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An Enhanced Digital Line Graph Design

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An Enhanced Digital Line Graph Design

STEPHEN C. GUPTILL, Editor

KENNETH J. BOYKO, MICHAEL A. DOMARATZ, ROBIN G. FEGEAS, HEDY J. ROSSMEISSL, and E. LYNN USERY, Contributing Authors

A feature-based data model for digital spatial data bases that represent geographic phenomenon

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, Jr., Secretary

U.S. GEOLOGICAL SURVEY

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PREFACE

This circular is the result of several years of work on the part of a number of individuals. Within the National Mapping Division, two groups were established to study aspects of the DLG–E design. The first group, the Data Structures Study Team, consisted of Kenneth J. Boyko, Michael A. Domaratz, Robin G. Fegeas, David Hair, and Stephen C. Guptill. This group developed the basic components of the DLG–E data model and issued a report in November 1987. The second group, the Committee Investigating Cartographic Entities, Definitions, and Standards, was responsible for developing the domain of features for use with DLG–E. This group consisted of Hedy J. Rossmeissl, Michael A. Domaratz, John List, and E. Lynn Usery, with Robert D. Rugg and Stephen C. Guptill as advisors. The first report of this group was issued in November 1987, and a subsequent report was issued in April 1988.

This circular attempts to consolidate the efforts of the two groups. In preparing the circular, various individuals focused their efforts on certain aspects of the work. Kenneth Boyko contributed to the data model activity and was instrumental in developing the representation rules and the example data set. Michael Domaratz, who was a member of both the data structure and the feature definition groups, was invaluable in developing feature representation rules and instance definitions. Robin Fegeas developed major portions of the DLG–E data model and its definitions and prepared the transfer specification and DLG–O+ implementations. Hedy Rossmeissl has been the focus of the feature definition activity and has labored to keep order in the face of chaos. Lynn Usery, now on the faculty of the University of Wisconsin, Madison, contributed to the feature definition methodology using the concept of world views. Although they did not directly contribute to this report, the efforts of David Hair and John List in the predecessor activities are gratefully acknowledged. In addition, Robert Rugg provided valuable assistance in developing the feature definitions by sharing with us his experience in developing the entity and attribute definitions for the "Spatial Data Transfer Standard."

Stephen C. Guptill

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Stephen C. Guptill, *Editor*
Kenneth J. Boyko, Michael A. Domaratz, Robin G. Fegeas,
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Abstract

In response to increasing information demands on its digital cartographic data, the U.S. Geological Survey has designed an enhanced version of the Digital Line Graph, termed Digital Line Graph – Enhanced (DLG–E). In the DLG–E model, the phenomena represented by geographic and cartographic data are termed entities. Entities represent individual phenomena in the real world. A feature is an abstraction of a set of entities, with the feature description encompassing only selected properties of the entities (typically the properties that have been portrayed cartographically on a map). Buildings, bridges, roads, streams, grasslands, and counties are examples of features. A feature instance, that is, one occurrence of a feature, is described in the digital environment by feature objects and spatial objects. A feature object identifies a feature instance and its nonlocational attributes. Nontopological relationships are associated with feature objects. The locational aspects of the feature instance are represented by spatial objects. Four spatial objects (points, nodes, chains, and polygons) and their topological relationships are defined. To link the locational and nonlocational aspects of the feature instance, a given feature object is associated with (or is composed of) a set of spatial objects. These objects, attributes, and relationships are the components of the DLG–E data model.

To establish a domain of features for DLG–E, an approach using a set of classes, or views, of spatial entities was adopted. The five views that were developed are cover, division, ecosystem, geoposition, and morphology. The views are exclusive; each view is a self-contained analytical approach to the entire range of world features. Because each view is independent of the others, a single point on the surface of the Earth can be represented under multiple views. Under the five views, over 200 features were identified and defined. This set constitutes an initial domain of DLG–E features.

A NEW DESIGN

Overview

The U.S. Geological Survey has been producing digital cartographic data in its Digital Line Graph (DLG) format for almost a decade. During this time, the tasks for which the data are being used have become increasingly diverse, placing information demands on the data that were not planned for in their initial design.

In response to these demands, the Geological Survey (as both a data supplier and a data user) has designed an enhanced version of the Digital Line Graph, termed Digital Line Graph – Enhanced (DLG–E). In simple terms, the DLG–E begins with the topological model now used in the Survey's present DLG data structure (USGS, 1987a) and builds a cartographic feature layer upon the topology. Features are the sum of our interpretations of phenomena on or near the Earth's surface. Buildings, bridges, roads, streams, grasslands, and counties are examples of features. The feature definition is open ended, allowing the definition of additional features of interest. The features are described using objects, attributes, and relationships. In addition, the DLG–E will include data quality information based on the recommendations contained in "The Spatial Data Transfer Standard" (Spatial Data Transfer Standard Technical Review Board, 1990).

Several other major agencies that collect digital cartographic data are also considering (or have implemented) new feature-based spatial data model designs. These agencies include the U.S. Bureau of the Census (Marx, 1986; Kinnear, 1987), U.S. Defense Mapping Agency (Defense Mapping Agency, 1988, p. 99-100), the Institut Géographique National (France) (Bernard and Piquet-Pellorce, 1986; Salgé and Piquet-Pellorce, 1986; and Salgé, written commun., 1989), Landesvermessungamt Nordrhein-Westfalen (West Germany) (Barwinski and Brüggemann, 1986; and Brüggemann, written commun., 1987), and the United Kingdom Ordnance Survey (Haywood, 1988, p. 116). This trend toward feature-based data models signals an evolution in the design of spatial data bases and geographic information systems.

Evolution of the Design

One of the demands for change arises from the Survey's major system development activity called Mark II. Mark II will be a digital cartographic production system with the National Digital Cartographic Data Base at its hub. Information in the data base will reflect the data content of the National Mapping Program's standard map series. This information will be periodically revised and new graphic products generated using computer-assisted cartographic methods. Maintaining the information required to support these processes is a driving force behind the design of an enhanced data model (Guptill, 1986; Morrison and others, 1987).

Numerous examples of user experiences with the existing DLG data could be cited to support requirements for change. Comments have been made on the restrictive nature of the current DLG attribute coding scheme and data formats. One shortcoming of the existing DLG data is that users cannot identify and retrieve individual real world features by name, such as Broad Brook Stream. At present, named features are not carried in DLG data. The Geographic Names Information System (USGS, 1987b) maintains a data base of named features, but there is little compatibility between the two sets of data. Clearly this deficiency needs to be corrected in any new data model design. Other issues related to flexibility, standardization, and compatibility require changes in data content, geographic coverage, accuracy, and consistency among data categories. Although these issues will be addressed in the specifications for DLG–E data products, they impact the design of the data model.

Additionally, the growing sophistication of geographic information systems (GIS's) and the increasing diversity of applications involving GIS and spatial data are beginning to demand a more flexible and comprehensive model for spatial information. This linkage between GIS capabilities and the need for more advanced data structures has been explored by Goodchild (1987).

Translating requirements into data model/structure/format constructs first requires that these constructs be defined and placed in context. The following framework itemizes levels of data abstraction (based on Peuquet, 1984). These levels can serve as steps in refining a design to meet a set of requirements.

Reality is the total phenomena as they actually exist.

Data reality is an abstraction of reality that includes only those entities thought to be relevant to anticipated needs. It is a definition of the scope of the data.

A data model specifies the sets of components and the relationships among the components pertaining to the specific phenomena defined by the data reality. A data model is independent of specific systems or data structures that organize and manage the data.

A data structure specifies the logical organization of the components of a data model and the manner in which relationships among components are to be explicitly defined.

A file structure is a set of rules that specify the logical implementation of a data structure within computing system environments.

Note that the data model is concerned with defining components and relationships among those components. The next level, data structuring, is the defining of how these components and relationships are organized in a computing environment. An important point to note is that many different data structures may be generated from one model. The support of a wide range of user requirements dictates the development of a comprehensive data model.

CONCEPTS OF THE DLG–E DESIGN

The underlying philosophy of DLG–E is to "view cartography as an information transfer process that is centered about a spatial data base which can be considered, in itself, a multifaceted model of geographic reality" (Guptill and Starr, 1984). DLG–E data form the contents of the spatial data base. The DLG–E features must be representative of a model of geographic reality.

The process of creating a representation of geographic reality, or more accurately of our conceptualization of reality, is variously referred to as semantic data modeling, knowledge representation, semantic network description, or, perhaps more broadly, conceptual modeling (the various terms have evolved from work in artificial intelligence and data base management research; see Winston, 1984, or Brodie and Mylopoulus, 1986). Using the terminology of conceptual modeling, the world is comprehended in terms of conceptual objects or entities, which have associated descriptions and are related to each other in meaningful ways (Borgida, 1986). To express these ideas, researchers have developed a modeling framework that includes the concepts listed below (adapted from Borgida, 1986, and Borgida and others, 1986):

- A model is described as a collection of object descriptions.

- Objects in the model correspond to entities in the world.

- Objects are grouped into classes.

- Every object has zero or more attributes/properties which relate it to other objects.

- Classes are also objects. Classes, therefore, are instances of other classes, sometimes called "meta-classes" and may have their own attributes.

- Attributes can have multiple values.

These modeling concepts have been used in the development of the DLG–E data model.

Entities and Features

A real world phenomenon that is not subdivided into phenomena of the same kind is termed an entity. For example, a bridge is an entity that exists in the real world. Although it has component parts such as a superstructure and deck, it cannot be divided into components that are, themselves, bridges.

A feature describes a class of entities, defined by a selected set of common attributes and relationships that are properties of the corresponding entities. All of the elements of this set of phenomena are homogeneous with respect to the set of selected common attributes and relationships used to define the feature. Spatial data bases and maps are a collection of spatial and nonspatial information about selected features, attributes of the features, and relationships between the features. All geographic features implicitly have location as a defining attribute.

For example, consider a "bridge." A bridge is one of a number of built-up structures on or near the surface of the Earth. The entity "bridge" is the erected unit in the real world (fig. 1). A bridge may be further defined to be a structure erected over a depression or obstacle to carry traffic. Thus, the feature "bridge" (describing a class of real world entities) is an element of a set of phenomena ("erected structures") with the common attributes of function ("to carry traffic") and location. It also has the common relationship of spanning another feature ("over a depression or obstacle").
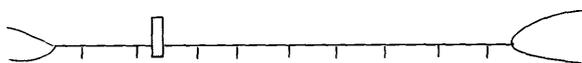
Figure 1. Example of an entity: Roosevelt Bridge in the "real world."

A feature instance is an occurrence of a feature and has a unique set of attribute and relationship values.

Expanding on the bridge example, the feature instance of a bridge (the Roosevelt Bridge) has unique values for the attributes function (vehicle traffic) and location. It also has unique values for the relationship of passing over another feature (spans the Potomac River).

The resolution, or level of detail, of a domain of defined features may vary between classification schemes created by different organizations. These differences in resolution are due to differences in the set of phenomena and common attributes and relationships used to define the features. For example, one could create "higher resolution" features such as "covered bridge" and "uncovered bridge," which are subsets of the feature "bridge," by modifying the set of phenomena to "an erected enclosed structure" and to "an erected exposed structure," respectively. Conversely, one could create a feature that includes bridge as a member of a superset by modifying the definition to "a structure built to carry traffic." This encompassing feature would include bridges and tunnels as members of the set.

Objects

Objects, along with their attributes and relationships, describe the characteristics of feature instances. For the bridge example, the objects on a map graphic might include point, line, and area symbols and associated text. Alternatively, the objects might be a collection of records in a file of digital data (fig. 2).
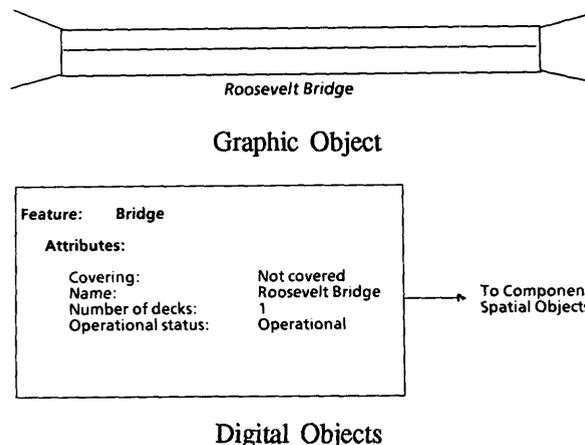
Figure 2. Examples of objects: representations of the Roosevelt Bridge.

The objects in the digital environment are used to represent both nonlocational and locational aspects of the feature instances. A feature object is an element that identifies the feature instance and its nonlocational attributes. Spatial objects are elements used to represent the location of a feature instance. The spatial objects are defined for zero-, one-, and two-dimensional objects. To be mapped, a feature object must be associated with one or more spatial objects. In a few cases the location of a

feature object may be unknown and thus not reference any spatial objects.

Mathematical Foundation of the Spatial Objects

The objects used to represent the spatial components of the DLG–E data model are formally described using terminology from graph theory. The DLG–E data model uses a directed, planar graph (more precisely a pseudograph) composed of vertices, edges, and faces to describe spatial objects. See, for example, Harary (1969) for an explanation of these terms and the concepts of graph theory.

The graph G consists of a nonempty set V(G) of vertices, where V is a finite set of points in real vector space R^2 with one point per vertex, together with a prescribed set E(G) of ordered pairs of (not necessarily distinct) vertices of G. Each pair $e = (u,v)$ of vertices in E is an edge of G, and e is said to join u and v. The graph is a plane graph in that the edges intersect only at their vertices (the edges are simple curves). The degree of a vertex v_i in graph G, denoted deg v_i, is the number of edges incident with v_i. The regions defined by the plane graph are called its faces, the unbounded region being called the exterior face.

Synonymous terms exist from geometry and topology and are often seen in the literature. Synonyms that have been used for vertex include point, node, 0-cell, junction, 0-simplex, and element; synonyms for edge include line, arc, 1-cell, branch, 1-simplex, and element. Books by Bondy and Murty (1976), Giblin (1977), and Lefschetz (1975) provide additional information on graph theory and topology. Corbett (1979) gives some insights on the topological principles used in cartography.

In order to conform with the terminology used in the proposed Spatial Data Transfer Standard (SDTS), the corresponding terms from SDTS and the mathematical terms described here are given below:

SDTS terminology	Graph theory terminology
Point	Vertex (deg v_i = 0)
Node	Vertex (deg $v_i \geq 1$)
Chain	Edge
Polygon, topological	Face

The SDTS terminology will be used in the remainder of this document. The set of relationships between members of these object classes (point, node, chain, and polygon) is given in "Relationships."

Attributes

Attributes are the locational and nonlocational characteristics of the entities represented by the objects or

of an attribute value. Locational attributes describe an object's geographic position (using x, y coordinates, for example) or a geometric characteristic (such as its accuracy). The nonlocational characteristics of an entity include such concepts as its operational status, name, and function. An attribute value is a measurement assigned to an attribute for a feature instance or for (another) attribute value. These measurements are made from one of the four levels of measurement (nominal, ordinal, interval, ratio).

A domain of nonlocational attributes is predefined for each feature. In addition, a domain of attribute values is specified for each attribute. An example of an attribute and its domain of attribute values is shown in table 1.

Table 1. Domain of attribute values for the attribute "operational status"

Attribute: Operational status

Attribute values:
    Abandoned
    Dismantled
    Operational
    Proposed
    Under construction
    Unknown

For a particular feature instance, appropriate attribute values describing the instance are chosen for each attribute. An example of the attributes and associated attribute values for the feature instance of the bridge is given in table 2.

Table 2. The encoding of attribute values for a feature instance

---

Feature: Bridge

Attributes:	Attribute values:
Covering:	Not covered
Name:	Roosevelt Bridge
Number of decks:	1
Operational status:	Operational

Three special attribute values, "not applicable," "unspecified," and "unknown," are available for selected attributes. They are defined as follows:

Not applicable:	Used to describe a feature instance that cannot take on a value for a particular attribute.

Unspecified: Used to value attributes of a feature instance for which the data collector does not provide a measurement.

Unknown: Used to note that an attribute could not be measured for a feature instance. In general, attributes having an attribute value of "unknown" will be resolved prior to the release of the data.

Every attribute in the domain of attributes describing a feature must be assigned at least one attribute value. More than one value may be required for an attribute to describe a feature instance. For example, for an instance of the feature "road," the attribute "route designator" may have multiple values (route numbers).

Attributes may also refine other attribute values. For example, the feature "well" has the attribute "product." An instance of the feature might have the value "water" for this attribute. The attribute value "water" is further modified by the attribute "water characteristics," which could contain a number of values as shown in table 3.

Table 3. Example of attributes of attribute values

Feature:	Well
Product:	
	Gas
	Heat
	Oil
	Water ------> Water characteristics:
	Alkaline
	Hot
	Mineral
	Salt

Features are represented as they exist at a given instant of time. Any temporal data are given as attributes of the feature objects. Appendix B contains examples of feature instances fully encoded with attributes and attribute values.

The spatial objects of the data model are defined for two dimensions upon a surface. Thus, the locational attributes for the spatial objects are limited to the definition of the surface upon which the zero-, one-, and two-dimensional objects occur. The coordinate data associated with a spatial object reflects that object's position on the surface of the Earth. For example, a section of road may be represented by a chain with x, y, z coordinates as locational attributes. The z coordinates reflect the surface elevation at the x, y location. Such z coordinates are optional in DLG–E. If a feature is elevated above the surface, that elevation measure is associated with the

feature object. Other elevation values, such as the elevation of the surface of a pond, are also considered to be attributes of the feature object.

Relationships

Relationships define the topological and nontopological links between objects. They are used within the model to describe not only the topological relationships of the elements of the graph but also the relationships between feature objects and spatial objects and between feature objects and other feature objects. Relationships are also used to model various aspects of spatial information that cannot be inferred from the spatial objects alone. The relationships between model components currently used are listed in table 4. The relationships listed are between members of the object classes and not between the classes themselves.

Table 4. Relationships between the objects of the DLG–E data model

Object class	Relationship	Object class
feature	----composed of---> <---part of-------	*
feature	----bounded by----> <---bounds--------	feature
feature	----inflow from---> <--outflow to-----	feature
feature	<--connected to--->	feature
feature	--vertically related to-->	feature
point	----within-------> <---contains------	polygon
node	----bounds--------> <---bounded by----	chain
chain	----within-------> <---contains------	polygon
chain	----bounds--------> <---bounded by----	polygon

*Any of the objects (feature, point, node, chain, or face) can be used in this relationship.

The relationships between feature objects are further described as follows:

"composed of/part of": Describes the formation of feature objects from feature objects and (or) spatial objects. Can be used to aggregate either disjoint or

adjoining spatial objects or feature objects. Example: Lake Michigan is part of the Great Lakes.

"bounded by/bounds": Describes the limits of the contiguous spatial extent that limit all or part of a given areal feature. Consists of a "boundary feature" that is an outer ring of chains containing the feature and inner rings that bound areas ("holes") that are not the feature. Example: Fairfax County, Va., is bounded by a boundary that is composed of a set of chains. One subset of chains defines the outer boundary of the county, and other subsets define holes in the county, such as the set of chains that denotes the limits of the Town of Vienna, a jurisdiction that is spatially within the outer boundary of the county but politically a separate entity.

"inflow from/outflow to": Used to model flows through networks in the cases where the network links are represented as areal features. The inflow and outflow relationships represent the source and discharge locations (that will be represented by a feature termed a "junction") for modeling network flows. Example: Where the Potomac and Anacostia Rivers (each represented by areas) meet, a junction is formed and the information that the water from the Anacostia River flows into the Potomac River is recorded using the inflow from and outflow to relationships. Also used with the feature "connector" to model flow through a network in cases where flow is known to exist, but the location of the objects are unknown.

"connected to": Similar to the inflow and outflow relationships but used where the flow is bidirectional, alternating, or unknown (as in the case of a road that is wide enough to be represented as an area).

"vertically related to": Used to link an instance of an underpass feature with the features that created the instance. The ordered relationship preserves the information that the first feature is "on top" and the second is "on the bottom."

The relationships between spatial objects consist of the boundary/coboundary topological relationships. These relationships were discussed in "Objects" and are defined in "Data Model Definitions." Note that the topological relationships of the spatial objects do not reflect any feature relationships. For example, the fact that a point (representing an oil tank) is contained in a polygon (representing an airport) does not necessarily define any relationship between the features that those spatial objects represent. A definite relationship between the oil tank and the

airport should not be assumed unless a specific relationship gives the information (for example, an indication that the oil tank is owned by the airport).

The most prevalent feature relationship is the "composed of" relationship (road A is composed of chains 1, 2, and 3) used to form the geometric representation of a feature instance from a set of spatial objects (which can also be done indirectly through other feature objects). Other relationships between feature objects could be defined to describe situations such as administrative hierarchies (the Town of Vienna, spatially contained within Fairfax County, is not part of the county's police jurisdiction). For flexibility and expansion, the model is open ended with respect to the addition of new relationships.

Note also that relationships can have attributes. One use of attributes of relations would be to describe the set of members included in the relation, particularly if those members were to be considered in an ordered or directed sense. For example a road might be composed of an ordered set of chains, or a stream composed of an ordered and directed set of chains. Chains are ordered in a linear sequence, with no branches, when chain (i+1) of the set has a common node with chain (i), and chain (i+2) has a common node with the other node of chain (i+1), and so on for each chain in the set. The elements are directed when a mechanism exists to arrange the chain set so that the end of one chain corresponds to the start of the next chain in the set. There is no requirement for all the coordinates in the chains in a directed set to be similarly sequenced, as long as some mechanism exists to record the "sense" of each chain being referenced ("forward" or "backward").

The representation of flows through a network and overpassing/underpassing features may require such attribution of relationships. For example, given feature objects composed of chains, the chains are to be considered as an ordered set having uniform direction. The direction is indicated by an attribute describing the direction for traversing the chain. In addition, a real world (ground) significance to this direction is indicated by attribution of the feature object. For the underpass, the relationship is ordered, with the first feature object overpassing the second. Under the present design, these are the only cases that utilize attributes of relationships. Any other cases requiring attribution of relationships are proposed to be handled by attributes of feature objects.

In another, hypothetical usage, attributes of relationships might be used to describe the accuracy of a spatial object, a chain, that represented both a road segment and the edge of a forest. The locational accuracy for the road is different from the locational accuracy of the forest edge (the edge being a gradual transition zone or "fuzzy" boundary). The respective accuracy figure could be used as an attribute on each instance of the "composed of" relationship.

DLG–E Data Model Summary

Features are the sum of our interpretations of phenomena on or near the Earth's surface. The components of the data model used to represent these features are objects, attributes, and relationships. Objects are the basic units of representation of the encoded phenomena. Attributes are the locational and nonlocational characteristics of the entities represented by the objects. Relationships are the links between the objects. Taken collectively, these objects, attributes, and relationships constitute the DLG–E data model.

Various logical components of DLG–E are shown diagrammatically in figure 3. The locational components of a feature instance are described by the spatial objects: points, nodes, chains, and polygons, or combinations of these objects. The spatial objects have a set of locational attributes, typically a set of coordinates that characterize their location in space. These consist of x, y, and optional z coordinates. A feature object identifies a feature instance and its nonlocational attribute.

A given feature object may consist of other feature objects. A given entity may always be represented as one feature object. However, for the representation to be complete, one or more spatial objects must also be associated with the feature object either directly or through other feature objects. Flow and connectivity information is encoded through the ordering of chains and the relationships of the features. Additional flow characteristics are nonlocational attributes of a feature instance. These constraints bound the data modeling task.

Data Model Definitions

The following definitions describe the components of the DLG–E data model. In some cases they replicate or further refine the definitions of cartographic objects given in "Spatial Data Transfer Standard."

Entity: A real world phenomenon that is not subdivided into phenomena of the same kind.

Feature: A class of entities with common attributes and relationships. The concept of feature encompasses both entity and object.

