<!-- Use EPA Keywords where applicable; choose those appropriate from below -->
<theme>
<themekt>EPA GIS Keyword Thesaurus</themekt>
    <themekey>Management</themekey>
    <themekey>Disaster </themekey>
    <themekey>Energy</themekey>
    <themekey>Environment</themekey>
    <themekey>Monitoring</themekey>
    <themekey>Air</themekey>
    <themekey>Water</themekey>
    <themekey>Land</themekey>
    <themekey>Biology</themekey>
    <themekey>Ecosystem</themekey>
    <themekey>Remediation</themekey>
    <themekey>Cleanup</themekey>
```

```xml
<themekey>Contaminant</themekey>
<themekey>Spills</themekey>
<themekey>Response</themekey>
<themekey>Hazards </themekey>
<themekey>Waste</themekey>
<themekey>Pesticides</themekey>
<themekey>Toxics</themekey>
<themekey>Compliance</themekey>
<themekey>Impact </themekey>
<themekey>Indicator</themekey>
<themekey>Risk</themekey>
<themekey>Exposure</themekey>
<themekey>Modeling </themekey>
<themekey>Quality</themekey>
<themekey>Indoor Air</themekey>
<themekey>Radiation</themekey>
<themekey>Climate</themekey>
<themekey>Surface water</themekey>
<themekey>Ground water</themekey>
<themekey>Marine </themekey>
<themekey>Estuary </themekey>
<themekey>Drinking Water</themekey>
<themekey>Health</themekey>
<themekey>Human</themekey>
<themekey>Natural Resources</themekey>
<themekey>Conservation </themekey>
<themekey>Marine</themekey>
<themekey>Disaster</themekey>
<themekey>Land</themekey>
<themekey>Recreation</themekey>
<themekey>Agriculture</themekey>
<themekey>Ecology</themekey>
<themekey>Transportation</themekey>
<themekey>Ground Water</themekey>
<themekey>Water</themekey>
<themekey>Regulatory </themekey>
<themekey>Compliance</themekey>
<themekey>Inspections</themekey>
<themekey>Permits</themekey>
<themekey>Facilities</themekey>
<themekey>Sites</themekey>
</theme>
<place>
<placekt>None</placekt>
<placekey>United States</placekey>
<placekey>Canada</placekey>
<placekey>Mexico</placekey>
<placekey>Alaska</placekey>
<placekey>Hawaii</placekey>
<placekey>District of Columbia</placekey>
<placekey>Washington DC</placekey>
<placekey>American Samoa</placekey>
<placekey>Puerto Rico</placekey>
<placekey>Virgin Islands</placekey>
<placekey>Alabama</placekey>
<placekey>Arizona</placekey>
```

```
            <placekey>Arkansas</placekey>
            <placekey>California</placekey>
            <placekey>Colorado</placekey>
            <placekey>Connecticut</placekey>
            <placekey>Delaware</placekey>
            <placekey>Florida</placekey>
            <placekey>Georgia</placekey>
            <placekey>Idaho</placekey>
            <placekey>Illinois</placekey>
            <placekey>Indiana</placekey>
            <placekey>Iowa</placekey>
            <placekey>Kansas</placekey>
            <placekey>Kentucky</placekey>
            <placekey>Louisiana</placekey>
            <placekey>Maine</placekey>
            <placekey>Maryland</placekey>
            <placekey>Massachusetts</placekey>
            <placekey>Michigan</placekey>
            <placekey>Minnesota</placekey>
            <placekey>Mississippi</placekey>
            <placekey>Missouri</placekey>
            <placekey>Montana</placekey>
            <placekey>Nebraska</placekey>
            <placekey>Nevada</placekey>
            <placekey>New Hampshire</placekey>
            <placekey>New Jersey</placekey>
            <placekey>New Mexico</placekey>
            <placekey>New York</placekey>
            <placekey>North Carolina</placekey>
            <placekey>North Dakota</placekey>
            <placekey>Ohio</placekey>
            <placekey>Oklahoma</placekey>
            <placekey>Oregon</placekey>
            <placekey>Pennsylvania</placekey>
            <placekey>Rhode Island</placekey>
            <placekey>South Carolina</placekey>
            <placekey>South Dakota</placekey>
            <placekey>Tennessee</placekey>
            <placekey>Texas</placekey>
            <placekey>Utah</placekey>
            <placekey>Vermont</placekey>
            <placekey>Virginia</placekey>
            <placekey>Washington</placekey>
            <placekey>West Virginia</placekey>
            <placekey>Wisconsin</placekey>
            <placekey>Wyoming</placekey>
</place>
</keywords>
<accconst>None.</accconst>
<useconst>This information is for planning purposes only and does not represent a commitment by
EPA to collect the proposed data.</useconst>