Feature Instance: An occurrence of a feature defined by a unique set of attribute and relationship values.

Object: A digital representation of all or part of an entity.

Feature object: An element that identifies a feature instance and its nonlocational attributes and relationships. A feature object may consist of other feature objects. The locational aspects of the feature instance are represented by spatial objects, either directly or through other feature objects.

Spatial object: An element used to represent locational attributes and topological relationships of a feature instance. Spatial objects are defined for zero, one, and two dimensions. Data for the third dimension are limited spatially to the definition of a surface upon which the zero-, one-, and two-dimensional objects occur.

Attribute: Characteristic of a feature or of an attribute value.

Attribute value: Measurement assigned to an attribute for a given feature instance or for (another) attribute value.

Locational attribute: An attribute that describes the geographic position of a feature instance; locational attributes are assigned to a spatial object.

Nonlocational attribute: Characteristic of a feature instance or attribute value other than location.

Relationships: Linkages between objects.

Topological relationship: Boundary/coboundary relationship between spatial objects.

Nontopological relationship: Relationships between feature objects and (or) feature objects and spatial objects.

Graph: A set of topologically interrelated zero-dimensional (node), one-dimensional (chain), and sometime two-dimensional (polygon) objects, conforming to a set of defined constraint rules: each chain is bounded by an ordered pair of nodes, not necessarily distinct; a node may bound one or more chains; and when realized in vector space, not more than one node may exist at any given point, and chains may not intersect (except at nodes). (SDTS definition)

Node: A zero-dimensional object that is the junction of two or more chains or is an end point of a chain. A node is a component of one and only one graph; as such, it may be located at one and only one point, and if so located it must be the only node of its graph located at that point. (SDTS definition)

Chain: A directed sequence of nonintersecting line segments with nodes, not necessarily distinct, at each end. A chain is a directed link (a one-dimensional object that is a connection between two nodes) with geometric location specified by a sequence of one or more line segments. A chain is a component of one and only one graph; as such, a chain may not intersect itself or any other chains within its own graph. (SDTS definition)

A chain may be contained within one polygon of a graph. The topological relationships of such a chain are still defined by the dual two-element ordered sets of nodes and polygons; however, the start and end nodes must be different, and the right and left polygons must be the same.

Polygon: A two-dimensional object of one and only one two-dimensional cell complex (a graph and its complement set
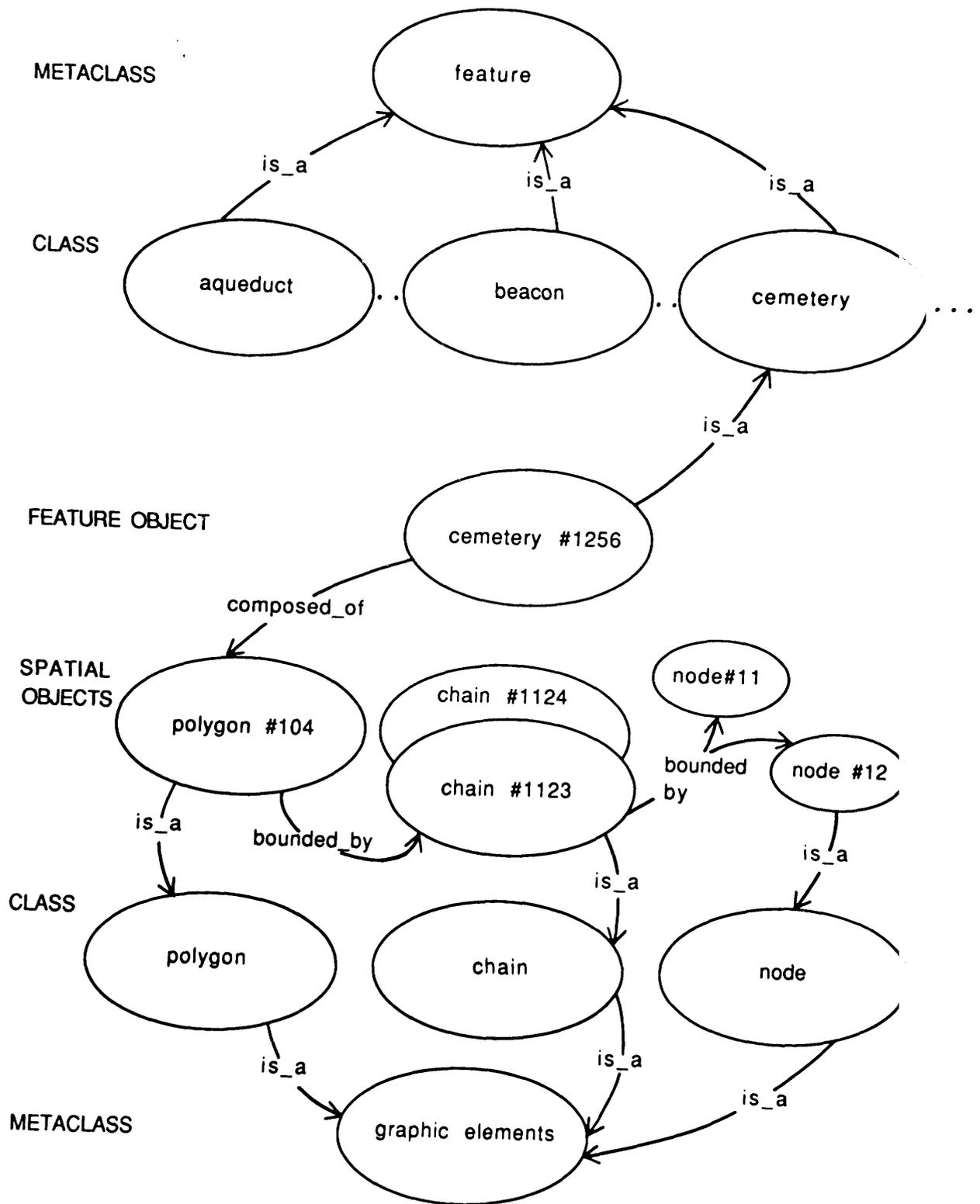
Figure 3. Logical components of the DLG–E data model.

of polygons). The polygon is bounded by one or more chains of the complex. (SDTS Definition)

Point: A zero-dimensional object that specifies geometric location. One coordinate pair or triplet (or equivalent locational attribute value) specifies the location. (SDTS Definition)

DEFINITION OF DLG–E FEATURES

Background

The DLG–E data model has a variety of components for representing a feature. However, before describing how those components are used to represent any given feature, the domain of features (that is, the data reality) to be described by the model should be discussed. The report "Proposed Definition of Cartographic Features for Digital Line Graph – Enhanced (DLG–E)" (April 1988), by the Committee Investigating Cartographic Entities, Definitions, and Standards, defined an initial domain of features. A synopsis of that work is incorporated in this report. In preparing the set of DLG–E features, the committee reviewed related efforts including those of the Digital Cartographic Data Standards Task Force (1988), the Defense Mapping Agency (1987), the Canadian Council of Surveying and Mapping (1982), the Bureau of Land Management (1978), and the South African Natural Research Institute for Mathematical Sciences (1987). The current list of DLG–E features is given in appendix A.

Methodology for Identifying Features

Persons reading a map perceive features according to their needs and experiences. For example, one may be interested in the extent of a given named feature, such as the Potomac River or the Blue Ridge Mountains. Others may have a different interest and employ a different set of criteria. They may be interested in bicycling from Mount Vernon, Va., to Leesburg, Va., and would be concerned with a connected network of roads and trails between the two locations. In a digital environment, one attempts to explicitly encode information that best satisfies most users. The designers are faced with the problem of specifying a set of information in a form that can be perceived unambiguously by the majority of users. This specification process can be viewed as a process of classification. An expandable method of classification is necessary when defining features.

Classification involves the selection and grouping of phenomena into classes on the basis of common properties or relationships. The selection of a classification system has implications beyond the definition of common names

for things. It is the classification scheme that defines the nature of the generalizations that are made about the phenomenon under study (Abler and others 1971). Note the linkage between the classification of map features and the concept of the map as a model. As stated by Board (1967), "it is important to realize that they [maps] are also conceptual models containing the essence of some generalization about reality." In the map model, the characteristics of the classification scheme and the resulting features specify this essence of the generalization of reality.

In the DLG–E feature classification process, an approach was taken that initially subdivided the world of geographic phenomena into five classes, termed views, that correspond to the major facets of a model of geographic reality as described by Geological Survey requirements and specifications. A view is defined as a systematic classification of a set of entities in which all members of the set possess a common defining characteristic. This characteristic is specified explicitly in the definition of the view. Views are similar to the geographical concepts of region and spatial system (James and Jones, 1954; James, 1972) and "geographic matrix" (Berry and Marble, 1968). Common cartographic terms such as category and overlay are related to views in derivation but lack the rigor of the defining characteristic.

While views provide a methodology for classifying features, it is the classification scheme that defines the nature of the generalizations about the phenomenon under study. These generalizations are reflected in feature definitions. For example, a road is an entity that covers a part of the Earth's surface. In the DLG–E methodology, it is classified in a view called "cover," a view with the defining characteristic of material at a location on or near the surface of the Earth. Other features in the view "cover" include "building," "bridge," "railway," and "grassland." A "county" is not a feature in the view "cover" because it is not covering material on the Earth's surface. A county is in the view "division" because it is a political entity independent of the actual material on or near the Earth's surface. Other examples of features in the view "division" include "state," "city," "reservation," and "census block."

New views are introduced in the methodology when an entity cannot be appropriately classified in existing views. For example, a contour line is an entity that does not fit the views "cover" or "division." A contour line reflects measurement data about the Earth's surface. The feature "contour" requires a view in which measurement data are the focus. That same view is needed to classify features such as "control station" and "spot elevation." Thus, a new view called "geoposition" that reflects entities of measurement was created.

In an approach similar to creating views, finer divisions of a view, called subviews, may be created to further refine the concepts included in the view. The view and subview approach allows a user to fit unclassified

entities into the appropriate part of the schema. It also provides a framework for comparison to other sets of features as defined by other organizations.

While the approach uses the concept of multiple views of the world and a hierarchy of subviews within each view, neither the views nor the hierarchy need be stored with feature data. Nor is it necessary to group the features into categories. The views and subviews are used only to define the domain of features. Alternative views will yield different features, and features within a single view can be modified or expanded. Users can apply other views or hierarchies to add new features to the list. Use of features in the domain and use of the data require limited information concerning the approach methodology. The views and subviews are illustrated in figure 4.

This approach allows for expansion by creating a completely different view, adding new subviews, or augmenting the features within the existing five views. To classify a new entity, one would first determine whether an existing view, subview, feature, attribute, or attribute value is appropriate by comparing the characteristics of the new entity to existing definitions in the domain. After making this comparison, the new entity would be placed in the correct level of the hierarchy either by creating new views or subviews, or by expanding the list of features, attributes, or attribute values. Some examples are given below.

Large-scale mapping of base category information considers entities not currently listed in the domain as features. A specific instance is a "curb." Examining the views, a curb would be classified as cover. Within the view "cover," the curb is considered to be in the subview "built-up land" and a "structure." In the subview "structure," entities are differentiated into features based on form. Examining the list of features under "structure," a curb does not fit any of the existing feature definitions, and, thus, a new feature must be created.

A second example from a large-scale product is a single housetrailer with a permanent foundation. A housetrailer is a type of cover, built-up land, and a structure. The feature "building" encompasses housetrailers, and the attribute "text" with a value of "housetrailer" is appropriate. An alternative would be to institute a new attribute such as "building construction type" with one possible value being "housetrailer."

Expanding the number of views can be used to encompass features such as those that occur on geologic or other thematic maps. A geologic or other thematic view would require complete generation of the hierarchy within the view and the development of a list of features and attributes for that view. The resulting set of features then becomes a part of the total list of features independent of the approach methodology and completely usable with the other features in the total set.

Five Views

The current DLG–E model classifies selected entities into five views on the basis of common defining characteristics. The five views are cover, division, ecosystem, geoposition, and morphology. The views are exclusive; each view reflects a self-contained analytical approach to world features. Because each view is independent, a single point on the surface of the Earth can be represented under multiple views, and features within any one view may coexist with features in the same or any other view. For example, examine the entity "boundary point." If a monument exists at the location of the boundary point, then two features will be recorded in the data. The feature "boundary point," referring to the monumented location on a boundary, is in the view "division" while the second feature, "point monument," denoting the structure on a boundary line, is in the view "cover." Brief definitions of the five views follow:

Cover: Reflects physical or material features at a location on or near the surface of the Earth. While this view is based on form, at the lowest level features it may be differentiated by function.

Division: Reflects cultural demarcations of the Earth's surface for a particular purpose or for separations resulting from human activity.

Ecosystem: Based on climate, vegetation, soils, and other controlling environmental factors that result in unique ecological units.

Geoposition: Reflects measurement data about the Earth's surface and contains points or lines on the Earth or its representation for which the location, relative to a particular datum, is well known.

Morphology: Based on the form of the land. While a strict geomorphological interpretation of landforms based on process is inherent in the contour information on Geological Survey maps, the actual features must be interpreted. However, some of the features carry names and those features must be coded in the digital data. Thus, morphological features are those landform features that are named, labeled, or symbolized as distinct entities on current map products.

Discussion of Views

The following section offers a more detailed discussion of each view and includes definitions of subviews.

Geographic Reality

Views:	Cover	Division	Ecosystem	Geoposition	Morphology

Subviews:	Barren land
	Built-up land
	-Network
	-Structure
	-Complex
	   -Agricultural
	   -Commercial
	   -Entertainment/
	     Recreational/
	     Memorial
	   -Disposal
	   -Extraction
	   -High density
	     building area
	   -Industrial
	   -Institutional
	   -Residential
	   -Transition
	   -Transportation
	   -Utility
	Cultivated cropland
	Vegetation
	-Grassland
	-Shrubland
	-Forestland
	Water
		Administrative
		Boundary
		Census
		Hydrologic unit
		Land parcel
		Locale
		Maritime
		Political
		Survey system			

Figure 4. The five views and associated subviews.

Cover

The view of cover reflects physical or material features at a location on or near the surface of the Earth. This view contains a mixture of land use and land cover information. Multiple features derived from this view may occupy the same location.

Because of the diversity in the features defined by this view, additional subviews were added to clarify the distinctions between features. There are five subviews, based on the land use and land cover terms and definitions recommended by the Department of the Interior Land Use and Land Cover Common Terminology Work Group (Department of the Interior, 1985).

Barren land: A surface composed of expo^ed bare rock, other earthen material, or ice with little or no vegetation.

Built-up land: Structures and areas associa'^d with intensive land use. This subview is furth^r divided into network, structure, and complex.

Network-- An interconnected set of constructions used for transportation or communication.

Structure--A construction having a uniq^e form.

Complex--Cover of intensive use with much of the land covered by constructions.

Agricultural. A group of associated structures functioning as a unit used predominantly for the production of food and fiber, such as livestock holding areas, fish hatcheries, and other developed land.

Commercial. A group of associated structures functioning as a unit used predominantly for wholesale and (or) retail sale of goods and services.

Entertainment/Recreational/Memorial. An area or group of associated structures functioning as a unit used predominantly (1) for leisure activities, (2) for athletic or artistic events, (3) as archaeological or historic sites, or (4) for burial of the dead.

Disposal. A designated area where refuse is dumped or exists.

Extraction. An excavation or a group of excavations or drillings in the Earth for the purpose of removing earth materials.

High density building area. A congested, built-up area where all buildings cannot be represented on the map because of map scale.

Industrial. A group of associated structures functioning as a unit used predominantly for manufacturing, testing, processing, or storage.

Institutional. A group of associated structures functioning as a unit used predominantly for educational, correctional, governmental, medical, or religious purposes.

Residential. A collection of structures used for human habitation.

Transition. Area in change from one land use activity to another and characterized by a lack of information to predict future use or discern past use.

Transportation. An area or group of structures that function as a unit associated with travel or conveyance of people and (or) goods, together with the necessary adjacent facilities.

Utility. An area or group of structures that function as a unit to provide a public service and are used for the generation and (or) transportation of communications, water, gas, oil, or electricity.

Cultivated cropland: Areas characterized by function that are tilled and dominated by vegetation growth for the production of food and (or) fiber. Cultivated cropland includes fallow land, land in any stage of annual crop production, and land being regularly cultivated for production of crops from perennial plants.

Vegetation: An area that is extensively covered with plant life.

Grassland--An extensive noncultivated area where vegetation is dominated by grasses or grass-like plants.

Shrubland--Areas covered with low-growing or stunted perennial vegetation, such as cactus, mesquite, or sagebrush, common to arid regions and usually not mixed with trees.

Forestland--Areas on which vegetation is dominated by woody perennial plants having a single, usually elongated main stem and generally few or no branches on its lower part.

Water: Cover composed of flowing or standing water, impounded or naturally occurring, with channels or basins that are largely naturally occurring.

Division

This view includes the cultural demarcations of the Earth's water and land surfaces. Two types of features exist in this view: areal divisions and boundaries. Boundaries may either delimit the areal divisions or, for historical reasons, occur as independent features. The subviews of the division view are defined as follows:

Administrative: A division under the jurisdiction of a common group for purposes such as preservation or exploitation of cultural or natural resources.

Boundary: Part or all of a bounding or separating line on the Earth's surface having current or past significance.

Census: Divisions of the Earth's surface established by the Bureau of the Census for enumerating and reporting the population of the United States.

Hydrologic unit: Divisions of the Earth's surface established by the U.S. Geological Survey based on properties, distribution, and circulation of water.

Land parcel: Divisions of the Earth's surface based upon land ownership.

Locale: A named place not otherwise categorized.

Maritime: Divisions of the Earth's water surface identified for the purpose of navigation or control of ship traffic.

Political: Divisions of the Earth's surface based upon governmental jurisdiction and activities such as voting and taxation.

Survey system: Divisions of the Earth's surface to determine and delineate the form, extent, and position of land tracts by taking linear and angular measurements.

Ecosystem

Ecosystem is a view based on climate, vegetation, soils, and other controlling environmental factors that result in unique entities. These entities are often of large extent and mapped as land use/land cover classes or as named places. Tundra, desert, and wetland are included in this view.

Geoposition

Geoposition contains features associated with the measurement of the size and shape of the Earth. The view reflects points or lines on the Earth or its representation for which the location, relative to a particular datum, is well known.

Morphology

Morphology is a view based on the form of the land surface. A domain of features has been developed that reflects morphology as presented on Survey map products. Although morphologic features appear on map graphics through hypsography, within the scale limitations of the products, only those features that are named, labeled, or otherwise symbolized as unique entities appear in the feature list. While these features may require interpretation of boundary limits, the text and symbol information distinguish them.

Attempts were made to organize morphologic features according to classical geomorphological treatments including processes such as erosion and deposition and generating agents such as glaciers, streams, wind, or volcanoes. While these approaches yield consistent features and correlate directly with geomorphological theory and practice, the information required to make these types of feature distinctions is not available on map source materials without significant effort in the interpretation of hypsography. The level of knowledge necessary to perform this interpretation requires a skilled geomorphologist. Therefore an alternate approach was taken

whereby the morphology of the land surface was organized directly into a domain of features that can be readily obtained from map graphics. The feature list reflects the named and symbolized entities organized and grouped to account for aliases such as cliff and bluff, or valley and hollow.

Examples of Feature Objects

This section provides examples of feature objects used to represent entities. The feature object represents the nonlocational aspect of the entity. To complete the representation of the entity, the feature object would be related to the spatial objects that represent the position and extent of the entity.

Building

Feature: Building
Angle of orientation: 45
Text: Not applicable
Name: Not applicable
Operational status: Operational

Square, 45° angle, black interior

Feature: Building
Angle of orientation: Not applicable
Text: Church
Name: Not applicable
Operational status: Operational
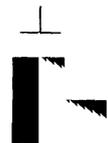
Feature: Building
Angle of orientation: Not applicable
Text: Not applicable
Name: The White House
Operational status: Operational

THE WHITE HOUSE

Each of the feature objects would be related to the spatial objects (points, nodes, chains, or polygons as appropriate) to complete the description of the feature.

Complex

Feature: Institutional site
Institutional function: Education
Name: Smithsonian Institution

Smithsonian Institution
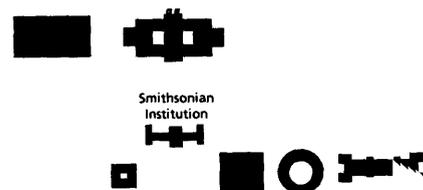
In addition to this feature object, the individual buildings would be encoded as building feature objects ("Building"). The feature object representing the Smithsonian Institution would be related to spatial objects (representing the grounds of the feature) and (or) other component features (representing the buildings or other component structures) to complete the description of the feature.

Road

Feature: Road
Access restrictions: None
Flow direction: Bidirectional
Median category: Without median
Name: Pletcher Road
Number of lanes or tracks: Unspecified
Operational status: Operational
Road class: 2nd
Road type: General case
Route designator: Not applicable
Width: Unspecified

PLETCHER   ROAD

The individual instances of the road feature are shown in the illustration. One feature object (feature, attribute, and attribute value set) is required for each feature instance.

REPRESENTATION OF FEATURES

By using the components of the DLG–E data model, it is possible to create a number of different configurations of objects, attributes, and relationships to describe the members of the domain of defined features. Therefore, rules must be established for the representation of feature instances. Representation rules for feature instances may be based on spatial (that is, locational attributes and topological relationships) and (or) nonspatial aspects of the data. There are two types of feature instances: a basic feature instance and a compound feature instance. The basic feature instance consists of a feature object that is "composed of" a set of spatial objects (nodes, points, chains, or polygons). A compound feature instance consists of a feature object that is "composed of" basic feature instances and (or) other compound feature instances. For example, a named road such as "Lee Highway" is a compound feature consisting of a set of basic features corresponding to the segments of the road.

In many cases, the feature instances are easily defined. For example, the feature instance of the feature "well" is a feature object "composed of" a single point representing the "well" location. Areal entities that are well-defined homogeneous regions, such as a pond without islands, are also easily represented with a single area corresponding to each instance. However, entities such as linear network systems present more difficulties in defining feature instances.

A drainage network, for example, as shown on a map may consist of single- and double-line streams with islands and may be crossed by road, railroad, and other features. Determination of feature instances for this case must account for the intersection of single- and double-line streams, direction of flow of the water, and intersections with the other features. Changes in nonlocational attributes, such as a name, also influence the extent of these instances.

For the purpose of creating the National Digital Cartographic Data Base from existing maps, a set of rules for the representation of feature instances should allow the basic features to be constructed directly from the map graphics. Aggregation of the basic feature instances to compound feature instances requires a combination of spatial and nonspatial rules. The delineation and representation rules should provide basic feature instances that are useful for aggregating into compound feature objects.

The preparation of a set of representation rules for feature instances is critical to the use of the domain of features. Although a domain of features has been developed, a variety of representations is possible for each instance of that feature. The work to arrive at a single consistent set of feature instance representation rules to complete the design of DLG–E is continuing.

Feature Delineation Strategies

A set of feature instance representation rules could be developed using a variety of criteria. A number of alternatives are discussed in this section. The specific set of rules chosen for the implementation of the DLG–E data model is described in "Rules for Feature Instances."

Representation rules describe what objects are used to represent a feature instance. Delimiting rules define where any given feature instance starts and stops. These rules can be developed on the basis of spatial characteristics (locational attributes and topological relationships), nonlocational attributes, nontopological relationships, or a combination of these.

One method is for feature instances to correspond to topological elements within the line graph representation of the features. This rule works well for entities represented as point and line objects. Areal features such as double-line streams present problems because of

intersecting single-line streams. Treating the entire area, that is, the topological elemental area, as a feature instance fails to retain critical information about direction of flow of water from the single-line streams into the double-line representation. Also, in a composite data base, this rule results in features in one category; for example, roads, delineated by intersection of features from the same or any other category. Thus, a road feature instance may be delineated by the intersection of a stream with the road on one end and the intersection of a contour line with the road on the opposite end. If the composite data base is structured as a single graph, all topological element intersections become delimiters of feature instances.

To avoid these problems, the rule can be changed so that feature instances are bounded by only "like" features; for example, a stream feature instance begins at the intersection with another stream and continues until a second intersection with a third stream occurs. Termination of the coordinate representation of an entity is also a bounding criteria. Essentially, road feature instances would only be bounded by road intersections, not by road/contour intersections and so forth. A problem with this rule is that changes in nonspatial attributes do not yield separate feature instances. For example, a two-lane road changing to a four-lane would all be part of the same feature instance and the two- and four-lane attributes must be attached to a single feature instance. Under this rule, are single- and double-line streams like features? One could impose a subrule that states that like features must be of the same dimensionality. The term "like" must be rigorously defined for this rule to be effective.

An alternate strategy is to delineate feature instances based solely on their nonspatial attributes. A new feature instance would occur only with a change in nonspatial attribution. For example, a road changing from four lanes to six lanes would dictate a new feature instance, but a road intersecting another road would not. A problem with this rule is that all roads with the same value for the attribute "road class," regardless of location, are a part of the same feature instance. A requirement of continuity partly solves this; however, roads that intersect and retain the same nonspatial attributes would still form the same feature instance.

The most useful representation of feature instances requires both spatial and nonspatial rules to be used together. The optimum combination of these rules will vary with the entity under consideration, but one or more rules must be used to specify unique feature instances for the Geological Survey.

Rules for Feature Instances

DLG–E uses a combination of spatial and nonspatial rules to represent feature instances. The sections below list a general set of rules that have been developed for determining feature instances in the DLG–E data model. These general rules are augmented by feature specific rules, examples of which are given in appendix P.

Basic Features

All objects that are part of a basic feature instance must be contiguous, uniform in dimensionality, and homogeneous in attribution. The feature instances are bounded by the intersection with a like feature.

Ground features having linear extent are represented by basic feature instances composed of a set of chains that are homogeneous in orientation and contiguous (that is, the chain sets are both ordered and directed). A linear basic feature instance has one starting point and one ending point and shall not contain any network type branches.

All features having areal extents are composed of the spatial object "polygon." Objects in the "composed of" relation will be unordered.

A defined subset of features having areal extent will, in addition to the "composed of" relation, carry a "bounded by" relation. The "bounded by" relation holds an ordered set of chains that define the boundary of the areal feature. The following features carry the "bounded by" relation:

All features in the Divisions/Administrative subview
All features in the Divisions/Political subview
All areal features in the Divisions/Survey Systems subview
Selected features in the Cover/Water subview

Features having areal extent but indeterminate boundaries will be spatially represented by an unordered set of topological polygons using the "composed of" relation. Nonfeature chains will be used where necessary to arbitrarily close off the extent of the areal feature. Ties to structures inside a complex (buildings in a university, for example) will not be directly represented.

Named Features

Features having a proper name may be represented by either the basic or compound type of feature. If the feature can be represented as a single basic feature instance, the name is stored as an attribute on that instance. If, however, the feature must be represented as a compound feature, the name is stored as an attribute on the higher level compound feature. Since a single name may apply to a number of different features at the basic level, the entity label of the higher level named feature need not match the constituent basic feature instances. Most often, the feature "Named Feature" will be used. Currently, the only attribute that may cause basic features to be linked to a higher level feature due to equivalence of the value assigned to that attribute is the "name" attribute.

Modeling Constructs

Most aspects of geographic reality are readily described using the feature objects derived from the five views, spatial objects, topological relationships, and the "composed of" and "bounded by" relationships. However, to model certain conditions some additional features, attributes, and relationships are required. [Note: The additional features referred to in this section are not listed in appendix A.] The use of these in modeling certain phenomena is discussed in the following sections.

Modeling of Network Flows

Flow and connectivity of linear features are encoded through the direction of the chains and by relationships between chains and nodes. Flow is represented as a nonspatial attribute on the feature instance as shown below.

Attribute: Directional status

> Alternating
> Bidirectional
> Not applicable
> One way
> Unknown
> Unspecified

This attribute indicates if the flow moves in both directions along the instance ("bidirectional"), alternates in direction along the flow ("alternating"), or moves one way along the instance.

Connectivity between linear and areal features is encoded using the nodes common to the chains that are part of the linear feature and the edge of the areal feature. Flow between areal features is encoded using the feature "junction" (the occurrence of an intersection of two areal features having flow) and the relationships "connected to" or "inflow from/outflow to." These relationships are attached to the areal features and link the features to the junctions where they meet other features. Sometimes in the map of hydrographic features, gaps will occur in the flow network (such as between the shoreline of a reservoir behind an earthen dam and the stream flowing from the reservoir). To model this situation the feature "connector" is used with the relationships "inflow from/outflow to." If the location of the "connector" is unknown, the connector feature object will not be composed of any spatial objects.

Vertical Feature Relationships

Use of attributes

The attribute "relationship to surface" is used with various feature instances to indicate the vertical location of a feature relative to the surface of the domain in potentially ambiguous situations. The attribute has the following attribute values:

Attribute:	Relationship to surface
	Awash at water surface
	Elevated or suspended above surface
	Exposed at surface
	Submerged below water surface
	Under land surface

In general, the features of the cover and ecosystem view are considered to be on the surface in land areas and to be exposed at the water surface in water areas. Exceptions include features normally considered elevated or suspended above surface, such as:

> Bridge
> Cableway
> Conveyor
> Transmission line

and features normally considered under the land surface, such as:

> Pipeline
> Tunnel

Selected features in the cover view (aqueduct, canal/ditch, railway, pipeline, road, road interchange, stream/river, and trail features) that coincide with a bridge or tunnel feature are considered to be on/in the bridge or tunnel. These coincident features are automatically considered to be "elevated or suspended above surface" or "under land surface" where they coincide with the bridge or tunnel. The "relationship to surface" attribute is not applied in these cases. Features that have instances where the relationship to the surface is other than the conditions described will carry the "relationship to surface" attribute.

The features in the morphology view describe the form of the surface. They are exposed at the land surface. In cases where they are coincident with water features, they are considered to be submerged below the water surface. In one ambiguous case, a rock (represented by a point) may be exposed, awash, or submerged. The rock feature carries the "relationship to surface" attribute.

Similar to morphology, features in the geoposition view are measurements of the surface, and occur at the surface. Because spot elevations and control stations are

occasionally located on elevated or suspended structures, this feature carries the "relationship to surface" attribute.

Use of "underpass"

Where it is necessary to preserve a vertical relationship between two feature instances, the feature "underpass" shall be utilized. This feature is employed where the relative vertical information between the features cannot be determined by other information. It is normally used where features carrying traffic or having flow (such as aqueduct, canal, railway, road, and stream) pass under other features.

It is not used where the relative vertical relationship between features can be determined from other information, such as knowledge of one feature being underground or elevated while the second feature is on the surface. For example, it would not be used where a road coincident with a bridge passes over another (not coincident) road, or where a road coincident with a tunnel passes under a railroad.

The dimensionality of an instance of an underpass shall depend on the dimensionality of the overpassing/ underpassing features, according to the following table.

Table 5. Dimensionality of "underpass" instance from intersection of features

		Dimension of feature 2	
		1	2
Dimension of feature 1	1	0	1
	2	1	2

Only two features may be vertically related with the "underpass" feature. In the case of three or more features overpassing each other at the same spatial location, only vertically adjacent features shall be referenced in the underpass feature. Thus, a triple overpass shall generate two underpass instances: one for the top and middle features and one for the middle and bottom features.

Spatial Extent

The feature "domain" is used to define the spatial extent of the data set. It includes the area of the Earth covered by the data set being transferred. It excludes the area outside the domain and any void or holiday areas occurring within the area. Features represented by points and (or) chains (or portions thereof) that coincide with the edge of domain appear in both data sets that adjoin that edge. Features represented by areas, of which only the

boundary is coincident with the edge of domain, appear only in the data set that contains the areal extent.

Using the Model to Represent Cartographic Features

Rules for bounding feature instances, composition rules for representing feature instances, rules for aggregating feature instances, and rules for modeling various situations have been discussed in this section. Different sets of rules for representing a feature may be useful in different applications of that feature. By varying these rules for creating instances of the features, a variety of implementations are possible using the elements and structure provided by the model.

However, for any given implementation, specific rules must be created and observed to define the representation of feature instances. A prototype set of rules for use with the set of features contained in the example data set is given in appendix B.

DATA MODEL IMPLEMENTATION

Previous sections have defined the DLG–E data reality, that is, the scope of the data that is of interest in this application, and the DLG–E data model, the sets of components and relationships that are used to describe the elements of the data reality. However, to encode, transfer, or use the data, the logical organization of the components and the component relationships of the DLG–E data model must be explicitly defined. This definition is done by creating a specific data structure. A data structure can, in turn, be translated into a specific file structure by a set of rules that specify the logical implementation of the data structure within a given computing system environment. Many different data structures and file structures can be generated from one data model.

Two implementations of the DLG–E data model are considered. The first implementation of the model uses the existing DLG–O file structure (USGS, 1987a) and adds modules to hold the DLG–E elements. This new file structure is called DLG–O+. The "DLG–O" part holds the spatial objects, locational attributes, and topological relationships. The "+" part adds a series of files to hold the DLG–E features, nonlocational attributes, and nontopological relationships. Details on this implementation are given in appendix B. The example data set described in appendix B is implemented in the DLG–O+ data structure.

The second implementation uses the framework of the Spatial Data Transfer Specification (SDTS) described in "The Proposed Standard for Digital Cartographic Data" (Digital Cartographic Data Standards Task Force, 1988). This framework has a strictly defined and organized set of modules, fields, and subfields that are used to hold the

various components of the DLG–E data model. The details on implementing the DLG–E model in SDTS are given in appendix C.

SUMMARY AND FUTURE RESEARCH

Summary

In the DLG–E model, the phenomena of geographic and cartographic data are considered, in totality, as entities. Entities are individual phenomena in the real world. A feature is an abstraction of a set of entities, defined by a selected set of common attributes and relationships that are properties of the corresponding entities. Features represent the sum of our interpretations of phenomena on or near the Earth's surface. Buildings, bridges, roads, streams, grassland, and counties are examples of features. The components of the digital representation of a feature instance are termed objects. Cartographic data may be considered to be composed of objects, attributes, and relationships.

Objects are the basic units of representation of the encoded phenomenon. Attributes are the locational and nonlocational properties of the entities represented by the objects. Relationships are the topological and nontopological links between the objects. The objects in the DLG–E model are of two types, feature objects and spatial objects. Nonlocational attributes and nontopological relationships are associated with feature objects. Locational attributes and topological relationships are associated with spatial objects. Four spatial objects are defined: points, nodes, chains, and polygons. A given feature object has relationships with other feature objects and (or) spatial objects. Taken collectively, these objects, attributes, and relationships constitute the DLG–E data model. These concepts are developed in "Concepts of the DLG–E Design."

To establish the domain of features for DLG–E, an approach using a set of classes, or views, of geographic entities was adopted. The views are exclusive; each view is a self-contained analytical approach to the entire range of world features. Because each view is independent of the others, a single point on the surface of the Earth can be represented under multiple views. The five views that were developed are cover, division, ecosystem, geoposition, and morphology. "Definition of DLG–E Features" describes the methodology used in creating the DLG–E features, and the domain of DLG–E features is enumerated in appendix A.

By using the DLG–E data model, a wide variety of representations of features could be formulated from the domain of defined features. Therefore, rules must be established for the representation of occurrences of the features or "feature instances." Representation rules for feature instances may be based on spatial and (or) non-spatial attributes of the data. A prototype set of rules for the representation of feature instances was created. Combining selected basic feature instances into compound feature instances uses a combination of spatial and non-spatial rules. Representation rules are discussed in "Representation of Features." An example DLG–E data set and the set of rules used to create it are provided in appendix B.

A specific data structure explicitly defines the logical organization of the components and the component relationships of the DLG–E data model. A data structure can, in turn, be translated into a file structure by a set of rules that specify the logical implementation of the data structure within a given computing system environment. Many different data structures and file structures can be generated from one data model. Two implementations of the DLG–E data model are discussed in "Data Model Implementation," and appendixes B and C provide the respective guidelines for implementing the DLG–E data model in the DLG–O+ data structure and in SDTS.

Future Research

The preparation of a set of representation rules for all feature instances is critical to the use of the domain of features. Although a domain of features has been developed, a variety of representations are possible for each instance of that feature. The work to arrive at a single, consistent set of feature instance representation rules to complete the design of DLG–E is continuing.

Further work on the implementation of the DLG–E data model in a variety of computer environments needs to be performed. One implementation of the model will be within the context of relational and (or) object-oriented data base systems. Research on this topic will be pursued.

Finally, a series of system development activities required to implement prototype DLG–E production must be undertaken. These activities include further refinement of feature, attribute, and attribute value definitions; creation of extraction and product rule sets; establishment of procedures and software for data collection and conversion of existing data sets; and further testing of implementations of the DLG–O+ and SDTS data structures with more extensive data sets.

Of course, these activities may point out areas not adequately addressed by the model. Therefore, modifications and improvements to the model may occur.

SELECTED REFERENCES

Abler, R., Adams, J., and Gould, P., 1971, Spatial organization-The geographer's view of the world: Englewood Cliffs, N.J., Prentice-Hall Inc., p. 149-158.

Anderson, J.R., Hardy, E.E., Roach, J.T., and Witmer, R.E., 1976, A land use and land cover classification system for use with remote sensor data: U.S. Geological Survey Professional Paper 964, 28 p.

Barwinski, Klaus, and Brüggemann, Heinz, 1986, Development of digital cadastral and topographic maps--Requirements, goals, and basic concept: Auto Carto London, Imperial College, South Kensington, London, Proceedings, v. 2, p. 76-85.

Bernard, Antoine, and Piquet-Pellorce, Daniel, 1986, A workstation for handling located data: PISTIL: Auto Carto London, Imperial College, South Kensington, London, Proceedings, v. 1, p. 166-174.

Berry, B.J.L., and Marble, D., 1968, Spatial analysis: A reader in statistical geography: Englewood Cliffs, N.J., Prentice-Hall, p. 24-34.

Board, C., 1967, Maps as models, in Chorley, R.J., and Hagget, P., eds., Models in geography: London, Methuen, p. 672.

Bondy, J.A., and Murty, U.S.R., 1976, Graph theory with applications: New York, North Holland, 264 p.

Borgida, Alexander, 1986, Conceptual modeling of information systems, in Brodie, Michael J., and Mylopoulos, John, eds., On knowledge base management systems: New York, Springer-Verlag, p. 461-469.

Borgida, Alexander, Mitchell, Tom, and Williamson, Keith, 1986, Learning improved integrity constraints and schemas from exceptions in databases and knowledge bases, in Brodie, Michael J., and Mylopoulos, John, eds., On knowledge base management systems: New York, Springer-Verlag, p. 259-286.

Brodie, Michael J., and Mylopoulos, John, eds., 1986, On knowledge base management systems: New York, Springer-Verlag, 660 p.

Bureau of Land Management, 1978, Glossary of Bureau of Land Management (BLM) survey and mapping terms: Bureau of Land Management Cadastral Survey Training Staff, Service Center, Denver, Colo., 21 p.

Canadian Council of Surveying and Mapping, 1982, National standards for the exchange of digital topographic data, in Standards for the classification of topographic features: 202 p.

Corbett, J.P., 1979, Topological principles in cartography: U.S. Department of Commerce Technical Paper 48.

Defense Mapping Agency, 1987, Feature attribute coding standard (FACS): 1351 p.

_____ 1988, Digitizing the future: DMA Stock No. DDIPDIGITALPAC, 104 p.

Department of the Interior, 1985, Recommended land use and land cover terms and definitions: Department of the Interior Land Use and Land Cover Common Terminology Work Group, January 1985, 45 p.

Digital Cartographic Data Standards Task Force, 1988, The proposed standard for digital cartographic data, The American Cartographer, v. 15, no. 1, 142 p.

Giblin, P.J., 1977, Graphs, surfaces, and homology, New York: Halsted Press, 329 p.

Goodchild, M.F., 1987, Towards an enumeration and classification of GIS functions: International GIS Symposium, Arlington, Va., November 1987, Proceedings, v. 2, p. 67-77.

Guptill, S.C., 1986, A new design for the U.S. Geological Survey's National Digital Cartographic Data Base: Auto

Carto London, Imperial College, South Kensington, London, Proceedings, v. 2, p. 10-18.

Guptill, S.C., Fegeas, R.G., and Domaratz, M.A., 1988, Designing an Enhanced Digital Line Graph: American Congress on Surveying and Mapping, 1988 ACSM-ASPRS Annual Convention, Technical Papers, v. 2, p. 252-261.

Guptill, S.C., and Starr, L.E., 1984, The future of cartography in the information age, in Computer-assisted cartography research and development report: International Cartographic Association Commission C Report, July 1984, p. 1-15.

Harary, Frank, 1969, Graph theory: Reading, Mass., Addison-Wesley, 274 p.

Haywood, Peter, 1988, From digital maps to structured data and database management at Ordnance Survey: Eurocarto Seven Proceedings, Enschede, The Netherlands, p. 115-125.

James, P.E., 1972, All possible worlds: A history of geographical ideas: Indianapolis, The Bobbs-Merrill Company, Inc., p. 622.

James, P.E., and Jones, C.F., 1954, American geography, inventory and prospect: Syracuse, N.Y., Syracuse University Press, 590 p.

Kinnear, C., 1987, The TIGER structure: Eighth International Symposium on Computer Assisted Cartography (Auto Carto 8), Baltimore, Md., Proceedings, p. 249-257.

Lefschetz, Solomon, 1975, Applications of algebraic topology: New York, Springer-Verlag, 189 p.

Loelkes, G.L., Jr., Howard, G.E., Jr., Schwertz, E.L., Jr., Lampert, P.D., and Miller, S.W., 1983, Land use/land cover and environmental photointerpretation keys: U.S. Geological Survey Bulletin 1600, 142 p.

Marx, R.W., 1986, The TIGER system: Automating the geographic structure of the United States census: Government Publications Review, v. 13, p. 181-201.

Morrison, J.L., Callahan, G.M., and Olsen, R.W., 1987, Digital systems development at the U.S. Geological Survey: International Cartographic Association Conference, Morelia, Michoacan, Mexico, October 12-21, Proceedings, p. 201-214.

Peuquet, D.J., 1984, A conceptual framework and comparison of spatial data models: Cartographica, v. 21, no. 4, p. 66-113.

Salgé, Francois, and Piquet-Pellorce, Daniel, 1986, The I.G.N. small scale geographical data base (1:100,000 to 1:500,000): Auto Carto London, Imperial College, South Kensington, London, Proceedings, v. 1, p. 433-446.

South African National Research Institute for Mathematical Sciences, 1987, A proposed national standard for the exchange of digital geo-referenced information: Pretoria, South Africa, 151 p.

Spatial Data Transfer Standard Technical Review Board, 1990, Spatial Data Transfer Standard, 181 p. (Available from U.S. Geological Survey, National Mapping Division, 510 National Center, Reston, VA, 22092).

U.S. Geological Survey, 1954, Glossary of names for topographic forms: U.S. Geological Survey National Mapping Division Topographic Instructions, ch. 7E1, 21 p.

_____ 1980, Cultural features (4A2), 46 p.; Boundaries (4A3), 17 p.; Public land subdivisions (4A4), 14 p.; Hydrographic features (4A5) 53 p.; Relief features (4A6) 27 p.; and Woodland (4A7), 4 p.: U.S. Geological Survey National Mapping Division Topographic Instructions, ch. 4A2-7.

_____ 1980, Features shown on topographic maps: U.S. Geological Survey National Mapping Division Topographic Instructions, ch. 1B1, 41 p.

_____ 1985, Attribute coding, pt. 3 of Standards for Digital Line Graphs: U.S. Geological Survey National Mapping Program Technical Instructions, 239 p.

_____ 1987a, Digital Line Graphs from 1:24,000-scale maps: U.S. Geological Survey Data Users Guide 1, 109 p.

_____ 1987b, Geographic Names Information System: U.S. Geological Survey Data Users Guide 6, 30 p.

_____ 1987c, Publication symbols, pt. 5, and, 1984, Supplement, pt. 6, of Standards for 1:24,000- and 1:25,000-scale quadrangle maps: U.S. Geological Survey National Mapping Program Technical Instructions, 99 p. (pt. 5), 26 p. (pt. 6).

Winston, Patrick Henry, 1984, Artificial intelligence, Second Edition: Reading, Mass., Addison-Wesley, p. 251-289.

APPENDIXES

APPENDIX A

DLG–E FEATURES

Section

APPENDIX A

DLG–E FEATURES

1. AN INTRODUCTION TO THE DLG–E DOMAIN

This appendix details the contents of the DLG–E domain. The content of this domain is not all-inclusive and does not attempt to define all the entities in the real world. This domain was established to define a set of features that are found on U.S. Geological Survey National Mapping Division (NMD) source materials and reflect the requirements of the NMD. The DLG–E domain is organized as follows:

| View: | Subview 1: | Subview 2: | Subview 3: |

Feature: Feature Definition

        Attribute

            Attribute Values------->Attribute of Attribute Value

                Attribute Values

A description of each of these concepts follows.

VIEW

The DLG–E domain was developed by using an approach that incorporates a concept of world views of spatial entities. The concept of multiple views of the world and a hierarchy of subviews within each world view was used to define a domain of features found on NMD products. The views should not be confused with data collection categories. Neither the views nor the subview hierarchy will be stored with the feature data. Categories may be chosen, if so desired, to group features during data collection.

A world view is defined as a systematic classification of a set of real world phenomena in which all members of the set possess a common defining characteristic. The defining characteristic is specified explicitly in the definition of each view. Five world views were developed and documented to reflect the source material and requirements of the NMD. The views along with their definitions and a brief explanation are as follows:

Cover: This world view reflects physical or material features at a location on or near the surface of the Earth. While this view is strictly based on form, at the lowest level features may be differentiated by function.

                 Most of the features in the domain are contained in this view (122 out of 202). Due to the diversity in the features defined by this view, additional subviews were added. These subviews clarify the distinctions between features in the view.

Division: This world view reflects cultural demarcations of the Earth's surface for a particular purpose or separations resulting from human activity.

                 This view includes the cultural demarcations of the Earth's water and land surfaces. Two types of features exist in this view: areal divisions and boundaries. Boundaries may either delimit the areal divisions or occur as independent features.

Ecosystem: This world view is based on the climate, vegetation, soils, and other controlling environmental factors that result in unique ecological units.

                 The entities in this view are often of large extent and are mapped as land use/land cover classes or as named places. Tundra, desert, and wetland are the features included in this view.

Geoposition: This world view reflects measurement data about the Earth's surface and contains points or lines on the Earth or its representation for which location, relative to a particular datum, is well known.

                 Several of the features in this view, such as contours and spot elevations, exist only on maps even though they represent real world phenomena.

Morphology: This world view is based on the form of the land. While a strict geomorphological interpretation of landforms based on process is inherent in the contour information on USGS maps, the actual features

must be interpreted. However, some of these features carry names and those features must be coded in the digital data. Thus, morphological features are those landform features that are named, labeled, or symbolized as distinct entities on current NMD products.

Attempts were made to organize morphologic features according to classical geomorphological treatments, including processes such as erosion and deposition and generating agents such as glaciers, stream, wind, or volcanoes. While these approaches yield consistent features and correlate directly with geomorphological theory and practice, the information required to make these types of feature distinctions is not available on NMD source materials without significant interpretation of hypsography. The level of knowledge necessary to perform this interpretation requires a skilled geomorphologist. Thus, the morphology of the land surface was organized directly into a domain of features that can be readily obtained from NMD graphics. The feature list reflects the named and symbolized entities organized and grouped to account for aliases such as cliff and bluff, valley and hollow, etc.