<!-- Change  to  contact person for your data set -->
<ptcontac>
<!-- Who to contact regarding the data specifically -->
<cntinfo>
```

```
      <cntorgp>
      <cntorg>USEPA XYZ Region Program or Lab</cntorg>
      <cntper>USEPA XYZ Region Program or Lab Person</cntper>
      </cntorgp>
      <cntaddr>
      <addrtype>mailing and physical</addrtype>
      <address>Street Address</address>
      <city>City</city>
      <state>State Name</state>
      <postal>Zip Code</postal>
      </cntaddr>
      <cntvoice>XXX.XXX.XXXX</cntvoice>
      <cntfax>XXX.XXX.XXXX</cntfax>
      <cntemail>person@epa.gov</cntemail>
</cntinfo>
</ptcontac>

<secinfo>
<secsys>FIPS Pub 199</secsys>
<!-- Change  to  classification relevant for your data set -->
<secclass>No Confidentiality</secclass>
<sechandl>Standard Technical Controls</sechandl>
</secinfo>
</idinfo>
<!-- ================================================================ -->
<!-- Part 6  -  Distribution Information.  resdesc used for ArcIMS  -->
<!-- ================================================================ -->
<distinfo>
<distrib>
<cntinfo>
<cntorgp>
<cntorg>US Environmental Protection Agency</cntorg>
<cntper>Wendy Blake-Coleman</cntper>
</cntorgp>
<cntaddr>
<addrtype>mailing and physical address</addrtype>
<address>1200 Pennsylvania Ave, NW</address>
<city>Washington</city>
<state>DC</state>
<postal>27513</postal>
</cntaddr>
<cntvoice>20460</cntvoice>
<cntemail>blake-coleman.wendy@epa.gov</cntemail>
</cntinfo>
</distrib>

<!-- Marketplace records must be classified as geographic activities to be a planned acquisition
record and show up in the search -->
<resdesc>Geographic Activities</resdesc>
<!-- Don't change -->
<distliab>This information is for planning purposes only and does not represent a commitment by the
EPA to collect the proposed data.</distliab>
</distinfo>
<!-- ================================================================ -->
<!-- Part 7  - Metadata Reference Information: Minimum FGDC Required -->
<!-- ================================================================ -->
```