This world view approach for specifying features was designed to be flexible and expandable by providing the capability to appropriately fit unclassified entities into the schema. It also provides a framework for comparison to other sets of features as defined by other organizations. Other organizations may have requirements for different views, subviews, or augmenting the features within the existing five views.

FEATURE

The DLG–E model defines the concept of feature as a class of phenomena with common attributes and relationships encompassing both real world entities along with their digital (object) representation.

```
                        Feature
                           |
          _____|_____
          |                             |
        Entity                        Object

      "Real World"                "Representation"
```
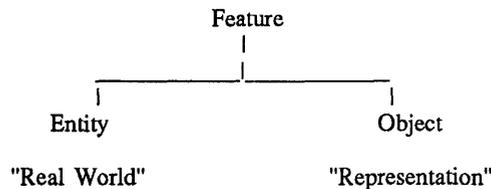
Only features found on NMD source material and reflecting NMD requirements are included in the domain. Features along with their definitions are listed alphabetically under each view or subview 1, 2, or 3 headings. Several indexes are provided in this appendix to help locate any feature.

ATTRIBUTE

Attributes are the locational or nonlocational characteristics of a feature or of an attribute value. Locational characteristics of a feature describe the geographic location or geometric dimension, while nonlocational characteristics include such concepts as operational status, name, and product. All attributes that are listed in the DLG–E domain for a feature must be populated with at least one attribute value. A list of all attributes with their associated attribute values existing in the DLG–E domain can be found in section 6 of this appendix. No definitions are included for the attributes and attribute values in this domain; an effort to complete this work is ongoing.

In the domain, all attributes along with their associated attribute values are listed for each feature. For example, the feature "Pipeline" has the following attributes:

> Name
> Operational status
> Product
> Relationship to surface

Other attributes such as "length" or "width" may be associated with the feature "pipeline"; however, they are not included in the DLG–E domain because they are not requirements of the Geological Survey.

ATTRIBUTE VALUE

Attribute values are measurements assigned to an attribute for a given feature occurrence or for another attribute value. At least one attribute value must be assigned to every attribute listed for a feature. Several of the attribute values that are frequently used in the DLG–E domain are described below.

Not Applicable, Unspecified, Unknown

These special attribute values are available for selected attributes and should be used as follows:

Not applicable: Used when there is no relevant value for a particular attribute.

Unspecified: Used when there is a possible value for an attribute but no value is provided.

Unknown: Used when a value should be provided but for some reason the information is not available. In general, values of unknown will be resolved prior to the release of the data.

General Case

The attribute value "general case" is used when the common usage of an attribute is required. For example, "railway category" is an attribute of the feature "railway," with values of "general case," "inclined railway," "logging," "rapid transit," and "unknown." The options "inclined railway," "logging," and "rapid transit" are special cases of railways that occur infrequently. Since the DLG–E model specifies that at least one attribute value must be chosen for each attribute, a general purpose railway would be coded as "general case."

ATTRIBUTE OF ATTRIBUTE VALUE

An attribute of an attribute value is a valid construct in the DLG–E model. The feature "well" will be used to illustrate this concept. A portion of the entry for "well" from the DLG–E domain is reproduced below.

Well   A pit or hole dug or bored into the Earth for the extraction of oil, water, other fluids, or gases.

    Product
       Gas
       Heat
       Oil
       Water------------> Flow Characteristics
       Unspecified   Flowing
       Unknown   Not flowing

                   Hydrographic Category
                       Dry
                       Not applicable
                       Perennial

                   Water Characteristics
                       Alkaline
                       Hot
                       Mineral
                       Salt
                       Unspecified

The attributes "flow characteristics," "hydrographic category," and "water characteristics" are attributes of the attribute value "water" under the attribute "product." This is modeled in this way because these three attributes are pertinent only when the value "water" is chosen from the attribute "product." These three attributes are not relevant for oil wells or natural gas wells but apply to water wells only, and therefore are associated as attributes of the attribute value "water" under the "product" attribute.

"Text" is a common attribute of an attribute value. The attribute "text" is used when a description for an attribute value is needed. For example, "text" is an attribute of the attribute value "sports site type" for the feature "sports site." If a municipal golf course must be collected, "golf course" is chosen as a value, and the "text" attribute would be used to hold the text "municipal." Any type of descriptive text may be included in the "text" field. This field is not to be used to record proper names.

2. SUMMARY OF DLG–E DOMAIN AND FEATURE COUNT

3. FEATURES OF THE DLG–E DOMAIN LISTED BY VIEW

<u>View</u>	<u>Subview 1</u>	<u>Subview 2</u>	<u>Subview 3</u>
Cover	Barren land		
	Barren land		
	Firebreak		
	Ice mass		
	Mud pot		
	Built-up land		

Network
  Aqueduct
  Canal/Ditch
  Cul de sac
  Pipeline
  Railway
  Road
  Trail
  Transmission line

Structures
  Apron
  Athletic field
  Beacon
  Boardwalk
  Breakwater/Jetty
  Bridge
  Building
  Cableway
  Chimney
  Cliff dwelling
  Conveyor
  Dam/Weir
  Dish
  Draw span
  Drilling platform
  Drive-in theater screen
  Drydock
  Fish ladder
  Flume
  Gaging station
  Gate
  Grave
  Helipad
  Historical marker
  Kiln
  Launch pad
  Launching ramp
  Lock
  Masonry shore
  Mine entrance
  Penstock
  Pier/Wharf
  Point monument
  Post
  Prospect
  Pump
  Racetrack
  Recreational slide
  Reservoir
  Runway
  Siphon
  Ski jump
  Spillway
  Tank

View	Subview 1	Subview 2	Subview 3
Cover	Built-up land	Structures (continued)	

Structures (continued)
  Taxiway
  Tower
  Tunnel
  Tunnel entrance
  Turntable
  Wall
  Water intake/outflow
  Well
  Windmill
  Wreck
Complex

Agricultural
  Fish hatchery
  Holding pen
  Marine activity
    site
Commercial
  Shopping center
Entertainment/
  Recreational/
  Memorial
  Archeological
    site/Ruins
  Campground
  Cemetery
  Exhibition
    ground
  Marina
  Outdoor theater
  Park
  Sports site
Disposal area
  Disposal site
  Wrecking yard
Extraction area
  Mine
  Well field
High density
  building area
  High density
    building area
Industrial
  Industrial site
  Mineral pile
  Proving ground
  Tank farm
Institutional
  Institutional site
Residential
  Trailer park
Transition area
  Transition area
Transportation
  Aircraft facility
  Interchange
  Launch facility
  Parking site
  Railway yard
  Rest site
  Toll plaza
  Traffic
    inspection
    facility

View	Subview 1	Subview 2	Subview 3
Cover	Built-up land	Complex (continued)	Utility Cable/Pipeline site Dam site Pipeline regulation station Power site Substation

Cultivated cropland
  Cultivated cropland
Vegetation

Grassland
  Grassland
Shrubland
  Shrubland
Forestland
  Tree
  Trees
  Snag/Stump

Water
  Area to be submerged
  Bay/Estuary/Inlet
  Ford
  Gut
  Inundation area
  Lake/Pond
  Rapids
  Sea/Ocean
  Shoreline
  Spring
  Stream/River
  Submerged stream
  Waterfall

Division

Administrative
  Reservation
Boundary
  Boundary line
  Boundary point
  Fence line
  International date line
Census
  Census block
  Census block group
  Census County Division (CCD)/
    Minor Civil Division (MCD)
  Census tract/Block Numbering Area (BNA)
  Metropolitan Statistical Area (MSA)
Hydrologic unit
  Hydrologic unit
Land parcel
  Land parcel
Locale
  Locale
Maritime
  Anchorage
  Hazard zone
  Lane
  Special use zone
Political
  City
  County
  Exclusive Economic Zone (EEZ)

View	Subview 1	Subview 2	Subview 3

Division Political (continued)
            Minor civil unit
            Minor civil subunit
            Nation
            State/Territory
          Survey system
            Baseline
            Georgia Survey District
            Homestead entry
            Land grant
            Principal meridian
            Public survey area
            Survey corner
            Survey point

Ecosystem
  Desert
  Tundra
  Wetland

Geoposition
  Contour (bathymetric)
  Contour (land)
  Control station
  Mile marker
  Spot elevation

Morphology
  Arch
  Bar
  Basin
  Beach
  Bend
  Cape
  Cave
  Cave entrance
  Cliff
  Crevasse
  Disturbed surface
  Dunes
  Embankment
  Fault
  Flat
  Foreshore
  Fumarole
  Gap
  Geyser
  Iceberg
  Iceberg tongue
  Incline/Flow
  Island
  Isthmus
  Moraine
  Mount
  Pinnacle
  Plain
  Range
  Reef
  Ridge
  Ridge line
  Rock
  Sastrugi
  Sink
  Summit
  Terrace

View	Subview 1	Subview 2	Subview 3

Morphology (continued)
  Trench
  Valley
  Wash

4. ALPHABETIC LIST OF FEATURES

5. DLG-E FEATURE DOMAIN

In this section, features are listed alphabetically under each view and subview 1, 2, and 3 headings.

A definition is listed for each feature. Definitions for view and subview headings may be found on pages 10-13 of the main text of this circular.

For each feature, all attributes with their associated attribute values are listed. For example: Barren land

    Attributes: Earth composition   Values: Gravel
                                                       Rock
                                                         Salt
                                                          Sand
                                                          Shell
                                                          Silt
                                                          Unspecified

Attributes of attribute values are also possible. Using "barren land" as an example, "rock type" is an attribute of the attribute value "rock" under the attribute "earth composition." This means that the attribute "rock type" applies only to the value "rock" under the attribute "earth composition."

    Attribute: Earth composition

        Value: Gravel
                  Rock---------------->Attribute: Rock type
                  Salt   Values: Coral
                  Sand   Lava
                  Shell   Unspecified
                  Silt   Unknown
                  Unspecified

View: Cover   Subview 1:   Barren land

Barren land   Places composed of bare rock, sand, silt, gravel, or other earthen
                                                     material with little or no vegetation and having limited ability to support
                                                     life.

          Earth composition
               Gravel
               Rock-------------->Rock type
               Salt   Coral
               Sand   Lava
               Shell   Unspecified
               Silt   Unknown
               Unspecified

Firebreak   An area cleared of vegetation for the purpose of impeding the progress of a
                                                     grass or forest fire.

Ice mass   A field of ice, formed in regions of perennial frost.

          Ice mass type
               Alpine glacier
               Continental
                    glacier-------->Continental glaciation type
               Pack ice
               Snowfield
               Inland ice sheet
               Ice shelf

          Name
               (Character identifier)
               Not applicable
               Unknown

Mud pot   A pool of mud from which gas or vapors issue.

View: Cover   Subview 1:   Built-up land   Subview 2:   Network

Aqueduct   A structure designed to transport water from a remote source, usually by
                                                     gravity.

          Directional status
               One way
               Unknown
               Unspecified

          Name
               (Character identifier)
               Not applicable
               Unknown

          Operational status
               Abandoned
               Operational
               Under construction
               Unknown

Canal/Ditch   An artificial waterway with no flow or a controlled flow used for naviga-
                                                     tion (canal), or for draining or irrigating land (ditch).

          Canal/Ditch category
               Canal
               Ditch
               Unspecified

Canal/Ditch (continued)

   Directional status
    One way
    Unknown
    Unspecified

   Hydrographic category
    Intermittent
    Perennial
    Unknown

   Name
    (Character identifier)
    Not applicable
    Unknown

   Operational status
    Abandoned
    Operational
    Proposed
    Under construction
    Unknown

Cul de sac   The round or circular section of the end of a dead-end street.

   Name
    (Character identifier)
    Not applicable
    Unknown

Pipeline   A tubular conduit of substantial length, with pumps, valves, and control devices, for conveying fluids, gases, or finely divided solids.

   Name
    (Character identifier)
    Not applicable
    Unknown

   Operational status
    Abandoned
    Operational
    Proposed
    Under construction
    Unknown

   Product
    Coal
    Sewage
    Water
    Unspecified
    Unknown

   Relationship to surface
    Elevated above surface
    Submerged below water surface
    Under ground surface

Railway   A rail or set of parallel rails on which a train or trolley runs.

   Number of lanes or tracks
    (Integer value)
    Unspecified
    Unknown

Railway (continued)

Operational status
Abandoned
Dismantled (Old railroad grade)
Operational
Under construction
Unknown

Railway category
General case
Inclined railway--->Inclined railway type
Cable
Cog
Unspecified
Logging
Rapid transit (includes carline)
Unknown

Railway gauge
Narrow
Standard
Monorail
Unknown

Railway type
Mainline
Siding

Road   An open way for passage of vehicles.

Access restrictions
None
Private
Restricted
Toll
Unknown

Directional status
Alternating
Bidirectional
One way
Unspecified
Unknown

Median category
With median
Without median

Name
(Character identifier)
Not applicable
Unknown

Number of lanes or tracks
(Integer value)
Unspecified
Unknown

Operational status
Abandoned
Operational
Proposed
Under construction
Unknown

Road (continued)

    Road class
        1st
        2nd
        3rd
        4th
        5th (4-wheel drive)
        Unknown

    Road type
        General case
        Overlook
        Ramp
        Rest area
        Runaway truck ramp
        Traffic circle
        Unknown

    Route designator
        (Alphanumeric identifier)------->Route type
        Unspecified
        Unknown   Alternate
                          Business
                          Bypass
                          Connector
                          Loop
                          Spur
                          Truck
                          Unspecified

    Width (meters)
        (Integer value)
        Unspecified

Trail   A cleared path, beaten track, or improved surface, as through woods or wilderness, not usually trafficked by vehicles because of width, seasonal conditions, or access restrictions.

    Access restrictions
        None
        Private
        Restricted
        Unknown

    Directional status
        Alternating
        Bidirectional
        One way
        Unspecified
        Unknown

    Historical significance
        Not significant
        Significant
        Unknown

    Name
        (Character identifier)
        Not applicable
        Unknown

Trail (continued)

        Trail type
            Bicycle
            Bridle
            Marked
            Pack
            Pedestrian
            Portage
            Ski
            Snowmobile
            Winter
            Unknown
            Not applicable

Transmission line   A system of wires that transmit electrical signals or electricity over distance.

        Operational status
            Operational
            Under construction
            Unknown

        Relationship to surface
            Elevated above surface
            Submerged below water surface
            Under ground surface

        Transmission Use
            Power
            Telegraph
            Telephone
            Unknown

View: Cover   Subview 1:   Built-up land   Subview 2:   Structure

Apron   A defined paved area at an aircraft facility intended for aircraft parking.

Athletic field   A defined but often unbounded open area constructed and maintained for the purpose of holding sporting events and activities.

        Athletic field type
            Archery range
            Ball
            Equestrian
            Pistol range
            Polo
            Rifle range
            Unspecified

        Name
            (Character identifier)
            Not applicable
            Unknown

Beacon   A visual, audible, or electronic signal for the guidance of marine or air navigation.

        Name
            (Character identifier)
            Not applicable
            Unknown

Beacon (continued)

        Navigation type
            Aeronautical---------- |
            Nautical |--> Text
            Unknown | (Character identifier)
            Unspecified----------- | Not applicable

        Operational status
            Abandoned
            Operational
            Unknown

        Signaling method
            Daybeacon
            Lighted---------->Lighthouse presence
            Radio
            Unspecified   With lighthouse
            Unknown   Without lighthouse

Boardwalk   A promenade, especially of planks, along a beach or waterfront.

        Name
            (Character identifier)
            Not applicable
            Unknown

Breakwater/Jetty   Structure built to break the force of waves or to restrain or di‾ect current
                                 so as to protect a beach, harbor, or other waterfront facility.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
             Operational
            Ruined
            Unknown

        Relationship to surface
            Exposed at surface
            Submerged below water surface

Bridge   A structure erected over a depression or obstacle to carry traffic.

        Covering
            Covered
            Not covered

        Name
            (Character identifier)
            Not applicable
            Unknown

        Number of decks
            (Integer value)
            Not applicable
            Unspecified
            Unknown

Bridge (continued)

        Operational status
            Abandoned
            Dismantled
            Operational
            Proposed
            Under construction
            Unknown

Building   A permanent construction that is roofed and usually walled.

        Angle of orientation
            0...89 degrees
            Not applicable

        Building class
            Class 1--------------------|-->Text
            Class 2--------------------| (Character identifier)
                                    Not applicable

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Ruined
            Unknown

Cableway   A conveyor system in which carrier units run on wire cables strung between supports.

        Cableway type
            Logging
            Ski lift
            Ski tow
            Tramway
            Unknown

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Dismantled
            Operational
            Unknown

Chimney   A structure containing a passage or flue for discharging smoke or gases, or for burning waste gases.

        Chimney type
            Flare pipe
            Stack
            Unknown

Cliff dwelling   A habitat built in the recesses of high vertical or overhanging faces of rock. (Geological Survey shows only those sites protected by Federal or State authorizations.)

        Angle of orientation
            0...359 degrees

Cliff Dwelling (continued)

        Name
            (Character identifier)
            Not applicable
            Unknown

Conveyor   Any permanent mechanism, such as a continuous moving belt, that transports bulk materials or packages from one place to another.

Dam/Weir   A barrier constructed to control the flow or raise the level of water.

        Material composition
            Earthen
            Masonry
            Unspecified

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Operational
            Proposed
            Under construction
            Unknown

        Spillway elevation   (Used when spillway not explicitly mapped)
            (nearest 0.1 meter)
            (Numeric value) ------>Vertical datum category
                        Guam Mean Sea Level Datum of 1963
                        Mean sea level (local)
                        National Geodetic Vertical Datum of 1929
                        North American Vertical Datum of 1988
                        Not applicable

Dish   A concave object used for transmitting or receiving electronic signals.

Draw span   The movable portion of a bridge deck.

Drilling platform   A raised structure located in a sea equipped for the extraction of petroleum products.

        Product
            Gas
            Oil
            Unknown

        Relationship to surface
            Exposed at surface
            Submerged below water surface

Drive-in theater screen   The large, flat, white or silver surface (and supporting structure) upon which a picture is projected for viewing.

Drydock   An artificial basin fitted with a gate or caisson into which a vessel may be floated and from which water may be pumped out to expose the bottom of the vessel.

        Flotation
            Floating
            Not floating

Fish ladder

A facility consisting of a series of small pools, each one slightly higher than the preceding, built around a dam to enable fish to make their way upstream.

    Directional status
        One way
        Unspecified
        Unknown

Flume

An open, inclined, artificial channel constructed of wood, metal, or concrete generally elevated and V-shaped that carries liquid for a special purpose.

    Directional status
        One way
        Unspecified
        Unknown

    Operational status
        Abandoned
        Operational
        Under construction
        Unknown

    Product
        Coal
        Logs
        Oil
        Water
        Unspecified
        Unknown

Gaging station

A structure used to measure the condition of a hydrographic feature.

    Gage type
        Tidal
        Unspecified

Gate

A structure that may be swung, drawn, or lowered to block an entrance or passageway.

    Gate type
        Check-------- |--->Text
        Flood | (Character identifier)
        Head | Not applicable
        Road---------------->Access restrictions
        Sluice | Private
        Tidal | Toll
        Unspecified | Not applicable

Grave

A place of burial for one person.

Helipad

A structure used for the landing and takeoff of helicopters.

    Name
        (Character identifier)
        Not applicable
        Unknown

    Operational status
        Abandoned
        Operational
        Under construction
        Unknown

    Surface condition
        Hard/Paved
        Not paved
        Unknown

Historical marker   A structure, not a building, that commemorates people or past events.

    Name
        (Character identifier)
        Not applicable
        Unknown

Kiln   Any of various ovens for hardening, burning, or drying substances.

    Product
        Brick
        Charcoal
        Coke
        Unknown

Launch pad   A structure from which a rocket or missile is launched.

    Name
        (Character identifier)
        Not applicable
        Unknown

    Operational status
        Abandoned
        Operational
        Under construction
        Unknown

Launching ramp   A partially submerged hard surface on a shoreline for launching or retrieving vessels or aircraft.

    Ramp type
        Boat
        Seaplane

Lock   An enclosure used to raise or lower vessels as they pass from one level to another.

    Name
        (Character identifier)
        Not applicable
        Unknown

Masonry shore   A structure built of stone, brick, or concrete that borders a body of water.

Mine entrance   Passage that affords entry to an underground mine.

    Angle of orientation
        0...359 degrees

    Mine entrance type
        Adit
        Shaft

    Name
        (Character identifier)
        Not applicable
        Unknown

    Operational status
        Abandoned
        Operational
        Unknown

Penstock   A closed pipe or channel used to convey water into the turbine of a hydroelectric generating plant.

Penstock (continued)

    Directional status
        One way
        Unspecified
        Unknown

    Operational status
        Abandoned
        Operational
        Under construction
        Unknown

Pier/Wharf   Structures to which vessels may be berthed:
                                          Pier: long narrow structure extending into the water
                                          Wharf: parallel to the shoreline and accommodates ships on one side only

    Name
        (Character identifier)
        Not applicable
        Unknown

    Operational status
        Operational
        Ruined
        Unknown

    Relationship to surface
        Exposed at surface
        Submerged below water surface

Point monument   A structure noting a spot on a boundary or survey line.

Post   An upright piece of timber or other material, in or adjacent to a body of water, used for mooring ships or supporting other structures.

    Post type
        Dolphin
        Piling

Prospect   A marked location where mineral exploration has occurred but no mine has been developed.

    Name
        (Character identifier)
        Not applicable
        Unknown

Pump   A device that raises, transfers, or compresses fluids or that attenuates gases especially by suction or pressure.

Racetrack   A course laid out for racing.

    Name
        (Character identifier)
        Not applicable
        Unknown

    Track condition/use
        Hard/Paved-Vehicle
        Improved/Loose-Vehicle/Animal
        Improved-Pedestrian
        Improved/Rough-Vehicle
        Unknown

Recreational slide   An amusement structure consisting of a smooth, usually inclined surface or track for sliding.

Reservoir   A constructed basin formed for recreation use, storage, treatment, collection,
                                            or processing of water or other liquids.

        Covering
            Covered
            Not covered

        Elevation (nearest 0.1 meter)
            (Numeric value)-->Vertical datum category
                                    Guam Mean Sea Level Datum of 1963
                                    Mean sea level (local)
                                    National Geodetic Vertical Datum of 1929
                                    North American Vertical Datum of 1988
            Unspecified
            Unknown

        Hydrographic category
            Intermittent
            Perennial
            Not applicable
            Unknown

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

        Reservoir use
            Clarification
            Cooling
            Debris basin
            Evaporator------------->Product
            Filtration bed   Salt
            Fish hatchery   Soda
            Fishpond   Unknown
            Guzzler
            Industrial processing
            Industrial waste
            Percolation basin (spreading ground)
            Purification
            Retardation basin
            Settling basin
            Sewage disposal
            Storage---------------->Liquid contained
                                           Oil
                                           Water
            Sump------------------->Liquid contained
                                           Oil
                                           Water
            Swimming
            Unknown

Runway   A straight path used for landing and takeoff of aircraft.

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

Runway (continued)

    Surface condition
        Hard/Paved
        Not paved
        Unknown

Siphon   A pipe conveying water by gravitational force to a lower level, over an obstruction higher than the intake.

    Operational status
        Abandoned
        Operational
        Under construction
        Unknown

    Directional status
        One way
        Unspecified
        Unknown

Ski jump   An inclined structure consisting of a track from which skiers vault.

Spillway   A passage for surplus water to run over or around a dam.

    Elevation (nearest 0.1 meter)
        (Numeric value)-->Vertical datum category
                        Guam Mean Sea Level Datum of 1963
                        Mean sea level (local)
                        National Geodetic Vertical Datum of 1929
                        North American Vertical Datum of 1988
                        Unspecified

Tank   A large container used for storage.