```
<metainfo>
<metd>20060606</metd>
<!-- Future Review Date for Marketplace Records should be the date of the metadata + 4 mos -->
<metfrd>20061006</metfrd>
<metc>
<!-- Who to contact regarding the metadata specifically -->
<cntinfo>
    <cntorgp>
    <cntorg>USEPA XYZ Region Program or Lab</cntorg>
    <cntper>USEPA XYZ Region Program or Lab Person</cntper>
    </cntorgp>
    <cntaddr>
    <addrtype>mailing and physical</addrtype>
    <address>Street Address</address>
    <city>City</city>
    <state>State Name</state>
    <postal>Zip Code</postal>
    </cntaddr>
    <cntvoice>XXX.XXX.XXXX</cntvoice>
    <cntfax>XXX.XXX.XXXX</cntfax>
    <cntemail>person@epa.gov</cntemail>
</cntinfo>
</metc>
<metstdn>FGDC Content Standards for Digital Geospatial Metadata</metstdn>
<metstdv>FGDC-STD-001-1998</metstdv>
</metainfo>
</metadata>
```

4.2.2 Full EPA Implementation Template

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE metadata SYSTEM "http://www.fgdc.gov/metadata/fgdc-std-001-1998.dtd">
<metadata>
<!-- ================================================================= -->
<!-- Part 1  -  Identification Information: Minimum FGDC Required  -->
<!-- ================================================================= -->
<idinfo>
<citation>
<citeinfo>
<!-- Change to specific office -->
<origin>USEPA XYZ Region Program or Lab</origin>
<!-- Change to your data specific needs this must be a date either YYYY OR YYYYMMDD -->
<pubdate>2006</pubdate>
<!-- Change to your data specific needs -->
<title>Generic EPA Geospatial Metadata Template for Downloadable Data</title>
<pubinfo>
    <pubplace>City, State</pubplace>
    <publish>U.S. Environmental Protection Agency</publish>
</pubinfo>
<!-- This should be the correct nomenclature for your services -->
<onlink>http://www.epa.gov</onlink>
<onlink>http://geogateway.epa.gov/Portal/download/EPA_templates_ALL.zip</onlink>
</citeinfo>
</citation>
<descript>
```

```
<!-- Change to your data specific needs -->
<abstract>These data were developed to ___.</abstract>
<!-- Change to your data specific needs -->
<purpose>The purpose of this data set is to ___.</purpose>
<!-- Change to your data specific needs this section is not required but is encouraged for
identifying additional information on source (EPA, non-EPA)-->
<supplinf>This is an EPA-produced data set.  Additional information regarding this data set is
available at ___.</supplinf>
</descript>
<!-- Data Set Time Period: change to reflect needs YYYY or YYYYMMDD -->
<timeperd>
<timeinfo>
    <sngdate>
    <caldate>2006</caldate>
    </sngdate>
</timeinfo>
<!-- What are your data current to? -->
<current>publication date</current>
</timeperd>
<status>
    <!-- Change to status of your work - what is the level of progress and how often do you update -->
    <progress>In work</progress>
    <update>As needed</update>
</status>
<!-- Important to update to UL and LR coordinates of your data set -->
<spdom>
    <bounding>
    <westbc>-138.21454852</westbc>
    <eastbc>-12.68151645</eastbc>
    <northbc>61.7110157</northbc>
    <southbc>6.65223303</southbc>
    </bounding>
</spdom>
<keywords>
<theme>
<!-- One ISO Keyword is required; change category your data specific needs the list is in the EPA
guidance -->
<themekt>ISO 19115 Topic Category</themekt>
<themekey>environment</themekey>
</theme>
<!-- Use EPA Keywords where applicable; choose those appropriate from below -->
<theme>
<themekt>EPA GIS Keyword Thesaurus</themekt>
    <themekey>Management</themekey>
    <themekey>Disaster </themekey>
    <themekey>Energy</themekey>
    <themekey>Environment</themekey>
    <themekey>Monitoring</themekey>
    <themekey>Air</themekey>
    <themekey>Water</themekey>
    <themekey>Land</themekey>
    <themekey>Biology</themekey>
    <themekey>Ecosystem</themekey>
    <themekey>Remediation</themekey>
    <themekey>Cleanup</themekey>
    <themekey>Contaminant</themekey>
```

```
            <themekey>Spills</themekey>
            <themekey>Response</themekey>
            <themekey>Hazards </themekey>
            <themekey>Waste</themekey>
            <themekey>Pesticides</themekey>
            <themekey>Toxics</themekey>
            <themekey>Compliance</themekey>
            <themekey>Impact </themekey>
            <themekey>Indicator</themekey>
            <themekey>Risk</themekey>
            <themekey>Exposure</themekey>
            <themekey>Modeling </themekey>
            <themekey>Quality</themekey>
            <themekey>Indoor Air</themekey>
            <themekey>Radiation</themekey>
            <themekey>Climate</themekey>
            <themekey>Surface water</themekey>
            <themekey>Ground water</themekey>
            <themekey>Marine </themekey>
            <themekey>Estuary </themekey>
            <themekey>Drinking Water</themekey>
            <themekey>Health</themekey>
            <themekey>Human</themekey>
            <themekey>Natural Resources</themekey>
            <themekey>Conservation </themekey>
            <themekey>Marine</themekey>
            <themekey>Disaster</themekey>
            <themekey>Land</themekey>
            <themekey>Recreation</themekey>
            <themekey>Agriculture</themekey>
            <themekey>Ecology</themekey>
            <themekey>Transportation</themekey>
            <themekey>Ground Water</themekey>
            <themekey>Water</themekey>
            <themekey>Regulatory </themekey>
            <themekey>Compliance</themekey>
            <themekey>Inspections</themekey>
            <themekey>Permits</themekey>
            <themekey>Facilities</themekey>
            <themekey>Sites</themekey>
        </theme>

        <!-- Use Place Keywords - not required but encouraged -->
        <place>
        <placekt>None</placekt>
            <placekey>United States</placekey>
            <placekey>Canada</placekey>
            <placekey>Mexico</placekey>
            <placekey>Alaska</placekey>
            <placekey>Hawaii</placekey>
            <placekey>District of Columbia</placekey>
            <placekey>Washington DC</placekey>
            <placekey>American Samoa</placekey>
            <placekey>Puerto Rico</placekey>
            <placekey>Virgin Islands</placekey>
            <placekey>Alabama</placekey>
```

```
            <placekey>Arizona</placekey>
            <placekey>Arkansas</placekey>
            <placekey>California</placekey>
            <placekey>Colorado</placekey>
            <placekey>Connecticut</placekey>
            <placekey>Delaware</placekey>
            <placekey>Florida</placekey>
            <placekey>Georgia</placekey>
            <placekey>Idaho</placekey>
            <placekey>Illinois</placekey>
            <placekey>Indiana</placekey>
            <placekey>Iowa</placekey>
            <placekey>Kansas</placekey>
            <placekey>Kentucky</placekey>
            <placekey>Louisiana</placekey>
            <placekey>Maine</placekey>
            <placekey>Maryland</placekey>
            <placekey>Massachusetts</placekey>
            <placekey>Michigan</placekey>
            <placekey>Minnesota</placekey>
            <placekey>Mississippi</placekey>
            <placekey>Missouri</placekey>
            <placekey>Montana</placekey>
            <placekey>Nebraska</placekey>
            <placekey>Nevada</placekey>
            <placekey>New Hampshire</placekey>
            <placekey>New Jersey</placekey>
            <placekey>New Mexico</placekey>
            <placekey>New York</placekey>
            <placekey>North Carolina</placekey>
            <placekey>North Dakota</placekey>
            <placekey>Ohio</placekey>
            <placekey>Oklahoma</placekey>
            <placekey>Oregon</placekey>
            <placekey>Pennsylvania</placekey>
            <placekey>Rhode Island</placekey>
            <placekey>South Carolina</placekey>
            <placekey>South Dakota</placekey>
            <placekey>Tennessee</placekey>
            <placekey>Texas</placekey>
            <placekey>Utah</placekey>
            <placekey>Vermont</placekey>
            <placekey>Virginia</placekey>
            <placekey>Washington</placekey>
            <placekey>West Virginia</placekey>
            <placekey>Wisconsin</placekey>
            <placekey>Wyoming</placekey>
</place>
</keywords>
<!-- Change these to any restrictions on your data set -->
<accconst>None.</accconst>
<useconst>None. Please check sources, scale, accuracy, currentness and other available
information. Please confirm that you are using the most recent copy of both data and metadata.
Acknowledgement of the EPA would be appreciated.</useconst>
<secinfo>
    <secsys>FIPS Pub 199</secsys>
```

```xml
        <!-- Change  to  classification relevant for your data set High, Medium, No -->
        <secclass>No Confidentiality</secclass>
        <sechandl>Standard Technical Controls</sechandl>
        </secinfo>
</idinfo>
<!-- ==================================================================== -->
<!-- Part 2  -  Data Quality Information EPA Mandatory; not Minimum FGDC -->
<!-- ==================================================================== -->