    Name
        (Character identifier)
        Not applicable
        Unknown

    Tank type
        Cistern
        General case--------->Product
                        Chemical
                        Fuel
                        Gas
                        Gasoline
                        Molasses
                        Oil
                        Oxygen
                        Water
                        Unspecified
            Silo------------------>Product
                        Grain
                        Unknown
                        Unspecified
            Storage bin----------->Product
                        Grain
                        Unknown
                        Unspecified
        Surge

Taxiway   An improved area providing access to/from runways and the apron.

Tower   A structure designed primarily with a view to elevation, typically higher than wide.

Tower (continued)

        Height above surface level (meters)
           (Numeric value)
           Unspecified
           Unknown

        Name
           (Character identifier)
           Not applicable
           Unknown

        Operational status
           Abandoned
           Operational
           Unknown

        Tower function
           Control
           Cooling
           Electronic----->Electronic signal
                        Microwave
                        Radar
                        Radio-------------- |-->Call letters
                        Television----------| (Alpha identifier--3-4 characters)
                        Unspecified--------| Unspecified
                        Unknown----------|

           Observation---->Observation type
                        Guard
                        Lookout
                        Mooring
                        Pylon
           Support-------->Support type
                        Water intake tower
                        Water
                        Unknown
                        Unspecified

Tunnel   An underground or underwater passage.

        Name
           (Character identifier)
           Not applicable
           Unknown

        Operational status
           Operational
           Proposed
           Under construction
           Unknown

Tunnel entrance   Opening that affords entry to an underground or underwater passage.

        Angle of orientation
           0...359 degrees

Turntable   A rotating platform with railroad tracks used for turning locomotives or cars.

        Operational status
           Abandoned
           Dismantled
           Operational
           Proposed
           Under construction
           Unknown

Wall   An upright structure of masonry, wood, plaster, or other building material
                                        serving to enclose, divide, or protect an area.

     Wall type
          General case
          Sea

Water intake/outflow   A structure through which water enters or exits a conduit.

     Relationship to surface
          Exposed at surface
          Submerged below water surface

     Water intake/outflow type
          Riser---------------->Text
          General case   (Character identifier)
                         Not applicable

Well   A pit or hole dug or bored into the Earth for the extraction of oil, water,
                                        other fluids or gases.

     Name
          (Character identifier)
          Not applicable
          Unknown

     Operational status
          Abandoned
          Drill hole
          Operational
          Unknown

     Product
          Gas
          Heat   (Geothermal)
          Oil
          Water------------->Flow characteristics
          Unspecified   Flowing
          Unknown   Not flowing

                     Hydrographic category
                       Dry
                       Not applicable
                       Perennial

                     Water characteristics
                       Alkaline
                       Hot
                       Mineral
                       Salt
                       Unspecified

Windmill   A mill or other machine that runs on the energy generated by a wheel of
                                        adjustable blades or flats rotated by the wind.

     Name
          (Character identifier)
          Not applicable
          Unknown

     Windmill function
          Pump
          Generator

Wreck   The hulk or the ruins of a disabled vessel which is attached to or foul of
                                        the bottom or cast up on the shore.

Wreck (continued)

>   Name
>   (Character identifier)
>   Not applicable
>   Unknown

>   Relationship to surface
>   Exposed at surface-------------->Exposed portion
>   Submerged below water surface
>   Mast and(or) funnel
>   Hull and(or) superstructure

View: Cover   Subview 1:   Built-up land   Subview 2:   Complex   Subview 3:   Agriculture

Fish hatchery   A set of pools of water and related structures used for spawring and growing of fish that are subsequently used to stock lakes and streams.

>   Name
>   (Character identifier)
>   Not applicable
>   Unknown

Holding pen   An enclosed area in which livestock are temporarily kept.

>   Holding pen type
>   Corral
>   Feedlot
>   Stockyard

Marine activity site   A group of associated structures functioning as a unit used for fishing, aquaculture, or related activities.

View: Cover   Subview 1:   Built-up land   Subview 2:   Complex   Subview 3:   Commercial

Shopping center   A group of structures used for the sale of products and services.

>   Name
>   (Character identifier)
>   Not applicable
>   Unknown

View: Cover   Subview 1:   Built-up land   Subview 2:   Complex   Subview 3:   Entertainment/Recreational/Memorial

Archeological site/Ruins   An area of historical significance containing the deteriorated remains of a structure(s) or where past human life and activities are under study.

>   Archeological site/Ruins type
>   Archeological site
>   Pictograph
>   Ruins
>   Unspecified

>   Name
>   (Character identifier)
>   Not applicable
>   Unknown

Campground   A designated area on which primitive structure(s) are erected for temporary shelter or where recreational vehicles are temporarily parked.

>   Campsite type
>   Campground (includes campsite)
>   Recreational vehicle
>   Unspecified

Campground (continued)

        Name
           (Character identifier)
           Not applicable
           Unknown

Cemetery   An area of land for burying the dead with two or more graves.

        Name
           (Character identifier)
           Not applicable
           Unknown

Exhibition ground   A public area where outdoor fairs, circuses, and other events are held that also contains structures for the display of livestock, machinery, agricultural produce, etc.

        Name
           (Character identifier)
           Not applicable
           Unknown

Marina   A harbor facility for recreational craft where supplies, repairs, and various services are available.

        Name
           (Character identifier)
           Not applicable
           Unknown

Outdoor theater   An outdoor area consisting of a stage or other focal point, and an area where the audience can be seated to view the performance or event.

        Outdoor theater type
           Amphitheater
           Aqua
           Drive-in

        Name
           (Character identifier)
           Not applicable
           Unknown

Park   A place or area developed for public use or recreation.

        Park type
           Amusement
           Botanical
           Parade ground
           Picnic area
           Playground
           Zoo
           Unspecified

        Name
           (Character identifier)
           Not applicable
           Unknown

Sports site   A field, center, or open area maintained for the purpose of holding sporting events and activities.

Sports site (continued)

Sports site type
        Golf course----------
        Gun club |
        Raceway |
        Rodeo grounds |-->Text
        Ski area | (Character identifier)
        Stadium | Not applicable
        Tennis center-------

Name
        (Character identifier)
        Not applicable
        Unknown

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Disposal

Disposal site   An area where refuse is dumped.

Discarded substance
        Dredged material   (Spoil bank)
        Garbage   (Dump, landfill)
        Slag pile
        Tailings
        Waste rock   (Mine dump)
        Unspecified
        Unknown

Operational status
        Abandoned
        Operational
        Under construction
        Unknown

Wrecking yard   An area or site engaged in the wrecking and reclamatio⌐ of discarded
                                                products.

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Extraction

Mine   An excavation in the Earth for the purpose of extractinℊ Earth materials.

Mine type
        Auger borings   Associated with linear strip mining, a method of extract⁼ng minerals by
                             boring horizontally into a seam.
        Open pit   Removal of large deposits of mineral ores.
        Pit   Removal of unconsolidated materials.
        Placer   Surficial mining of alluvial or glacial deposits containin⌐ valuable
                             minerals.
        Quarry   Excavations in solid rock where building stone, limestor⌐, etc., is
                             removed.
        Strip   Excavations where overburden is removed to extract minerals (coal),
                             leaving waste material piled at random.

Name
        (Character identifier)
        Not applicable
        Unknown

Operational status
        Abandoned
        Operational
        Reclaimed
        Unknown

Mine (continued)

        Product
            Bentonite
            Caliche
            Chert
            Cinders
            Clay
            Coal
            Copper
            Gold
            Gravel
            Pumice
            Salt
            Sand
            Scoria
            Shale
            Silver
            Soil
            Uranium
            Unspecified
            Unknown

Well field   An area where petroleum and(or) natural gas is or was removed from the Earth.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Unknown

        Product
            Gas
            Oil
            Unspecified
            Unknown

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: High Density Building Area

High density building area   A congested, built-up area.

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Industrial

Industrial site   A group of associated structures functioning as a unit used for refining a material or manufacturing a product.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

Industrial site (continued)

        Industrial plant type
            Ammunition
            Cannery
            Cement
            Filtration (includes waterworks)
            Refinery
            Sawmill
            Sewage disposal
            Unspecified

Mineral pile   A manmade heap of products resulting from mines.

Proving ground   An area set aside for scientific testing.

        Name
            (Character identifier)
            Not applicable
            Unknown

Tank farm   A set of tanks and related structures used for the storage of liquids and(or) gases.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Product
            Gas
            Oil
            Unspecified

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Institutional

Institutional site   A group of buildings or associated structures functioning as a unit used predominantly for educational, correctional, governmental, medical, or religious purposes.

        Institutional function
            Civil government---|
            Correctional |
            Education/Research |
            Historical |
            Medical |
            Military |--> Text
            Orphanage | (Character identifier)
            Religious | Not applicable
            Unspecified |
            Unknown------------|

        Name
            (Character identifier)
            Not applicable
            Unknown

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Residential

Trailer park   An area maintained for the parking of inhabited mobile homes.

        Name
            (Character identifier)
            Not applicable
            Unknown

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Transition

Transition area

Area in transition from one land use activity to another, and characterized by a lack of information to predict future use or discern past use.

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Transportation

Aircraft facility

An area where aircraft can take off and land, usually equipped with associated buildings and facilities.

Aircraft facility type
Airport
Heliport
Seaplane base

Facility used primarily by conventional, fixed-wing aircraft.
Facility used primarily by rotary-wing aircraft.
Facility used primarily where water is the landing surface.

Name
(Character identifier)
Not applicable
Unknown

Operational status
Abandoned
Operational
Under construction
Unknown

Interchange

An area designated to provide traffic access from one road to another.

Interchange designator
(Alphanumeric identifier)
Not applicable
Unknown

Name
(Character identifier)
Not applicable
Unknown

Launch facility

An area from which rockets/missiles may be housed and projected, usually equipped with associated buildings and facilities.

Name
(Character identifier)
Not applicable
Unknown

Operational status
Abandoned
Operational
Under construction
Unknown

Parking site

A designated area where motor vehicles are set and left temporarily.

Railway yard

An area provided with a system of tracks and associated structures where railway trains are assembled and railway cars are switched, stored, or serviced.

Name
(Character identifier)
Not applicable
Unknown

Railway yard (continued)

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

Rest site   A roadside area usually having facilities for people and(or) vehicles.

        Name
            (Character identifier)
            Not applicable
            Unknown

Toll plaza   An open area having the facility to collect tolls.

Traffic inspection facility   An open area having facilities to examine vehicles and(or) their cargo.

        Traffic inspection facility type
            Agricultural
            Customs
            Weigh

View: Cover   Subview 1: Built-up land   Subview 2: Complex   Subview 3: Utility

Cable/Pipeline site   An area where cables or pipelines are located under water.

Dam site   An area including a dam and associated structures functioning to control the flow or raise the level of water.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

Pipeline regulation station   An ancillary facility along a pipeline route in which the flow of fluids or gases is controlled.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

        Pipeline regulation station type
            Compressor
            Pumping
            Valve

Power site   A group of associated structures functioning as a unit used for generating electricity.

Power site (continued)

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
            Abandoned
            Operational
            Under construction
            Unknown

        Power generation method
            Nuclear
            Solar
            Unknown
            Unspecified

Substation   An ancillary facility along a powerline route in which electric current is transformed.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Operational status
             Abandoned
            Operational
            Under construction
            Unknown

View: Cover   Subview 1: Cultivated cropland

Cultivated cropland   Land that has been plowed or otherwise cultivated for crop production.

        Cultivated cropland type
            Nursery
            Orchard
            Vineyard
            Unspecified
            Unknown

        Vegetation type
            Cranberry
            Rice
            Unspecified
            Unknown

View: Cover   Subview 1: Vegetation   Subview 2: Grassland

Grassland   An extensive noncultivated area where vegetation is dominated by grasses or grass-like plants.

View: Cover   Subview 1: Vegetation   Subview 2: Shrubland

Shrubland   Areas covered with low-growing or stunted perennial vegetation and usually not mixed with trees.

View: Cover   Subview 1: Vegetation   Subview 2: Forestland

Tree   Woody perennial plants having a self-supporting main stem or trunk and a definite crown. (Used for individual trees having historical or cultural significance.)

     Name
         (Character identifier)
         Not applicable
         Unknown

Trees   An extensive area of land covered with woody perennial plants having a self-supporting main stem or trunk and a definite crown.

     Tree category
         Deciduous
         Evergreen

     Vegetation characteristics
         Mangrove
         Unspecified

Snag/Stump   A firmly attached stem or trunk of a tree near the surface of water.
     Relationship to surface
         Exposed at surface
         Submerged below water surface

View: Cover   Subview 1: Water

Area to be Submerged   The known limits of the intended lake that will be created behind a dam under construction.

     Elevation (nearest 0.1 meter)
         (Numeric value)-->Vertical datum category
                  Guam Mean Sea Level Datum of 1963
                  Mean sea level (local)
                  National Geodetic Vertical Datum of 1929
                  North American Vertical Datum of 1988
         Unspecified
         Unknown

     Name
         (Character identifier)
         Not applicable
         Unknown

Bay/Estuary/Inlet   A water area that is an inlet of the sea/ocean.

     Name
         (Character identifier)
         Not applicable
         Unknown

Ford   Location in a body of water where the physical characteristics of the bottom, water depth, and approaches permit the passage of vehicles.

     Name
         (Character identifier)
         Not applicable
         Unknown

Gut   A narrow natural passage or contracted strait connecting two bodies of water where no flow can be determined.

Gut (continued)

        Name
            (Character identifier)
            Not applicable
            Unknown

Inundation area   An area of land subject to flooding.

        Inundation control
            Controlled------->Inundation area use
                            Dewatering area
                            Duck pond
            Not controlled

Lake/Pond   A standing body of water surrounded by land.

        Elevation (nearest 0.1 meter)
            (Numeric value)-->Vertical datum category
                        Guam Mean Sea Level Datum of 1963
                        Mean sea level (local)
                        National Geodetic Vertical Datum of 1929
                        North American Vertical Datum of 1988
                -->Stage
                        Average water elevation
                        High water elevation
                        Normal pool elevation
             Unspecified
            Unknown

        Hydrographic category
            Intermittent
            Perennial
            Unknown

        Name
            (Character identifier)
            Not applicable
            Unknown

        Water characteristic
            Fresh
            Salt

Rapids   An area of swift current in a stream or river, characterized by standing waves or by boulders and rocks.

        Directional status
            One way
            Unknown
            Unspecified

        Name
            (Character identifier)
            Not applicable
            Unknown

Sea/Ocean   The great body of salt water of the oceans.

        Name
            (Character identifier)
            Not applicable
            Unknown

        Sea/Ocean type
            Reef pool
            Unspecified

Shoreline   A naturally occurring line of contact between a body of water and the
                                               land.

        Delineation status
            Apparent
            Definite
            Indefinite/
                Approximate
            Unsurveyed

Spring   A place where water issues from the ground naturally.

        Angle of orientation
            0...359 degrees

        Name
            (Character identifier)
            Not applicable
            Unknown

        Water characteristics
            Alkaline
            Hot
            Mineral
            Sulfur
            Unspecified

Stream/River   A body of flowing water.

            Delineation status
        Definite
        Unsurveyed

        Elevation (nearest 0.1 meter)
            (Numeric value)-->Vertical datum category
                        Guam Mean Sea Level Datum of 1963
                        Mean sea level (local)
                        National Geodetic Vertical Datum of 1929
                        North American Vertical Datum of 1988
                    -->Stage
                        Normal pool elevation
            Unspecified
            Unknown

        Directional status
            One way
            Unknown
            Unspecified

        Hydrographic category
            Intermittent
            Perennial
            Unknown

        Hydrographic form
            Braided
            Not braided

        Name
            (Character identifier)
            Not applicable
            Unknown

Submerged stream   An old river course inundated by an impounded water area.

Submerged stream (continued)

    Name
        (Character identifier)
        Not applicable
        Unknown

Waterfall   A vertical or nearly vertical descent of water over a step or ledge in the bed of a river.

    Name
        (Character identifier)
        Not applicable
        Unknown

View: Division   Subview 1: Administrative

Reservation   Bounded land set aside for a particular purpose generally having certain use restrictions.

    Name
        (Character identifier)
        Not applicable
        Unknown

    Reservation class
        Forest---------------- |
        General case |
        Grassland |
        Indian land |
        Military |-->Text
        Park | (Character identifier)
        Prison | Not applicable
        Wilderness |
        Wildlife |
        Unknown------------|

    Reservation use status
        National
        State
        Regional
        County
        Minor civil unit
        City
        Private
        Unknown

View: Division   Subview 1: Boundary

Boundary Line   A separation between divisions of current or past significance.

    Delineation status
        Definite
        Disputed
        Historical
        Indefinite/Approximate
        Proposed-------------|--->Text
        Protracted------------| (Character identifier)
        Unknown   Not applicable

    Name
        (Character identifier)
        Not applicable
        Unknown

Boundary point	An identified location on a boundary.
Boundary point identifier (Alphanumeric identifier) Not applicable Unknown	
Fence line	An identifiable fence or field line visible on an aerial photograph.
International Date Line	A line generally coinciding with the 180th meridian, modified to avoid land, and designated as the place where each calendar day begins.

View: Division   Subview 1: Census

Census block	The primary statistical unit for which census information is collected and published.
Census block number (Alphanumeric value)	
Census block group	An aggregate of census blocks for which statistical information is published.
Census block group number (Integer value - 1-9)	
Census County Division (CCD)/ Minor Civil Division (MCD)	Subcounty aggregates of census tracts and Block Numbering Areas (BNA's) for which statistical information is published. CCD's are established in areas where MCD's do not exist.
CCD/MCD number (Integer value - 001-999)	
Census tract/Block Numbering Area (BNA)	Aggregates of census block groups for which statistical information is published. Tracts occur in MSA's and potential MSA's, and BNA's occur outside MSA's.
Census tract/BNA Number (Numeric value - 0001.01-9989.99)	
Metropolitan Statistical Area (MSA)	An area with a population greater than 50,000.
MSA type Part MSA (PMSA) Consolidated MSA (CMSA) General case	
MSA FIPS code (Integer value - 0001-9999)	

View: Division   Subview 1: Hydrologic unit

Hydrologic Unit	Subdivisions used for the collection and organization of data dealing with the properties, distribution, and circulation of water. These codes provide a standardized base for use by water resources organizations in the storage, retrieval, and exchange of hydrologic data; the indexing and inventorying of hydrologic data and information; the cataloging of water data acquisition activities; and a variety of other applications.
Region unit code (Integer value - 01...21)	
Subregion unit code (Integer value - 01...99) Not applicable	

Hydrologic unit (continued)

        Accounting unit code
           (Integer value - 00...99)
           Not applicable

        Cataloging unit code
           (Integer value - 00...99)
           Not applicable

        Name
           (Character identifier)
           Unknown

View: Division   Subview 1: Land parcel

Land parcel   A tract or plot of the Earth's surface distinguishable by ownership.

        Ownership
           National---------->Owning agency
           State   Agricultural Research Service
                           Air Force
                           Army
                           Army (Corps of Engineers -
                               Civil Works)
                           Bonneville Power Administration
                           Bureau of Indian Affairs
                           Bureau of Land Management
                           Bureau of Mines
                           Bureau of Prisons
                           Bureau of Reclamation
                           Energy Research and Development
                               Administration
                           Federal Aviation Administration
                           Federal Railroad Administration
                           Fish and Wildlife Service
                           Forest Service
                           General Services Administration
                           International Boundary and Water
                               Commission, United States
                               and Mexico
                           National Aeronautics and Space
                               Administration
                           National Oceanic and Atmospheric
                               Administration
                           National Park Service
                           Navy
                           Tennessee Valley Authority
                           U.S. Coast Guard
                           Veterans' Administration

View: Division   Subview 1: Locale

Locale   A named place not otherwise categorized.

        Name
           (Character identifier)
           Unknown

View: Division   Subview 1: Maritime

Anchorage   An area where a vessel anchors or may anchor, either because of suitability or designation.

Anchorage (continued)

        Anchorage type
            Explosives isolation
            General case
            Seaplane

        Name
            (Character identifier)
            Not applicable
            Unknown

Hazard zone   An area identified as a danger to maritime navigation.

        Hazard zone type
            Crib
            Foul ground
            Mine danger area
            Piling
            Platform
            Reef
            Rock
            Snag/Stump
            Unknown
            Unspecified
            Well
            Wreckage

Lane   A prescribed course for ships, boats, or seaplanes.

        Lane type
            Airboat trail
            Dredged channel
            Ferry crossing
            Seaplane landing/takeoff
            Shipping

        Name
            (Character identifier)
            Not applicable
            Unknown

Special use zone   An area where distinctive types of shipping activities occur.

        Special use activity
            Dumping ground for hazardous material
            Spoil area

View: Division   Subview 1: Political

City   An incorporated populated place such as a village, city, town, borough, or hamlet, and includes an independent city.

        Name
            (Character identifier)

County   Second-order division of a nation such as parish, borough, county, municipio, or judicial division, and independent cities in Maryland, Missouri, Nevada, and Virginia.

        FIPS code identifier-2nd
            (Integer value - 001...999)

        Name
            (Character identifier)

Exclusive Economic Zone (EEZ)   A zone contiguous to the territorial sea, including zones contiguous to the territorial sea of the United States, Puerto Rico, the Northern Mariana Islands, and U.S. overseas territories and possessions. The EEZ extends to a distance 200 nautical miles from the baseline from which the breadth of the territorial sea is measured. In cases where the maritime boundary with a neighboring state remains to be determined, the boundary of the EEZ shall be determined by the U.S. and other states concerned in accordance with equitable principles.

Minor civil unit   Third-order division of a nation such as township, town, district, precinct, and barrio.

    FIPS code identifier-3rd
        (Integer value - 0001...9999)
        Not applicable

    Name
        (Character identifier)

Minor civil subunit   Fourth-order division of a nation such as Hawaiian ahupuaas.

    Name
        (Character identifier)

Nation   An area under the jurisdiction of a sovereign government.

    Name
        (Character identifier)

State/Territory   First-order division of a nation.

    FIPS code identifier-1st
        (Integer value - 01...99)

    Name
        (Character identifier)

View: Division   Subview 1: Survey system

Baseline   The line extending east and west from the initial point of a Public Land Survey System (PLSS) survey. Townships will be north or south of the baseline.

    Name
        (Character identifier)

Georgia Survey District   Public lands surveyed by the State of Georgia from 1805-1832. The land was divided by county into districts and lots. The State contains 389 districts, and each district can have over 1,000 lots. The lots were sized according to their perceived value and range from 40 to 490 acres. Generally these land lines have NOT been shown on 7.5-minute quadrangles except in the Atlanta area.

    District number
        (Integer value - 001...999)

    Lot number
        (Integer value - 0001...9999)

Homestead entry   Title to portions of the public domain was granted to individuals under various homestead acts, based on residence, cultivation, and some improvement to the land over several years. Homestead entries are not normally identified on published maps.

Land grant   Grants established prior to the original subdivisional public surveys.

        Land grant code
            (Integer value - 0001...7302)
            Unknown

        Name
            (Character identifier)
            Unknown

Principal meridian   The line extending north and south from the initial point of a Public Land Survey System (PLSS) survey. Townships will be east or west of the principal meridian.

Public survey area   An area of the public land survey systems established by public, private, or combined surveys.

        Origin of survey name
            (Character identifier)

        Origin of survey number
            (Integer value - 01...48)

        Public survey area type
            General case
            Donation land claim

        Range number
            (Numeric value with 1 alpha character (E/W))

        Section number
            (Alphanumeric value)

        Township number
            (Numeric value with 1 alpha character (N/S))

Survey corner   A public land survey or other land survey corner.

        BLM corner identifier
            (Alphanumeric value)

        Field identification
            Identified
            Not identified
            Unknown

        Name
            (Character identifier)

        Survey corner type
            Arbitrary
            Auxiliary meander
            Closing
            Isolated
            Land grant
            Meander
            Quarter section
            Section
            Tract
            Witness off line
            Witness on line

Survey point   A survey location other than a survey corner.