<dataqual>
<logic>Not presently available</logic>
<complete>Not presently available</complete>
<posacc>
<horizpa>
<!-- Change  to  description relevant for your data set -->
<horizpar>Positional accuracy for the data set varies for individual features within the data set.
Actual horizontal positional accuracy for the data set is unknown.</horizpar>
</horizpa>
</posacc>
<lineage>
<!-- Change  to  description relevant for your data set if you do processing -->
        <procstep>
        <procdesc>Metadata Created</procdesc>
        <procdate>2006</procdate>
        </procstep>
</lineage>
</dataqual>
<!-- ==================================================================== -->
<!--Part 4  -  Spatial Reference Information EPA Proposed; not Minimum FGDC -->
<!-- ==================================================================== -->
<!-- VERY IMPORTANT. Projection Information. Please change to your specifics -->
<spref>
<horizsys>
<geograph>
<latres>0.000001</latres>
<longres>0.000001</longres>
<geogunit>Decimal degrees</geogunit>
</geograph>
<geodetic>
<horizdn>North American Datum of 1983</horizdn>
<ellips>Geodetic Reference System 1980</ellips>
<semiaxis>6378137.0000000</semiaxis>
<denflat>298.2572221</denflat>
</geodetic>
</horizsys>
</spref>
<!-- ==================================================================== -->
<!-- Part 6  -  Distribution Information.  resdesc used for ArcIMS  -->
<!-- ==================================================================== -->
<distinfo>
<distrib>
<!-- Who to contact regarding distribution of the data -->
<cntinfo>
        <cntorgp>
        <cntorg>USEPA XYZ Region Program or Lab</cntorg>
        <cntper>USEPA XYZ Region Program or Lab Person</cntper>
        </cntorgp>
```

```xml
<cntaddr>
<addrtype>mailing and physical</addrtype>
<address>Street Address</address>
<city>City</city>
<state>State Name</state>
<postal>Zip Code</postal>
</cntaddr>
<cntvoice>XXX.XXX.XXXX</cntvoice>
<cntfax>XXX.XXX.XXXX</cntfax>
<cntemail>person@epa.gov</cntemail>
</cntinfo>
</distrib>
<!-- Reflect specifics of your data set there is an acceptable list in the EPA guidance-->
<resdesc>Downloadable Data</resdesc>
<!-- Add Not to be distributed if the data cannot be distributed -->
<distliab>Although these data have been processed successfully on a computer system at the
Environmental Protection Agency, no warranty expressed or implied is made regarding the accuracy
or utility of the data on any other system or for general or scientific purposes, nor shall the act of
distribution constitute any such warranty. It is strongly recommended that careful attention be paid to
the contents of the metadata file associated with these data to evaluate data set limitations,
restrictions or intended use. The U.S. Environmental Protection Agency shall not be held liable for
improper or incorrect use of the data described and/or contained herein.</distliab>
<!-- This section can be omitted if the information does not need to be ordered, but if it is not available
through download, then this section should be documented -->
<stdorder>
<digform>
<digtinfo>
<!-- Data format -->
<formname>XX Format</formname>
</digtinfo>
<digtopt>
    <onlinopt>
    <computer>
    <networka>
    <!-- Access through a network -->
    <networkr>http://www.epa.gov</networkr>
    </networka>
    </computer>
    </onlinopt>
</digtopt>
</digform>
<fees>None</fees>
</stdorder>

</distinfo>
<!-- ================================================================= -->
<!-- Part 7  - Metadata Reference Information: Minimum FGDC Required -->
<!-- ================================================================= -->
<metainfo>
<metd>2006</metd>
<!-- Should be 4 years from metadata data at a minimum -->
<metfrd>2010</metfrd>
<metc>
<!-- Who to contact regarding the metadata specifically -->
<cntinfo>
    <cntorgp>
```

```
            <cntorg>USEPA XYZ Region Program or Lab</cntorg>
            <cntper>USEPA XYZ Region Program or Lab Person</cntper>
         </cntorgp>
         <cntaddr>
         <addrtype>mailing and physical</addrtype>
         <address>Street Address</address>
         <city>City</city>
         <state>State Name</state>
         <postal>Zip Code</postal>
         </cntaddr>
         <cntvoice>XXX.XXX.XXXX</cntvoice>
         <cntfax>XXX.XXX.XXXX</cntfax>
         <cntemail>person@epa.gov</cntemail>
      </cntinfo>
   </metc>
   <metstdn>FGDC Content Standards for Digital Geospatial Metadata</metstdn>
   <metstdv>FGDC-STD-001-1998</metstdv>
   </metainfo>
   </metadata>
```

4.3   Controlled Vocabularies

Part 1: Theme Keyword list from ISO19115 Topic Category Thesaurus
Used to provide a general data layer classification description.

##	Description	##	Description
001	farming	010	imageryBaseMapsEarthCover
002	biota	011	intelligenceMilitary
003	boundaries	012	inlandWaters
004	climatologyMeteorologyAtmosphere	013	location
005	economy	014	oceans
006	elevation	015	planningCadastre
007	environment	016	society
008	geoscientificInformation	017	structure
009	health	018	transportation
		019	utilitiesCommunication

Part 2: Theme Keyword list from the EPA Geospatial Keyword Thesaurus
Used to describe EPA-specific data sets (approach is to align with EPA business areas).

EPA-specific keywords are meant to serve as an EPA-centric list that will augment the existing ISO-keyword required for meeting GOS specifications. They may not be suitable for all Agency data layers used for GIS needs, such as base data layers that are obtained to use as reference information (roads, towns, etc).   However, they can be used to provide common classification and description for those data layers that are developed specifically for EPA purposes, such as remediation or site assessment.

Management Disaster Energy Environment	Monitoring Air Water Land Biology Ecosystem	Remediation Cleanup Contaminant Spills Response Hazards Waste Pesticides Toxics Compliance Impact Indicator Risk Exposure Modeling	Quality Indoor Radiation Climate Surface water Ground water Marine Estuary Drinking Water Health Human	Natural Resources Conservation Marine Disaster Land Recreation Agriculture Ecology Transportation Ground Air Water	Regulatory Compliance Inspections Permits Facilities Sites

4.4   Providing Online Linkage for Data Sets and Services

Online Linkage is important for providing users with direct access to the data described by the metadata record.   This element, called <onlink>, is located within the citation information section of the FGDC CSDGM. Often this element is used within web-based applications as a means to directly consume a service or data layer.   For example, GOS relies on the documentation provided in the onlink element to load information directly into its online map viewer using the 'add to map' function.   As such, it is important that this element be documented appropriately.

The onlink element is closely related to the resdesc element. If a data set is listed as one of the 'Live Data and Maps' classes, then the information regarding the connection parameters for this live data set is listed in the onlink element. Likewise, if a data set is classified as Static Map Images or Downloadable Data, then the onlink element should list the URL of the ftp site, the html file, or other data download location. Providing online linkage for data sets that are not live services is straightforward. The user is only required to provide the link to the location of file.   Providing online linkage for live data and maps requires additional detail for correct consumption within other applications.

Live Mapping Services
Of the twelve different resource description classifications, three are classified as types of Live Mapping Services.   These include ArcIMS Image Services, ArcIMS Feature Services, and WMS Image Services.   Each of these services may be consumed directly from a metadata record by web-based mapping applications if they are documented correctly.   These are documented in the onlink element as follows:

ArcIMS Image Services
For a service with the following parameters:
Server: http:// geodata.epa.gov
Service: NPL

The appropriate URL for the onlink element would be:
<onlink>http://geodata.epa.gov/image/NPL</onlink>

ArcIMS Feature Services
The current functionality of ESRI software used to consume ArcIMS feature services requires that they be documented according to Web Feature Service protocols. As such, the ArcIMS

feature service must be configured appropriately as a Web Feature Service to provide interactive connection that can be consumed by ESRI's current versions of web-based software viewers. The appropriate documentation for this type of services is as follows:

<u>Server</u>: http:// geodata.epa.gov
<u>Service</u>: NPL_FS

The appropriate URL for the onlink element would be:
<onlink>http://geodata.epa.gov/wfsconnector/com.esri.wfs.Esrimap/NPL_FS?request=getcapabilities&service=wfs</onlink>

WMS Image Services
WMS Image services created using the ESRI WMS connector would have the following format:
<u>Server</u>: http:// geodata.epa.gov
<u>Service</u>: NPL
<onlink>http://geodata.epa.gov/wmsconnector/com.esri.wms.Esrimap/NPL?request=getcapabilities&service=wms</onlink>

4.5 Templates For Calculating Root Mean Square Accuracy

Part 1: NSSDA Horizontal Accuracy Statistic Worksheet
(Entire template including formulae available at
http://www.mnplan.state.mn.us/resource.html?Id=1852)