        Survey point type
            Angle point
            Land grant monument
            Location monument (includes mineral monument)

Survey point (continued)

    Survey point type (continued)
       Reference monument
       Witness point

    Monument number
       (Integer value)
       Not applicable

View: Ecosystem

Desert   A region rendered barren or partially barren by environmental extremes, especially by low rainfall.

    Name
       (Character identifier)
       Not applicable
       Unknown

Tundra   A treeless, level, or gently rolling plain characteristic of arctic or subarctic regions, having a permanently frozen subsoil, and usually supporting low growing vegetation such as lichens, mosses, and stunted shrubs.

Wetland   A vegetated area that is inundated or saturated by surface or ground water for a significant part of the year. The vegetation is adapted for life in saturated soil conditions.

    Name
       (Character identifier)
       Not applicable
       Unknown

View: Geoposition

Contour (bathymetric)   A line connecting points of equal depth with reference to the sounding datum.

    Contour symbolization category
       Mound
       Not applicable

    Delineation status
       Amended
       Definite
       Indefinite/
          Approximate

    Depth (nearest 0.1 meter)
       (Positive Numeric Value)----->Bathymetric datum
                             Gulf Coast low water
                             Lowest low water
                             Mean low lake level
                             Mean low water
                             Mean lower low water
                             Mean sea level
                             Tropic lower low water
                             Water surface as indicated--->Text
                                                   (Character identifier)
                             Unknown

Contour (land)   A line connecting points of equal elevation with reference to a vertical
                                                  datum.

    Contour symbolization category
       Depression
       Not applicable

    Delineation status
       Amended
       Definite
       Indefinite/
         Approximate

    Elevation (nearest 0.1 meter)
       (Numeric value)-->Vertical datum category
                  Guam Mean Sea Level Datum of 1963
                  Mean sea level (local)
                  National Geodetic Vertical Datum of 1929
                  North American Vertical Datum of 1988

Control station   A point with an accurate position and(or) elevation used as a base for a
                                                  dependent survey.

    Elevation (nearest 0.001 meter)
       (Numeric value)-->Vertical datum category
                  Guam Mean Sea Level Datum of 1963
                  Mean sea level (local)
                  National Geodetic Vertical Datum of 1929
                  North American Vertical Datum of 1988
       Unspecified

    Horizontal control accuracy
       First order
       Not applicable
       Second order-------- |-->Control class
       Third order---------- | Class I
       Third order or better   Class II

    Monument type
       No tablet
       Tablet

    Name
       (Character value)
       Not applicable
       Unknown

    Relationship to surface
       Elevated above surface
       Exposed at surface

    Vertical control accuracy
       First order---------- |
       Not applicable |-->Control class
       Second order-------- | Class I
       Third order   Class II
       Third order or better

Mile marker   A point on a feature indicating the distance, in miles, measured along the
                                                  course or path of the feature, from an established origin point cn the
                                                  feature.

    Mile marker type
       Railroad
       Watercourse

    Mileage number (nearest 0.1 mile)
       (Numeric value)

Spot elevation   A point with a measured vertical position, measured relative to a refer-
                                                        ence datum, of less than third-order accuracy.

        Elevation (nearest 0.1 meter)
            (Numeric value)-->Vertical datum category
                            Guam Mean Sea Level Datum of 1963
                            Mean sea level (local)
                            National Geodetic Vertical Datum of 1929
                            North American Vertical Datum of 1988

        Relationship to surface
            Elevated above surface
            Exposed at surface

View: Morphology

Arch   A naturally occurring curved structure that supports the weight of material
                                                        over space.

        Name
            (Character identifier)

Bar   A natural accumulation of sand, gravel, or other material forming an
                                                        underwater or exposed embankment.

        Bar type
            Offshore
            Point

        Name
            (Character identifier)
            Not applicable

Basin   A bowl-shaped depression in the surface of the land or ocean floor.

        Basin type
            Carolina Bay
            Crater--------------->Crater type
            Unspecified
                            Bomb
                            Meteoric
                            Volcanic

        Name
            (Character identifier)

Beach   The gently sloping shore that is washed by waves, usually composed of
                                                        sand and pebbles.

        Name
            (Character identifier)

Bend   The land within the curve of a stream sometimes including the course of
                                                        the stream.
        Name
            (Character identifier)
Cape   A projection of land extending into a body of water that prominently
                                                        marks a change in or interrupts the coastal trend of that water body.

        Name
            (Character identifier)

Cave   A naturally formed, subterranean open area or chamber.

        Name
            (Character identifier)

Cave entrance   Passage that affords entry to a naturally formed, subterranean open area or chamber.

    Angle of orientation
        0...359 degrees

    Name
        (Character identifier)

Cliff   A high vertical, near-vertical, or overhanging face of rock, earth, or ice.

    Name
        (Character identifier)

Crevasse   A deep fissure in the surface of the Earth caused by breaking or parting.

Disturbed surface   An area that is broken into a chaotic pattern of elevations and depressions.

Dunes   Hills of sand piled up by the wind.

    Name
        (Character identifier)
        Not applicable

    Stability
        Stable
        Shifting

Embankment   A raised, solid-fill linear mound.

    Embankment type
        Levee
        Redoubt

Fault   A fracture in the Earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

    Name
        (Character identifier)
        Not applicable

Flat   A level tract of land.

    Flat type
        Playa
        Tidal

    Name
        (Character identifier)
        Not applicable

Foreshore   The part of a seashore between high-water and low-water marks.

Fumarole   A hole in the Earth's crust from which steam and gases are emitted.

    Name
        (Character identifier)
        Not applicable

Gap   A low point or opening between mounts or in a ridge.

    Name
        (Character identifier)
        Not applicable

Geyser

A natural intermittent fountain of hot water ejected with force into the air from a hole in the Earth's crust.

    Name
        (Character identifier)
        Not applicable
        Unknown

Iceberg

Large mass of floating or stranded ice of greatly varying shape, more than 5 meters above sea level, which has broken away from a glacier.

Iceberg tongue

A major accumulation of icebergs projecting from the coast, held in place by grounding and joined together by fast ice.

Incline/Flow

A feature characterized by a sloping surface or a formation resulting from movement down a sloping surface.

    Name
        (Character identifier)

Island

An area of dry or relatively dry land surrounded by water or low wetland.

    Name
        (Character identifier)
        Not applicable

Isthmus

A narrow strip of land, bordered on both sides by water that connects two larger land areas.

    Name
        (Character identifier)

Moraine

An accumulation of earth and stones carried and deposited by a glacier.

    Name
        (Character identifier)
        Not applicable

Mount

A landmass that projects conspicuously above its surroundings.

    Mount type
        General case
        Hummocked ice
        Ice dome
        Indian mound
        Pingo

    Name
        (Character identifier)

Pinnacle

A vertical, standing, often spire-shaped natural rock formation.

    Name
        (Character identifier)

Plain

A region of general uniform slope, comparatively level and of considerable extent.

    Name
        (Character identifier)

Range

A chain of mounts.

    Name
        (Character identifier)

Reef   A chain of rocks or coral at or near the surface of water.

    Name
        (Character identifier)
        Not applicable

Ridge   A long and narrow upland with steep sides.

    Name
        (Character identifier)

Ridge line   The line separating drainage basins.

    Name
        (Character identifier)

Rock   A concreted mass of stony material.

    Relationship to surface
        Awash
        Exposed at surface
        Submerged below water surface

Sastrugi   Sharp, irregular ridges formed on a snow surface by wind erosion and deposition. The ridges are parallel to the direction of the prevailing wind.

Sink   The place at which a stream disappears underground in a karst area.

    Name
        (Character identifier)
        Not applicable

Summit   The peak of a mount or ridge.

    Name
        (Character identifier)

Terrace   A step-like land surface between higher and lower ground.

    Name
        (Character identifier)

Trench   A long cut in the surface created through excavation.

Valley   An elongated depression in the Earth's surface that generally slopes from one end to the other.

    Name
        (Character identifier)

Wash   The dry portion of a bed of a stream that contains water only during or after a local rainstorm or heavy snowmelt.

    Name
        (Character identifier)
        Not applicable

6. ALPHABETIC LIST OF DLG–E ATTRIBUTES AND ASSOCIATED ATTRIBUTE VALUES

This section lists alphabetically all DLG–E attributes and all possible attribute values and identifies the features to which a value is associated. For example, the entry for the attribute "water characteristics" appears as follows:

Water characteristics
Alkaline	-Spring, (Well)
Fresh	-Lake/Pond
Hot	-Spring, (Well)
Mineral	-Spring, (Well)
Salt	-Lake/Pond, (Well)
Sulfur	-Spring
Unspecified	-Spring, (Well)

The attribute "water characteristics" will be found for the features Lake/Pond, Spring, and (Well). The feature "well" is in parentheses to indicate that the attribute "water characteristics" is an attribute of an attribute value included under the feature "well" (it is not directly an attribute of the feature itself).

The attribute values of "water characteristics" are different for each of the features listed above.

Feature:	Lake/Pond
Attribute:	Water characteristics
Values:	Fresh and Salt

Feature:	Spring
Attribute:	Water characteristics
Values:	Alkaline, Hot, Mineral, Sulfur, Unspecified

Feature:	(Well)
Attribute:	Product
Value:	Water------->Attribute: Water characteristics

Value: Alkaline
Hot
Mineral
Salt
Unspecified

Access restrictions
None	-Road, Trail
Private	-(Gate), Road, Trail
Restricted	-Road, Trail
Toll	-(Gate), Road,
Not applicable	-(Gate)
Unknown	-Road, Trail

Accounting unit code
(Integer value (00...99))   -Hydrologic Unit
Not applicable

Aircraft facility type
Airport	-Aircraft facility
Heliport	
Seaplane base	

Anchorage type
Explosives isolation	-Anchorage
General case	
Seaplane	

Angle of orientation
0...89	-Building
0...359	-Cave entrance, Cliff dwelling, Mine entrance, Spring, Tunnel entrance
Not applicable	-Building

Archeological site/Ruins type
        Archeological site   -Archeological site/Ruins
        Pictograph
        Ruins
        Unspecified

Athletic field type
        Archery range   -Athletic field
        Ball
        Equestrian
        Pistol range
        Polo
        Rifle range
        Unspecified

Bar type
        Offshore   -Bar
        Point

Basin type
        Carolina bay   -Basin
        Crater
        Unspecified

Boundary point identifier
        (Alphanumeric identifier)   -Boundary point
        Not applicable
        Unknown

Building class
        Class 1   -Building
        Class 2

Bureau of Land Management (BLM) identification number
        (Alphanumeric value)   -Survey corner

Building class
        Class 1   -Building
        Class 2

Cableway type
        Logging   -Cableway
        Ski lift
        Ski tow
        Tramway
        Unknown

Campsite type
        Campground   -Campground
        Recreational vehicle
        Unspecified

Canal/Ditch category
        Canal   -Canal/Ditch
        Ditch
        Unspecified

Cataloging unit code
        (Integer value (00...99))   -Hydrologic unit
        Not applicable

Census block group number
        (Integer value - 1-9)   -Census block group

Census block number
        (Alphanumeric value)   -Census block

Census County Division (CCD)/
  Minor Civil Division (MCD) number
    (Integer value - 001-999)   -CCD/MCD

Census tract/Block Numbering Area (BNA) number
    (Numeric value - 0001.01-9989.99)   -Census tract/BNA

Chimney type
    Flare pipe   -Chimney
    Stack
    Unknown

Contour symbolization category
    Depression   -Contour (land)
    Mound   -Contour (bathymetric)
    Not applicable -Contour (bathymetric), Contour (land)

Covering
    Covered   -Bridge, Reservoir
    Not covered

Cultivated cropland type
    Nursery   -Cultivated cropland
    Orchard
    Vineyard
    Unspecified
    Unknown

Delineation status
    Amended   -Contour (bathymetric), Contour (land)
    Apparent   -Shoreline
    Definite   -Boundary line, Contour (bathymetric), Contour (land), Shoreline, Stream/River
    Disputed   -Boundary line
    Historical   -Boundary line
    Indefinite/
      Approximate   -Boundary line, Contour (bathymetric), Contour (land), Shoreline
    Proposed   -Boundary line
    Protracted   -Boundary line
    Unsurveyed   -Shoreline, Stream/River
    Unknown   -Boundary line

Depth
    (Positive numeric value)   -Contour (bathymetric)

Discarded substance
    Dredged material   -Disposal site
    Garbage
    Slag pile
    Tailings
    Waste rock
    Unspecified
    Unknown

District number
    (Integer value - 001...999)   -Georgia Survey District

Earth composition
    Gravel   -Barren land
    Rock
    Salt
    Sand
    Shell
    Silt
    Unspecified

Elevation
    (Numeric value -nearest 0.001 meter)   -Control station
    (Numeric value -nearest 0.1 meter)   -Area to be submerged, Contour (land), Lake/Pond, Reservcir, Spillway,
                      Spot elevation, Stream/River
    Unspecified   -Area to be submerged, Control station, Lake/Pond, Reservcir, Spillway,
                      Stream/River
    Unknown   -Area to be submerged, Lake/Pond, Reservoir, Stream/River

Embankment type
    Levee   -Embankment
    Redoubt

FIPS code identifier-1st
    (Integer value - 01...99)   -State/Territory

FIPS code identifier-2nd
    (Integer value - 001...999)   -County

FIPS code identifier-3rd
    (Integer value - 0001...9999) -Minor Civil Unit
    Not applicable

Field identification
    Identified   -Survey corner
    Not identified
    Unknown

Flat type
    Playa   -Flat
    Tidal

Flotation
    Floating   -Drydock
    Not floating

Directional status
    Alternating   -Road, Trail
    Bidirectional   -Road, Trail
    One way   -Aqueduct, Canal/Ditch, Fish ladder, Flume, Penstock, Rapids, Road, Siphon, Stream/River,
               Trail
    Unspecified   -Aqueduct, Canal/Ditch, Fish ladder, Flume, Penstock, Rapids, Road, Siphon, Stream/River
               Trail
    Unknown   -Aqueduct, Canal/Ditch, Fish ladder, Flume, Penstock, Rapids, Road, Siphon, Stream/River,
               Trail

Gage type
    Tidal   -Gaging station
    Unspecified

Gate type
    Check   -Gate
    Flood
    Head
    Road
    Sluice
    Tidal
    Unspecified

Hazard zone type
    Crib   -Hazard zone
    Foul ground
    Mine danger area
    Piling
    Platform
    Reef
    Rock
    Snag/Stump
    Unknown

Hazard zone type (continued)
Unspecified
Well
Wreckage

Height above surface level (meters)
(Numeric value)   -Tower
Unspecified
Unknown

Historical significance
Not significant   -Trail
Significant
Unknown

Holding pen type
Corral   -Holding pen
Feedlot
Stockyard

Horizontal control accuracy
1st order   -Control station
2nd order
3rd order
3rd order or better
Not applicable

Hydrographic category
Dry   -(Well)
Intermittent   -Canal/Ditch, Lake/Pond, Reservoir, Stream/River
Perennial   -Canal/Ditch, Lake/Pond, Stream/River, (Well)
Not applicable -Reservoir, (Well)
Unknown   -Canal/Ditch, Lake/Pond, Reservoir, Stream/River

Hydrographic form
Braided   -Stream/River
Not braided

Ice mass type
Alpine glacier   -Ice mass
Continental glacier
Pack ice
Snowfield

Industrial plant type
Ammunition   -Industrial site
Cannery
Cement
Filtration
Refinery
Sawmill
Sewage disposal
Unspecified

Institutional function
Civil government   -Institutional site
Correctional
Education/Research
Historical
Medical
Military
Orphanage
Religious
Unspecified
Unknown

Interchange designator
    (Alphanumeric identifier)   -Interchange
    Not applicable
    Unknown

Inundation control
    Controlled   -Inundation area
    Not controlled

Land grant code
    (Integer value - 0001...7302)   -Land grant
    Unknown

Lane type
    Airboat trail   -Lane
    Dredged channel
    Ferry crossing
    Seaplane landing/takeoff
    Shipping

Lot number
    (Integer value - 0001-9999)   -Georgia Survey District

Material composition
    Earthen   -Dam/Weir
    Masonry
    Unspecified

Median category
    With median   -Road
    Without median

Metropolitan Statistical Area FIPS code
    (Integer value - 01-9999)   -Metropolitan Statistical Area (MSA)

Metropolitan Statistical Area (MSA) type
    Part MSA (PMSA)   -Metropolitan Statistical Area (MSA)
    Consolidated MSA (CMSA)
    General case

Mile marker type
    Railway   -Mile marker
    Watercourse

Mileage number
    (Numeric value)   -Mile marker

Mine entrance type
    Adit   -Mine entrance
    Shaft

Mine type
    Auger borings   -Mine
    Open pit
    Pit
    Placer
    Quarry
    Strip

Monument number
    (Integer value)   -Survey point
    Not applicable

Monument type
    No tablet   -Control station
    Tablet

Mount Type
General case   -Mount
Hummocked ice
Ice dome
Indian mound
Pingo

Name
(Character   -Aircraft facility, Anchorage, Aqueduct, Arch, Archeological site/Ruins, Area to be submerged,
identifier)   Athletic field, Bar, Baseline, Basin, Bay/Estuary/Inlet, Beach, Beacon, Bend, Boardwalk, Boundary
Not applicable   line, Breakwater/Jetty, Bridge, Building, Cableway, Campground, Canal/Ditch, Cape, Cave, Cave
Unknown   entrance, Cemetery, City, Cliff, Cliff dwelling, Control station, County, Cul de sac, Dam site,
                     Dam/Weir, Desert, Dunes, Exhibition ground, Fault, Fish hatchery, Flat, Ford, Fumarole, Gap,
                     Geyser, Gut, Helipad, Historical marker, Hydrologic unit, Ice mass, Incline/Flow, Industrial site,
                     Institutional site, Interchange, Island, Isthmus, Lake/Pond, Land grant, Lane, Launch facility, Launch
                     pad, Locale, Lock, Marina, Mine, Mine entrance, Minor Civil Unit, Minor Civil Subunit, Moraine,
                     Mount, Nation, Outdoor theater, Park, Pier/Wharf, Pinnacle, Pipeline, Pipeline regulation station,
                     Plain, Power site, Prospect, Proving ground, Racetrack, Railway yard, Range, Rapids, Reef,
                     Reservation, Reservoir, Rest site, Ridge, Ridge line, Road, Sea/Ocean, Shopping center, Sink, Sports
                     site, Spring, State/Territory, Storage site, Stream/River, Submerged stream, Substation, Summit,
                     Survey corner, Tank, Tank farm, Terrace, Tower, Trail, Trailer park, Tree, Tunnel, Valley, Wash,
                     Waterfall, Well, Well field, Wetland, Windmill, Wreck

Navigation type
Aeronautical   -Beacon
Nautical
Unspecified
Unknown

Number of decks
(Integer value)   -Bridge
Not applicable
Unspecified
Unknown

Number of lanes or tracks
(Integer value)   -Railway, Road
Unspecified
Unknown

Operational status
Abandoned   -Aircraft facility, Aqueduct, Beacon, Bridge, Building, Cableway, Canal/Ditch, Dam site,
                     Disposal site, Flume, Helipad, Industrial site, Launch facility, Launch pad, Mine, Mine
                     entrance, Penstock, Pipeline, Pipeline regulation station, Power site, Railway, Railway yard,
                     Reservoir, Road, Runway, Siphon, Substation, Tower, Turntable, Well, Well field
Dismantled   -Bridge, Cableway, Railway, Turntable
Drill hole   -Well
Operational   -Aircraft facility, Aqueduct, Beacon, Breakwater/Jetty, Bridge, Building, Cableway,
                     Canal/Ditch, Dam site, Dam/Weir, Disposal site, Flume, Helipad, Industrial site, Launch
                     facility, Launch pad, Mine, Mine entrance, Penstock, Pier/Wharf, Pipeline, Pipeline regulation
                     station, Power site, Railway, Railway yard, Reservoir, Road, Runway, Siphon, Substation,
                     Tower, Transmission line, Tunnel, Turntable, Well, Well field
Proposed   -Bridge, Canal/Ditch, Dam/Weir, Pipeline, Road, Tunnel, Turntable
Reclaimed   -Mine
Ruined   -Breakwater/Jetty, Building, Pier/Wharf
Under construction   -Aircraft facility, Aqueduct, Bridge, Canal/Ditch, Dam site, Dam/Weir, Disposal site, Flume,
                     Helipad, Industrial site, Launch facility, Launch pad, Penstock, Pipeline, Pipeline regulation
                     station, Power site, Railway, Railway yard, Reservoir, Road, Runway, Siphon, Substation,
                     Transmission line, Tunnel, Turntable
Unknown   -Aircraft facility, Aqueduct, Beacon, Breakwater/Jetty, Bridge, Building, Cableway,
                     Canal/Ditch, Dam site, Dam/Weir, Disposal site, Flume, Helipad, Industrial site, Launch
                     facility, Launch pad, Mine, Mine entrance, Penstock, Pier/Wharf, Pipeline, Pipeline regulation
                     station, Power site, Railway, Railway yard, Reservoir, Road, Runway, Siphon, Substation,
                     Transmission line, Tower, Tunnel, Turntable, Well, Well field
Origin of survey name
(Character identifier)   -Public survey area

Origin of survey number
      (Integer value - 01...48) - Public survey area

Outdoor theater type
      Amphitheater   -Outdoor theater
      Aqua
      Drive-in

Ownership
      National   -Land parcel
      State

Park type
      Amusement   -Park
      Botanical
      Parade ground
      Picnic area
      Playground
      Zoo
      Unspecified

Pipeline regulation station type
      Compressor   -Pipeline regulation station
      Pumping
      Valve

Post type
      Dolphin   -Post
      Piling

Power generation method
      Nuclear   -Power site
      Solar
      Unspecified
      Unknown

Product
      Bentonite   -Mine
      Brick   -Kiln
      Caliche   -Mine
      Charcoal   -Kiln
      Chemical   -(Tank)
      Chert   -Mine
      Cinders   -Mine
      Clay   -Mine
      Coal   -Flume, Mine, Pipeline
      Coke   -Kiln
      Copper   -Mine
      Fuel   -(Tank)
      Gas   -Drilling platform, (Tank), Tank farm, Well, Well field
      Gasoline   -(Tank)
      Gold   -Mine
      Grain   -(Tank)
      Gravel   -Mine
      Heat   -Well
      Logs   -Flume
      Molasses   -(Tank)
      Oil   -Drilling platform, Flume, (Tank), Tank farm, Well, Well field
      Oxygen   -(Tank)
      Pumice   -Mine
      Salt   -Mine, (Reservoir)
      Sand   -Mine
      Scoria   -Mine
      Sewage   -Pipeline
      Shale   -Mine
      Silver   -Mine
      Soda   -(Reservoir)
      Soil   -Mine

Product (continued)
    Uranium   -Mine
    Water   -Flume, Pipeline, Reservoir, (Tank), Well
    Unspecified   -Flume, Mine, Pipeline, (Tank), Tank farm, Well, Well Field
    Unknown   -Drilling platform, Flume, Kiln, Mine, Pipeline, (Reservoir), (Tank), Well, Well field

Public survey area type
    General case   -Public survey area
    Donation land claim

Railway category
    General case   -Railway
    Inclined railway
    Logging
    Rapid transit
    Unknown

Railway gauge
    Narrow   -Railway
    Standard
    Monorail
    Unknown

Railway type
    Mainline   -Railway
    Siding

Ramp type
    Boat   -Launching ramp
    Seaplane

Range number
    (Numeric value with 1 alpha character (E/W)) -Public service area