A	B	C	D	E	F	G	H	I	J	K
Point #	Point desc	x (ind)	x (test)	diff x	$(diff\ x)^2$	y (ind)	y (test)	diff y	$(diff\ y)^2$	$(diff\ x)^2 + (diff\ y)^2$
1				0	0			0	0	0
2				0	0			0	0	0
3				0	0			0	0	0
4				0	0			0	0	0
5				0	0			0	0	0
6				0	0			0	0	0
7				0	0			0	0	0
8				0	0			0	0	0
…….				0	0			0	0	0
……				0	0			0	0	0
20				0	0			0	0	0
									sum	0
									average	#DIV/0!
									RMSE	#DIV/0!
									NSSDA	#DIV/0!

Part 2: RMS Error Estimation Templates
Traditional Engineering Survey (Typically completed prior to 1940's)

		Feet			Meters		
Scale		1:10,000	1:20,000	1:40,000	1:10,000	1:20,000	1:40,000
Field Survey Errors	Field Interpretation Errors	13.12	13.12	13.12	4.00	4.00	4.00
	Error due to interpretation between features	16.40	16.40	16.40	5.00	5.00	5.00
	Position of Points collected	3.28	3.28	3.28	1.00	1.00	1.00
	Location of Plane Table	9.84	9.84	9.84	3.00	3.00	3.00
Cartographic Errors	Inaccurate Control Point Location	9.84	19.69	39.37	3.00	6.00	12.00

	Placement of Feature on Map	16.40	32.81	65.62	5.00	10.00	20.00
	Line Width Representing Features	9.84	19.69	39.37	3.00	6.00	12.00
	Digitizer Error	3.28	6.56	13.12	1.00	2.00	4.00
	Operator Error	3.28	6.56	13.12	1.00	2.00	4.00
RMS Error Output		**32.137**	**49.866**	**91.098**	**9.798**	**15.199**	**27.767**

Part 2: RMS Error Estimation Template (continued)
Historical Aerial Survey (Typically completed post-1940's)

Scale		1:10,000	1:20,000	1:40,000	1:10,000	1:20,000	1:40,000
Survey Errors	Delineating Feature Position	16.40	32.81	65.62	5.00	10.00	20.00
Cartographic Error	Inaccurate Control Point Location	9.84	19.69	39.37	3.00	6.00	12.00
	Placement of Feature on Map	16.40	32.81	65.62	5.00	10.00	20.00
	Line Width Representing Feature	9.84	19.69	39.37	3.00	6.00	12.00
	Digitizer Error	3.28	6.56	13.12	1.00	2.00	4.00
	Operator Error	3.28	6.56	13.12	1.00	2.00	4.00
RMS Error Output		**27.4424**	**54.904**	**109.801**	**8.3666**	**16.7332**	**33.4664**

Part 2: RMS Error Estimation Template (continued)
Digital Aerial Photo Interpretation (Typically completed post-1970's)

		Feet	Meters
Interpretation Errors	Delineating Feature Position	16.40	5.00
Registration Errors	Aerial Photo Registration Error	10.15	3.09
RMS Error Output	Total RMS Error Estimate	**19.287**	**5.879**

4.6 National Geospatial Data Policy Accuracy Tier Table

Tier Level	Accuracy Range	Examples of Horizontal Collection Method	Example Program Application
Tier 1	<1 m	Classical Surveying Techniques; plus GPS Carrier Phase Static Relative Position	Surveying to support definition of Institutional Controls to return land to productive use
Tier 2	1 – 5 m	GPS Carrier Phase Kinematic Relative Position	Definition of contamination boundaries of site
Tier 3	6 – 25 m	GPS Code (Pseudo Range) Standard Position	Stack location; drinking water intake location
Tier 4	26 – 100 m	GPS unspecified; Photo/GIS Interpolation	Site centroid; large area facility boundary
Tier 5	101 – 200 m	Urban style address matching	Preliminary site location
Tier 6	201 – 999 m	Public Land Survey – Sixteenth Section	Prediction of Local Air Dispersion
Tier 7	1000 – 2000 m	Address Matching – Block Face	Batch Geo-coding
Tier 8	2001 – 5000 m	Census Block Centroid	State-level Population Statistics
Tier 9	> 5000 m	Zip Code Centroid	Generalized National Mapping