Region unit code
    (Integer value (01...21))   -Hydrologic unit

Relationship to surface
    Awash   -Rock
    Elevated above surface   -Control station, Pipeline, Spot elevation, Transmission line
    Exposed at surface   -Control station, Drilling platform, Pier/Wharf, Rock, Snag/Stump, Spot elevation,
                                Water intake/outflow, Wreck
    Submerged below water surface -Drilling platform, Pier/Wharf, Pipeline, Rock, Snag/Stump, Transmission lire,
                                Water intake/outflow, Wreck
    Under ground surface   -Pipeline, Transmission line

Reservation class
    Forest   -Reservation
    General case
    Grassland
    Indian land
    Military
    Park
    Prison
    Wilderness
    Wildlife
    Unknown

Reservation use status
    National   -Reservation
    State
    Regional
    County
    Minor Civil Unit
    City
    Private
    Unknown

Reservoir use
    Clarification   -Reservoir
    Cooling
    Debris basin
    Evaporator
    Filtration bed
    Fish hatchery
    Fish pond
    Guzzler
    Industrial processing
    Industrial waste
    Percolation basin (spreading ground)
    Purification
    Retardation basin
    Settling basin
    Sewage disposal
    Storage
    Sump
    Swimming
    Unknown

Road class
    1st   -Road
    2nd
    3rd
    4th
    5th
    Unknown

Road type
    General case   -Road
    Overlook
    Ramp
    Rest area
    Runaway truck ramp
    Traffic circle
    Unknown

Route designator
    (Alphanumeric identifier)   -Road
    Unspecified
    Unknown

Sea/Ocean type
    Reef pool   -Sea/Ocean
    Unspecified

Section number
    (Alphanumeric value)   -Public survey area

Signaling method
    Daybeacon   -Beacon
    Lighted
    Radio
    Unspecified
    Unknown

Special use activity
    Dumping ground for hazardous material   -Special use zone
    Spoil area

Spillway elevation
    (Numeric value)   -Dam/Weir
    Not applicable

Sports site type
    Golf course   -Sports site
    Gun club
    Raceway
    Rodeo grounds
    Ski area
    Stadium
    Tennis court

Stability
    Stable   -Dune
    Shifting

Subregion unit code
    (Integer value (01-99))   -Hydrologic unit
    Not applicable

Surface condition
    Hard/Paved   -Helipad, Runway
    Not paved
    Unknown

Survey corner type
    Arbitrary   -Survey corner
    Auxiliary meander
    Closing
    Isolated
    Land grant
    Meander
    Quarter section
    Section
    Tract
    Witness off line
    Witness on line

Survey point type
    Angle point   -Survey point
    Land grant monument
    Location monument (includes mineral monument)
    Reference monument
    Witness point

Tank type
    Cistern   -Tank
    General case
    Silo
    Storage bin
    Surge

Tower function
    Control   -Tower
    Cooling
    Electronic
    Observation
    Mooring
    Pylon
    Support
    Water
    Unspecified
    Unknown

Township number
    (Numeric value with 1 alpha character (N/S)) -Public survey area

Track condition/Use
    Hard/Paved-Vehicle   -Racetrack
    Improved/Loose-Vehicle/Animal
    Improved-Pedestrian

Track condition\Use (continued)
    Improved/Rough-Vehicle
    Unknown

Traffic inspection facility type
    Agricultural   - Traffic inspection facility
    Customs
    Weigh

Trail type
    Bicycle   -Trail
    Bridle
    Marked
    Pack
    Pedestrian
    Portage
    Ski
    Snowmobile
    Winter
    Not applicable
    Unknown

Transmission use
    Power   -Transmission line
    Telegraph
    Telephone
    Unknown

Tree category
    Deciduous   -Trees
    Evergreen

Vegetation characteristics
    Mangrove   -Trees
    Unspecified

Vegetation type
    Cranberry   -Cultivated cropland
    Rice
    Unspecified
    Unknown

Vertical control accuracy
    1st order   -Control station
    2nd order
    3rd order
    3rd order or better
    Not applicable

Wall type
    General case   -Wall
    Sea

Water characteristics
    Alkaline   -Spring, (Well)
    Fresh   -Lake/Pond
    Hot   -Spring, (Well)
    Mineral   -Spring, (Well)
    Salt   -Lake/Pond, (Well)
    Sulfur   -Spring
    Unspecified   -Spring, (Well)

Water intake/outflow type
    Riser   -Water intake/outflow
    General case

Width (meters)
    (Integer value)   -Road
    Unspecified

Windmill function
    Pump   -Windmill
    Generator

7. ALPHABETIC LIST OF DLG-E ATTRIBUTES OF ATTRIBUTE VALUES

Attribute: Access restrictions

    Private
    Toll
    Not applicable

of Feature: Gate
Attribute: Gate type
Value: Road

Attribute: Bathymetric datum

    Gulf Coast low water
    Lowest low water
    Mean low lake level
    Mean low water
    Mean lower low water
    Mean sea level
    Tropic lower low water
    Water surface as indicated
    Unknown

of Feature: Contour (bathymetric)
Attribute: Depth
Value: Positive numeric value)

Attribute: Call letters

    (Alpha identifier
    3-4 characters)
    Not applicable

of Feature: Tower
Attribute: Electronic signal
Value: Radio
    Television
    Unspecified
    Unknown

Attribute: Continental glaciation type

    Inland ice sheet
    Ice shelf

of Feature: Ice mass
Attribute: Ice mass type
Value: Continental glacier

Attribute: Control class

    Class I
    Class II

of Feature: Control station
Attribute: Horizontal control accuracy
Value: 2nd order
    3rd order

of Feature: Control station
Attribute: Vertical control accuracy
Value: 1st order
    2nd order

Attribute: Crater type

    Bomb
    Meteoric
    Volcanic

of Feature: Basin
Attribute: Basin type
Value: Crater

Attribute: Electronic signal

    Microwave
    Radar
    Radio
    Television
    Unspecified
    Unknown

of Feature: Tower
Attribute: Tower function
Value: Electronic

Attribute: Exposed portion

    Mast and/or Funnel
    Hull and/or Super-
        Structure

of Feature: Wreck
Attribute: Relationship to surface
Value: Exposed at surface

Attribute: Flow characteristics

    Flowing
    Not flowing

of Feature: Well
Attribute: Product
Value: Water

Attribute:	Hydrographic category	of Feature:	Well
		Attribute:	Product
	Dry	Value:	Water
	Perennial		
	Not applicable		

Attribute: Hydrographic category   of Feature: Well
                                    Attribute: Product
        Dry   Value: Water
        Perennial
        Not applicable

Attribute: Inclined railway type   of Feature: Railway
                                    Attribute: Railway category
        Cable   Value: Inclined railway
        Cog
        Unspecified

Attribute: Inundation area use   of Feature: Inundation area
                                    Attribute: Inundation control
        Dewatering area   Value: Controlled
        Duck pond

Attribute: Lighthouse presence   of Feature: Beacon
                                    Attribute: Signaling method
        With lighthouse   Value: Lighted
        Without lighthouse

Attribute: Liquid contained   of Feature: Reservoir
                                    Attribute: Reservoir use
        Oil   Value: Storage
        Water
                                    of Feature: Reservoir
                                    Attribute: Reservoir
                                    Value: Sump

Attribute: Observation type   of Feature: Tower
                                    Attribute: Tower function
        Guard   Value: Observation
        Lookout

Attribute: Owning agency   of Feature: Land parcel
                                    Attribute: Ownership
        Agricultural Research Service   Value: National
        Air Force
        Army
        Army (Corps of Engineers - Civil Works)
        Bonneville Power Administration
        Bureau of Indian Affairs
        Bureau of Land Management
        Bureau of Mines
        Bureau of Prisons
        Bureau of Reclamation
        Energy Research and Development Administration
        Federal Aviation Administration
        Federal Railroad Administration
        Fish and Wildlife Service
        Forest Service
        General Services Administration
        International Boundary and Water Commission,
            United States and Mexico
        National Aeronautics and Space Administration
        National Oceanic and Atmospheric Administration
        National Park Service
        Navy
        Tennessee Valley Authority
        U.S. Coast Guard
        Veterans' Administration

Attribute: Product   of Feature: Reservoir
                                    Attribute: Reservoir use
        Salt   Value: Evaporator
        Soda
        Unknown

Product	of Feature:	Tank
	Attribute:	Tank type
Chemical	Value:	General case
Fuel		
Gas		
Gasoline		
Molasses		
Oil		
Oxygen		
Water		
Unspecified		
Product	of Feature:	Tank
	Attribute:	Tank type
Grain	Value:	Silo
Unspecified		
Unknown		
Product	of Feature:	Tank
	Attribute:	Tank type
Grain	Value:	Storage bin
Unspecified		
Unknown		

Attribute:	Rock type	of Feature:	Barren land
		Attribute:	Earth composition
	Coral	Value:	Rock
	Lava		
	Unspecified		
	Unknown		
Attribute:	Route type	of Feature:	Road
		Attribute:	Route designator
	Alternate	Value:	(Alphanumeric identifier)
	Business		
	Bypass		
	Connector		
	Loop		
	Spur		
	Truck		
	Unspecified		
Attribute:	Support type	of Feature:	Tower
		Attribute:	Tower function
	Water intake tower	Value:	Support
Attribute:	Stage	of Feature:	Lake/Pond
		Attribute:	Elevation
	Average water elevation	Value:	(Numeric value)
	High water elevation		
	Normal pool elevation		
Attribute:	Text		
	(Character	of Feature:	Beacon
	identifier)	Attribute:	Navigation type
	Not applicable	Value:	All entries
	(Character	of Feature:	Boundary line
	identifier)	Attribute:	Delineation status
	Not applicable	Value:	Proposed
			Protracted
	(Character	of Feature:	Building
	identifier)	Attribute:	Building class
	Not applicable	Value:	Class 1
			Class 2

Attribute: Text (continued)

(Character	of Feature:	Contour (bathymetric)
identifier)	Attribute:	Bathymetric datum
Not applicable	Value:	Water surface as indicated
(Character	of Feature:	Gate
identifier)	Attribute:	Gate type
Not applicable	Value:	All entries
(Character	of Feature:	Institutional site
identifier)	Attribute:	Institutional function
Not applicable	Value:	All entries
(Character	of Feature:	Reservation
identifier)	Attribute:	Reservation class
Not applicable	Value:	All entries
(Character	of Feature:	Sports site
identifier)	Attribute:	Sports site type
Not applicable	Value:	All entries
(Character	of Feature:	Tower
identifier)	Attribute:	Tower type
Not applicable	Value:	All entries
(Character	of Feature:	Water intake/outflow
identifier)	Attribute:	Water intake/outflow type
Not applicable	Value:	Riser

Attribute: Vertical datum category

	of Feature:	Dam/Weir
	Attribute:	Spillway elevation
Guam Mean Sea Level Datum of 1963	Value:	(Numeric value)
Mean sea level (local)	of Feature:	Reservoir
National Geodetic Vertical	Attribute:	Elevation
Datum of 1929	Value:	(Numeric value)
North American Vertical Datum of 1988		
	of Feature:	Spillway
	Attribute:	Elevation
	Value:	(Numeric value)
	of Feature:	Area to be submerged
	Attribute:	Elevation
	Value:	(Numeric value)
	of Feature:	Lake/Pond
	Attribute:	Elevation
	Value:	Numeric value)
	of Feature:	Stream/River
	Attribute:	Elevation
	Value:	(Numeric value)
	of Feature:	Contour (land)
	Attribute:	Elevation
	Value:	(Numeric value)
	of Feature:	Control station
	Attribute:	Elevation
	Value:	(Numeric value)
	of Feature:	Spot elevation
	Attribute:	Elevation
	Value:	(Numeric value)

Attribute: Water characteristics

        Alkaline
        Hot
        Mineral
        Salt
        Unspecified

of Feature: Well
Attribute: Product
Value: Water

APPENDIX B

DLG–E EXAMPLE DATA SET

Section

APPENDIX B

1. DLG–E EXAMPLE DATA SET

OVERVIEW

To apply the concepts discussed in the body of this report, a contrived comprehensive example DLG–E data set was developed. This example is intended to show the relationships between original source materials (used to construct the DLG–E data) and the feature/attribute definitions, delineation rules, data extraction specifications, and data representation rules. The example also illustrates how these specifications would contribute to the definition and building of a DLG–E data set. It is critical to note that a DLG–E data set, even a contrived one, cannot be built without these supporting specifications. The example is designed to show not only possible data content and structure for DLG–E data, but also the content and structure of the supporting specification documents.

The example strives to be highly deterministic by specifying how the various preliminary rule sets are to be applied. The intent in any data exchange scheme is to communicate an understanding of the phenomena being represented. In the DLG–E case, this requires that the data user understand the feature definitions, extraction specifications, meanings of attributes, attribute values, digital object representations and their relationship to features, and so forth, used by the National Mapping Division. The ultimate goal is to have these specifications defined so precisely, that, given the same original source materials, two trained individuals could produce identical digital representations of a given phenomena by strictly adhering to all the definitions and rules. It is realized that this degree of precision may not be attainable, but nonetheless that should not deter the attempt to strive for this level.

The procedures used to develop the example DLG–E data set were as follows:

1. Building on the feature definitions and attribute lists in appendix A and the general representation rules in chapter 4, candidate "DLG–E feature data specifications" (including delineation, data extraction, and representation rules) were developed for 24 selected DLG–E features in the example data set. It is important to note here that the rules developed in this step should be considered very preliminary; meant for illustration and experimentation purposes only. Actual DLG–E feature data specifications are currently being developed.

2. A contrived graphic map and field notes were generated to illustrate possible source materials. It was decided to develop contrived materials (instead of using an actual real-world example) in order to include as many of the selected features and special cases as possible.

3. Using the feature definitions in appendix A (plus four additional feature constructs developed for modeling purposes) and the specifications developed in step 1, the ground phenomena described in the source materials were categorized as DLG–E feature instances. Specifically, a total of 67 feature instances of 24 DLG–E features were found.

4. Using the representation rules from step 1, a planar graph, representative of the DLG–E feature instances found in step 3, was abstracted from the graphic map. This linear graph was digitized as a set of topologically integrated nodes, points, chains, and polygons (the DLG–E spatial objects).

5. Each feature instance was encoded as a feature object, attributed, and related to other feature objects (if appropriate) and to the digitized spatial objects by building a set of relational tables.

THE DLG–O+ IMPLEMENTATION

The DLG–E example has been implemented using a specific data and file structure. It is important to remember that the same data and data model may be implemented using different structures within other environments. In fact, the planned distribution format for DLG–E data will be an implementation of the Spatial Data Transfer Specification (see appendix C), not what has been used for this example. The data structure is used here for illustration and experimentation purposes only. It includes the familiar DLG–3 structure (see USGS Data Users Guide 2, pages 2-3) for the implementation of the DLG–E spatial objects, attributes (location) and topological relationships. DLG–3 nodes, lines, and areas are used to represent DLG–E nodes, chains, and polygons, respectively. (Note: a DLG–E point is implemented as a DLG–3 "degenerate" line with node.) Feature objects, attributes, attribute values, and relationships are implemented as a set of relational tables.

DLG–O+ is the file structure chosen for the DLG–E example. DLG–O+ consists of two parts: the "DLG–O" part and the "+" part. The DLG–O part is simply a Digital Line Graph in Optional distribution format that holds the spatial objects as "topological elements." Neither attribute codes nor text are associated with the topological elements--just coordinate data and topological relationships. The specifications for the "DLG–O" part are well documented in the current Standards for Digital Line Graphs (see USGS Data Users Guide 2, appendix B), and need not be repeated here.

The "+" part of DLG–O+ consists of "flat files" associated with a DLG–O file. In the case of our example, the "+" part is a set of eight relational tables, each table implemented as a single flat file. These tables serve to hold data representing the feature objects, nonspatial attribute values, and feature-to-feature and feature-to-spatial object relations of the DLG–E. The following named tables have been specified for use with DLG–E data:

1. Feature Object table
   provides a summary of the information carried in the other tables. There is one record in this table for each feature object.

2. Entity Label table
   serves to store the actual entity labels (i.e., DLG–E feature terms) associated with feature objects. There is one record in this table for each unique entity label assigned to one or more feature objects.

3. Attribute Definition table
   provides the means for interpreting attribute values in the Attribute Value table, and text in the Name/Text table. There is one record in this table for each unique attribute term in the data set.

4. Relationship Definition table
   provides information for interpreting Relationship Tuple records. There is one record in this table for each unique type of relationship in the data set (for DLG–E data, these relationships are listed in table 4, page 5 of this circular).

5. Attribute Value table
   serves to store the actual attribute values of attributes associated with (1) feature objects, (2) other attribute values, or (3) relationships.

6. Name/Text table
   serves to store names and text strings associated with (1) feature objects, (2) attribute values, or (3) relationships.

7. Attribute Assignment table
   provides the means by which (1) attribute values, and (2) names/text, are assigned to (a) feature objects, (b) relationships (as instanced in the Relationship Tuple records), (c) attribute assignments (as instanced in the records of this table), (d) other attribute values, and (e) other feature names/text. Also, this table can associate entity labels with feature objects.

8. Relationship Tuple table
   is an object linkage table. Feature and topological objects are related to feature objects through named relationships (defined in the Relationship Definition table).

These tables will be described in more detail in Section 6.

2. SOURCE MATERIALS

Source materials are the actual materials used for compilation of the DLG–E data set. All information in the DLG–E must be traceable to the set of source materials. Sources may consist of graphic maps, imagery, field notes, or any other ancillary information containing name, boundary, or other information. For the example, a contrived graphic map and field classification notes were used.

Contrived Field Classification Notes

• Entire extent of U.S. 63 on map is Alternate U.S. 63 and also is named Bishop Avenue (from Highway Department).

• The four-lane portion of Alternate U.S. 63 is also known as Memorial Drive (from local residents and businessmen).

• The entire extent of the map is in Township 6 South (from Bureau of Land Management).

• The spillway elevation for the dam on East Fork Lake is 974 feet (from County Engineer).

• The trail connecting the large part of Lane Spring State Park with the smaller south portion of the park is also part of the park (from Park Administrative Office).

Contrived Source Map Graphic
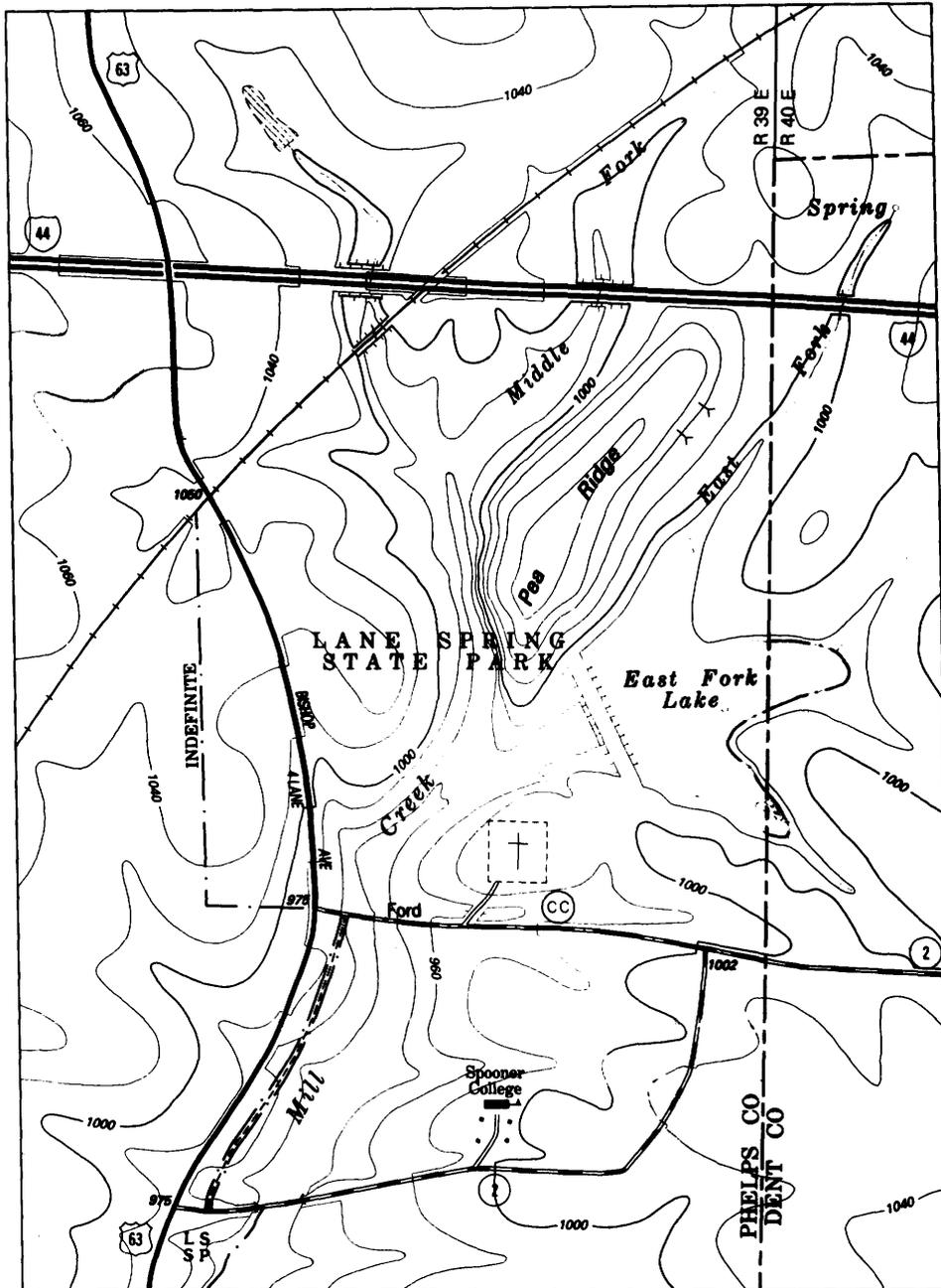
3. DLG-E FEATURE DATA SPECIFICATIONS

The feature data specifications define the domain of features that may be represented in DLG-E data. An attempt will be made to extract occurrences or "instances" of these features from the source material provided. For this reason, the portions of the DLG-E feature data specifications related to this task are referred to as data extraction specifications. Features meeting the capture conditions defined in the data extraction specifications and discernible from the source will be present in the DLG-E. All remaining ground phenomena will not be represented.

For each feature in the DLG-E feature data specification, a domain of attributes is defined. Each attribute is assigned a value, taken from the domain of values specified by the attribute definition authority. All attributes and attribute values used in the example are taken from the DLG-E features list (appendix A).

Attributes are used to describe characteristics of features as well as attribute values. In addition, multivalued attributes are demonstrated. While the DLG-O+ relational table specifications allow for several rather abstract forms of attribution, such as attributing the assignment of an attribute or relationship, the example demonstrates only the more common applications of attributes.

This section presents a number of the DLG-E feature data specifications used to build the DLG-E example data set from the contrived source materials in the previous section. Each DLG-E feature data specification is presented using the following generic template:

DLG-E FEATURE DATA SPECIFICATION

FEATURE - definition as documented in DLG-E domain of features.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Attribute	definitions of attributes and values
Value	(those common to more than one feature are generic definitions)

DELINEATION - (ground truth) - what the feature looks like on the ground.

DATA EXTRACTION -

Capture Condition - criteria for determining when a feature is to be captured for inclusion in the data base. This is independent of source.

Source Interpretation Guidelines - criteria for extracting ground truth, for those situations that are ambiguous, from various sources (image, field, graphic, DLG-3).

Valid Attributes - which attributes are valid for a given scale.

REPRESENTATION RULES-

Composition Rules - under these conditions, feature has these relationships (allowed relationships may not always occur).
If (feature) is (condition), (feature) is composed of/part of...., bounded by/bounds...., inflows to/outflows from...., connected to, and vertically related to....

Delimiting Rules - definition of feature instance based on global rules.
Special Conditions - specific definition rules which are peculiar to a specific feature.

Vector Model Consideration - TBR

On the next several pages, the very preliminary DLG-E feature specifications for the following DLG-E features are presented: stream/river, spring, road, underpass, junction, shoreline, reservation, boundary line, and ridge.