4.7 Common GPS Unit Accuracy Ranges

| Unit Type | Unit Name | Horizontal | | | Vertical | |
		GPS Accuracy	DGPS Accuracy (USCG)	DGPS Accuracy (WAAS)	Altitude Accuracy/ Range	Web Reference
Recreational Personal	Garmin® Rino 120	< 15 meters, 95% typical*	3-5 m, 95% typical*	< 3 m, 95% typical		
	Garmin® Rino 110	< 15 meters, 95% typical*	3-5 m, 95% typical*	< 3 m, 95% typical		
	Garmin® eTrex Summit	15 meters (49 feet) RMS			10 ft**/ -2,000 to 30,000 ft	
	Garmin® eTrex Venture	< 15 meters, 95% typical*		3-5 meters, 95% typical		
	Garmin® Street Pilot III	< 15 meters, 95% typical*	3-5 meters, 95% typical*			
	Garmin® 12XL	15 meters (49 feet) RMS	1-5 meters			
	Garmin® 76 GPS System	< 15 meters, 95% typical*	3-5 meters, 95% typical*	< 3 meters, 95% typical		
	Magellan® Explorist 300	< 7 meters, 95% typical		< 3 meters, 95 % typical	< 10 meters	
	Magellan® Explorist 200	< 7 meters, 95% typical		< 3 meters, 95 % typical	< 10 meters	
	Magellan® Explorist 100	< 7 meters, 95% typical		< 3 meters, 95 % typical	< 10 meters	
	Magellan® SportTrak	< 7 meters, 95% typical		< 3 meters, 95 % typical	< 10 m/ max 60,000 ft	
	Brunton® Muli-Navigation GPS	15 meters RMS	1-5 meters		1 m/ -700 to 9200 m	
		Horizontal	**Vertical**			

Unit Type	Unit Name	GPS Accuracy	DGPS Accuracy (USCG)	DGPS Accuracy (WAAS)	Altitude Accuracy/ Range	Web Reference
Commercial/ Survey/ Scientific	HP-GPS-L4 w/ collector		30 cm RMS/ 30-60 cm typ.			
	Hawkeye 2000 series	15 meters	<1 RMS w/ differential cor.	5 m RMS		http://www.arrb. com.au/docum ents/PB-Hawkeye2000 GPS.pdf
	Hyperdata GPS	15 meters 2D RMS		10 m 2D RMS	max 18,000 m	http://www.hyp erdatadirect.co m/product/GPS /gps.htm
	Trimble® Pathfinder Pro XRS			Sub-meter (1-50cm) HRMS		http://trl.trimble. com/docushare /dsweb/Get/Do cument-128929/13275 G_GPS%20Pat hfinder%20Pro %20XRS_DS_ 0405_lr.pdf
	Trimble® R8 GPS Receiver		0.5 - 25 cm +1ppm RMS	< 5 m 3D RMS	0.5 - 50 cm + 1 ppm RMS	http://www.livon agis.co.yu/pdf/ R8_GPS_DS_0 704_lr.pdf
	Trimble® 5800 GPS Receiver		0.5 - 25 cm +1ppm RMS	< 5 m 3D RMS	0.5 - 50 cm + 1 ppm RMS	http://www.seile rinst.com/imag es/gps/product s/gps5800/580 0DSE.pdf
	Leica® System 500		0.2mm - 30cm (RMS)			http://www.surv eyingsupplies.c om/surveyingsu pplies/pdfs/gps 500tech.pdf
	NavCom's SF-2040G		12 cm	50 cm	25-70 cm/ <18,300 m	http://www.smi. com/GPS/SF20 40GSSpecs.ht m
	AG Leader: GPS 1000 Plus	4 meter RMS		2 meter RMS		http://www.agle ader.com/gps1 000-specs.htm
*Subject to accuracy degradation to 100m 2DRMS under the U.S. Department of Defense Selective Availability Program.						
**with proper calibration (user and/or automatic calibration)						
Other References: http://home-2.worldonline.nl/~samsvl/oemtable.htm						