STREAM/RIVER - A body of flowing water.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Delineation status -   The level of confidence with which a feature can be
                                              defined.
    Apparent   Conditions prevent the feature from being confidently
                                              defined because of obscuring vegetation or shadows.
    Definite   Conditions permit the feature to be confidently defined.
    Not applicable

Directional status -   The state of movement along the feature.
    Alternating   Movement occurs in both directions, however only one
                                              way at a time.
    Bidirectional   Movement occurs in both directions simultaneously.
    Not applicable
    One way   Movement occurs in only one direction.
    Unknown
    Unspecified

Elevation -   The vertical distance of a feature above a given datum.
                                              Increment: 0.1 feet
    (Numeric value)

-->Vertical Datum Category   The base elevation used as a reference from which to
                                              reckon heights or depths.
    Mean Sea Level (Local)
                                              The average height of the surface of the sea for all
                                              stages of the tide, usually determined by averaging
                                              height readings observed hourly over a 19-year period.
    National Geodetic Vertical Datum of 1929
                                              A fixed reference adopted as a standard geodetic datum
                                              for heights, derived for land surveys from a general
                                              adjustment of first order land nets of both the United
                                              States and Canada.
    North American Vertical Datum of 1988
                                              As of 2/89 this proposed vertical datum has not been
                                              defined.

-->Stage   The height of water surface above the vertical datum.
    Normal Pool Elevation
                                              The normal stage of water that prevails for most of the
                                              year for a controlled body of water.
    High water elevation
                                              A stage of water that prevails when the feature is at or
                                              near capacity.
    Unknown
    Not applicable

Hydrographic category -   The portion of the year the feature contains water.
    Intermittent   Contains water for only part of the year, but more than
                                              just after rainstorms and at snowmelt (see feature
                                              WASH).
    Perennial   Contains water throughout the year, except for
                                              infrequent periods of severe drought.
    Unknown

Hydrographic form -   The pattern of channels.
    Braided   Feature has a stream course which is not filled at
                                              normal flow, and that subdivides into interlacing
                                              channels.
    Not braided   Feature has a stream course that is filled at normal flow
                                              and that does not subdivide into interlacing channels.

Name -   The proper name, specific term, or expression by which
                                the feature is known.

          (Character identifier)
          Not applicable
          Unknown

DELINEATION -

The upper limit of a stream is determined to be the point at which the feature first becomes evident as a channel.
The limits of a perennial stream are determined to be the height on the banks when water is at average water elevation.
The limits of an intermittent stream are determined to be the height of the banks when water is at high water.
The lower limit of areal streams entering into bays, estuaries, gulfs, oceans, or seas is defined at the place where the stream reaches a width of 1 nautical mile with no further constrictions, if the land and water do not otherwise make the division obvious.

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
All streams are captured to within 0.5" of saddles or divides.
Capture all tributaries with a length of 1.25" or longer.
Capture additional tributaries less than 1.25" in length if needed for contour portrayal.
If overedge source is not available to make length determination, all streams intersecting cell boundaries will be captured, regardless of length.
Capture all streams that are connected to springs or ponds.
Capture only the above-ground portion of streams. See feature SINK for those streams which disappear in karst areas.
Capture a representative pattern for braided streams: always collect perennial streams, always collect double-line streams, always collect streams which form bounding limits.

Source Interpretation Guidelines -
All sources -
If a stream/river is controlled by locks, a normal pool elevation is required. Water surface elevations are given to the nearest whole foot. Artificial lakes formed by water impounded by a dam are considered under the feature LAKE/POND.
Dry washes, arroyos, dry gulches, and ephemeral streams are considered under the feature WASH.

Image -
If image shows a lower than average water elevation, look for evidence of water marks, delineate at that level.
If image shows higher than average water elevation, the mean water level must be obtained from ancillary sources.

Graphic -
Approximate, indefinite, and unsurveyed streams/rivers have a delineation status of "apparent."
Braided stream - capture all channels.

DLG-3 -
Approximate, indefinite, and unsurveyed streams/rivers have a delineation status of "apparent."

Valid Attributes -
All attributes are valid.

REPRESENTATION RULES at 1:24,000 scale-

Composition Rules -
If stream is linear, stream is composed of sequenced, directed chain(s).
If stream is areal, stream is composed of area bounded by shoreline(s), with inflow to/outflow from junction, vertically related to other feature.

Delimiting Rules - delimit instance using rules for network links.
Special Conditions -
The stream representation will change from the linear representation to areal representation when the stream width becomes greater than 0.02".
To accommodate variations in stream width:
if stream (area) becomes
less than 0.02" but greater than 0.01" for greater than 2.64", represent feature as an area
less than 0.02" but greater than 0.01" for less than 2.64", represent feature as a line
less than 0.01" regardless of distance, represent as a line
if stream (line) becomes
greater than 0.02" but less than 0.03" for less than 2.64", represent as a line
greater than 0.02" but less than 0.03" for greater than 2.64", represent as an area
greater than 0.03" regardless of distance, represent as an area.

Transitional tapering from linear representation to areal representation will take place over a distance of 0.15" prior to the 0.02" width requirement, and vice versa.

SPRING - A place where water issues from the ground naturally.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Angle of orientation - The angular measurement of a feature, calculated from true north (0 degrees), clockwise to the major axis of the feature.

0 - 359 degrees   Increment: 1 degree
Not applicable

Name - The proper name, specific term, or expression by which the feature is known.

(Character identifier)
Not applicable
Unknown

Water characteristics - The distinctive properties of the water.

Alkaline   Water shows evidence of alkali salts.
Hot   Water temperature is higher than that of the human body (98 degrees).
Sulfur   Water shows evidence of enough hydrogen sulfide to smell and/or taste.

Unspecified

DELINEATION -

A spring is an area, bounded by the edges of the place where water issues from the ground.

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
All required

Source Interpretation Guidelines -
All sources -
The major axis for angle of orientation on isolated springs is along its downward slope.
Springs located within stream/river or lake/pond do not require angle of orientation.

DLG–3 -
If the DLG–3 descriptive code is 050.0615 (mineral or hot), the compiler must reference the source graphic to determine the attribute value.

Field -
Evidence of alkali salts is determined by observation of alkali residue around the spring.

Valid Attributes -
All attributes are valid.

REPRESENTATION RULES at 1:24,000 scale -

Composition Rules -
If spring is located within a stream, spring is composed of a node.
If spring is not located within a stream, spring is composed of a point.

Delimiting Rules -
         Special Conditions -

UNDERPASS - The occurrence of an intersection of two feature instances with a vertical relationship.

ATTRIBUTE/ATTRIBUTE VALUE LIST - None

DELINEATION - Not applicable

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
Use when features carrying traffic or having flow pass under other features and the relative vertical information cannot be determined by other information.

Source Interpretation Guidelines -
Not applicable

Valid Attributes -
Not applicable

REPRESENTATION RULES at 1:24,000 scale -

Composition Rules -
When the overpassing/underpassing features are both chains, and not coincident, underpass is composed of a node, vertically related to other features.

When the overpassing/underpassing features are both chains, and are coincident, underpass is composed of chains, vertically related to other features.

When one of the overpassing/underpassing features is a chain and the other is an area, underpass is composed of a chain, vertically related to other features.

When the overpassing/underpassing features are both areas, underpass is composed of an area, vertically related to other features.

Delimiting Rules -

Special Conditions -
Only two features may be vertically related with the feature "underpass." In the case of three or more features overpassing each other at the same spatial location, only vertically adjacent features shall be referenced in the "underpass" feature. Thus, a triple overpass shall generate two underpass instances - one for the top and middle features and another for the middle and bottom features.

JUNCTION - The occurrence of an intersection of two areal features having flow.

ATTRIBUTE/ATTRIBUTE VALUE LIST - None

DELINEATION - Not applicable

DATA EXTRACTION at 1:24,000 scale -

> Capture Condition -
> Use when one areal network link with flow joins another or when an areal network link with flow intersects the cell boundary.
>
> Source Interpretation Guidelines -
> Not applicable
>
> Valid Attributes -
> Not applicable

REPRESENTATION RULES at 1:24,000 scale -

> Composition Rules -
> Junction is composed of chains, with inflow to/outflow from other areal features.
>
> Delimiting Rules -
>
> > Special Conditions -

SHORELINE - A naturally occurring line of contact between a body of water and land.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Delineation status -	The level of confidence with which a feature can be defined.
Apparent	Conditions prevent the feature from being confidently defined because of obscuring vegetation or shadows.
Definite	Conditions permit the feature to be confidently defined.

DELINEATION -

The definite shoreline is the line of contact between water and land. The apparent shoreline in tidal areas is the seaward edge of marine vegetation where that limit would reasonably appear as the shoreline to the mariner. The apparent shoreline for inland areas is the estimated line of contact between water and land.

DATA EXTRACTION at 1:24,000 Scale -

Capture Condition -
Capture all natural shorelines bounding other features that meet minimum capture conditions.

Source Interpretation Guidelines -
Image - The position of a shoreline is interpreted at a water level defined by the feature to be bounded.

Graphic - All shorelines are captured as shown on graphic. Shorelines shown as indefinite, approximate, or unsurveyed will be captured as with a delineation status of "apparent."

DLG-3 - The following attributes will convert to the DLG-E feature shoreline:
    050 0200 Shoreline - collect as definite shoreline
    050 0203 Indefinite Shoreline - collect as apparent shoreline
    050 0207 Apparent Shoreline - collect as apparent shoreline
    050 0201 Manmade Shoreline becomes a feature in DLG-E.

Valid Attributes -
All attributes are valid.

REPRESENTATION RULES at 1:24,000 scale -

Composition Rules - shoreline is composed of chain(s), bounds lake/pond, sea/ocean, stream/river, areas to be submerged, bay/estuary/inlet, inundation area.

Delimiting Rules - Delimit instances using the rules for network links.
        Special Conditions -

RESERVATION - Bounded land set aside for a particular purpose, generally having certain use restrictions.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Name -	The proper name, specific term, or expression by which the feature is known.
(Character identifier) Not applicable Unknown	
Reservation class -	The primary use associated with the reservation.
Forest	Area primarily for the management of forest resources.
General case	
Grassland	Area primarily for the management of native grasses.
Indian land	As defined by Bureau of Indian Affairs.
Military	Area primarily for military activities and purposes.
Park	Area primarily for preservation of a cultural or natural resource.
Prison	Area for housing persons convicted or accused of crimes.
Wilderness	Area virtually unsettled and uncultivated (natural); includes areas designated by an administrative group as wilderness, primitive, wild and scenic, or similar designation.
Wildlife	Area primarily for wildlife management or preservation; includes the following areas: conservation, game, hunting/fishing, preserve, or other area with "wildlife" in name.
Unknown	
Reservation administrative status - National State	Managing authority.
Regional	Group of State, county, and/or city governments.
County City Unknown	

DELINEATION -

The reservation area is delineated by the boundary line that surrounds the reservation. The area is usually defined by law, proclamation, or ownership.

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
Capture all reservations.
Nonproclaimed inholdings greater than .05" in the shortest dimension should be excluded from the reservation.

Source Interpretation Guidelines -
Graphic - capture limits (boundaries) of area as shown on graphic. Update as current description indicates.

DLG-3 - capture area attribute codes:
090 0103 through 0111, 0129 through 0134, 0150 - compiler must reference the source graphic to determine appropriate reservation class.
090 0420 (cemetery) with coincidence code 209 0009 - this indicates National cemetery.

Field - contact administrative group and obtain legal description. When bounded by a road, determine whether the reservation extends to the center of the road or to the edge of the road. The description should be used to verify other sources.

Valid Attributes -
all attributes are valid.

REPRESENTATION RULES at 1:24,000 scale -

Composition Rules -
Reservation is composed of area, bounded by boundary line.

Delimiting Rules -
        Special Conditions -

BOUNDARY LINE - A separation between divisions of current or past significance.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Delineation status -	The level of confidence with which a feature can be defined.
Approximate/Indefinite	Conditions prevent the feature from being located to meet NMAS.
Definite	Conditions permit the feature to be confidently defined.
Disputed	The location of State, county or national reservation boundary is in controversy because of conflicting or unclear legal definitions.
Historical	The location can be confidently defined but has lost its original significance.
Protracted	Boundary line is extended from or fit between established surveyed points pending actual ground survey.
Name -	The proper name, specific term, or expression by which a particular geographic entity is known.
(Character identifier)	
Not applicable	
Unknown	

DELINEATION -

Boundary lines are delineated as defined by law or proclamation.

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
Capture all established civil boundaries.

Source Interpretation Guidelines -
Graphic -
Interpret as shown and adjust to legal description if required.

DLG-3 -
Capture following line attribute codes:
090.0201 becomes Indefinite/Approximate.
090.0202 becomes Disputed.
090.0203 becomes Historical.
If line in DLG-3 boundary category does not carry any of the above descriptive codes, attribute value becomes Definite.
300.0202 becomes Protracted.
300.0205 becomes Definite.

Field -
Obtain legal descriptions. Determine whether boundary lines are coincident with centerlines or edges of features, such as roads, railroads, and streams.

Valid Attributes -
All attributes are valid.

REPRESENTATION RULES at 1:24,000 scale -

Composition Rules -
Boundary line is composed of ordered chains, bounds other features.

Delimiting Rules -
    Special Conditions -

RIDGE - A long and narrow upland with steep sides.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

        Name -   The proper name, specific term, or expression by which the feature is known.

              (Character identifier)

DELINEATION -

        The limits of the ridge are defined by the break in slope between the steep sides of the feature and the relatively flat terrain at the base of the feature.

DATA EXTRACTION at 1:24,000 scale -

        Capture Condition -
        All ridges and associated generics contained in the Geographic Names Information System Phase II listing are required.

        Source Interpretation Guidelines -

        Valid Attributes -
        All attributes are valid.

REPRESENTATION RULES at 1:24,000 scale -

        Composition Rules -
        A ridge is composed of an area.

        Delimiting Rules -
                Special Conditions -

ROAD - An open way for the passage of vehicles.

ATTRIBUTE/ATTRIBUTE VALUE LIST -

Access restrictions -
The constraints on use.

    Private — Maintained by private funds and not open to the public.

    Restricted — Designated for official use only.

    Toll — Controlled by payment of fee for travel.

    Unknown

    Unspecified

Directional status -
The state of movement along the feature.

    Alternating — Movement occurs in both directions, however only one way at a time.

    Bidirectional — Movement occurs in both directions simultaneously.

    Not applicable

    One way — Movement occurs in only one direction.

    Unknown

    Unspecified

Median category -
The existence of a median.

    With median — Curbs or median strips separate opposing traffic lanes.

    Without median — Traffic lanes are not separated by curbs or median strips.

Name -
The proper name, specific term, or expression by which the feature is known.

    (Character identifier)

    Not applicable

    Unknown

Number of lanes or tracks -

    (Integer value)

    Unspecified

    Unknown

Operational status -
The state or condition.

    Abandoned — Intact but not maintained or intended for use.

    Operational — Usable and intended for use.

    Proposed — Planned in detail, but construction not started.

    Under construction — Construction started, but not complete.

    Unknown

Road class -
The classification of roads based on design, weatherability, governmental designation, and the Department of Transportation functional classification system.

    1st — Hard-surface highways including interstate and U.S. numbered highways (including alternates, primary State routes, and all controlled access highways).

    2nd — Hard-surface highways including secondary State routes, primary county routes, and other highways that connect principal cities and towns, and link these places with the primary highway system.

    3rd — Hard-surface highways not included in a higher class and improved, loose-surface roads passable in all kinds of weather. These roads are adjuncts to the primary and secondary highway systems. Also included are important private roads such as main logging or industrial roads which serve as connecting links to the regular road network.

4th	Improved, loose-surface roads passable only in fair weather.
5th	Unimproved roads passable only with four-wheel-drive vehicles. Included are one-lane roads on levees, and maintenance roads along transmission and other similar features.
Unknown	

Road type -	The purpose or function.
General case	Common use.
Overlook	A pull-off area designated as scenic, having definite entrance and exit points that are separated from the roadway.
Ramp	An inclined road connecting roads of differing levels.
Rest area	An access road to service facilities such as service stations, weigh stations, comfort stations, restaurants, and parking areas.
Runaway truck ramp	A short inclined road constructed of unconsolidated material that exits gradually from and runs adjacent to the right lane of a descending highway, for stopping runaway trucks.
Traffic circle	A junction of roads that forms a circle around which traffic moves in one direction.
Unknown	

Route designator -	The official alphanumeric identifier.

(Alphanumeric identifier)

   -->Route type

      Alternate
      Business
      Bypass
      Connector
      Loop
      Spur
      Truck
      Unspecified

Unspecified
Unknown

Width -	The span of the feature perpendicular to traffic flow.
(Integer value)	
Unspecified	
Unknown	

DELINEATION -

A road is delineated by the edge of all traffic lanes, excluding the shoulders.

DATA EXTRACTION at 1:24,000 scale -

Capture Condition -
All roads are captured, excluding driveways that are less than .25".

<u>Source Interpretation Guidelines</u> -
All sources -
Hard-surface construction is generally concrete, asphaltic concrete, or bituminous macadam. Surfaces are waterproof. Minimum maintenance is required.

Improved, loose-surface construction is on light foundation and is usually gravel or stone surface, or of some stable material, such as selected sand-clay, treated oil gravel, or light tar-bound macadam. The roads are generally drained and graded, but the surface is not waterproof. Periodic maintenance is required.

Unimproved-surface construction is usually stabilized soil, sand-clay, or disintegrated rock with poor or no foundation. The road is sometimes drained or graded. If the roads are maintained at all, continual maintenance is required.

Only class 3 roads are designated to have an access restriction of "private."

Route designators are captured for Interstate highways, U.S. numbered highways, and State highways.

Names are captured for expressways and turnpikes, historical names required to preserve continuity of a feature, all streets in urban areas, and well-known or posted roads in rural areas.

Image -
For dual highways less than or equal to .035" in overall width, capture the median centerline, with median category value of "with median" and width with a value for the extent of the road including the median.

For dual highways greater than .035" in overall width, capture the centerline of each roadway, with median category value of "with median" and width with a value for the width of each roadway.

REPRESENTATION RULES at 1:24,000 scale -

<u>Composition Rules</u> -
If width is less than or equal to .05", road is composed of ordered chain(s), vertically related to other feature.

If width is greater than .05", road is composed of area, connected to junction, with inflow to/outflow from junction, vertically related to other feature.

<u>Delimiting Rules</u> - Delimit instances using rules for network links.
   <u>Special Conditions</u> -

4. INSTANCE COUNT SUMMARY

For the example DLG–E feature data specification, 24 features were selected from the 202 features defined in the DLG–E features list (and four additional modeling constructs). Note: only nine of the feature data specifications are actually documented in this appendix. A total of 67 feature instances (of the 24 features) were discernible from the source material provided and met the capture conditions specified in the DLG–E feature data specification. The instance count summary details how many instances occurred for each feature and the number of attributes for each feature.

Feature	Number of Feature Instances (A)	Number of Attributes (B)	A x B
Named Feature	7	1	7
Road	15	7	105
Railway	1	4	4
Stream	8	3	24
Lake	1	2	2
Spring	1	2	2
Dam	1	3	3
Shoreline	2	1	2
Junction	1	0	0
Nation	1	1	1
State Territory	1	2	2
County	2	2	4
Domain	1	0	0
Public Survey Area	2	3	6
Ridge	1	1	1
Cemetery	1	1	1
Institutional Site	1	2	2
Reservation	3	3	9
Bridge	1	4	4
Building	5	2	10
Underpass	4	0	0
Trail	1	3	3
Ford	1	1	1
Boundary Line	5	1	5
TOTALS	67 instances (counted)		198 computed attribute values

5. GRAPH PLOTS

Plots of the resultant DLG–O are provided to identify the spatial objects referenced by the Relationship Tuple Table. For clarity, two plots were produced. Chain (line) and point ID's are labeled on the first plot. Area ID's are labeled on the second plot. Arrows on the chain plot indicate the direction of each chain.

Chains and Points with ID Numbers

► – Chains   ▪ – Points

Labeled Chains and Points
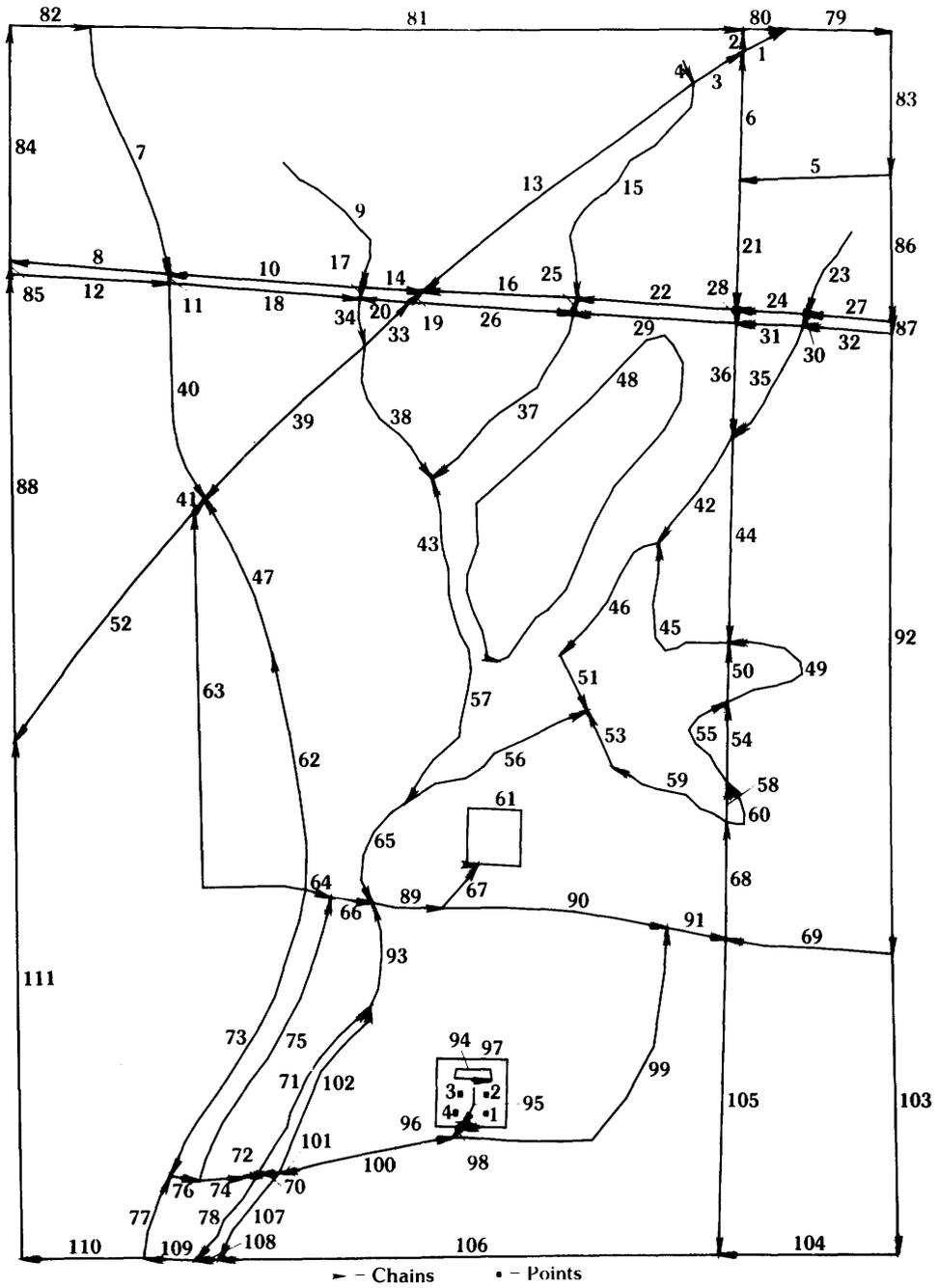
Areas with ID Numbers
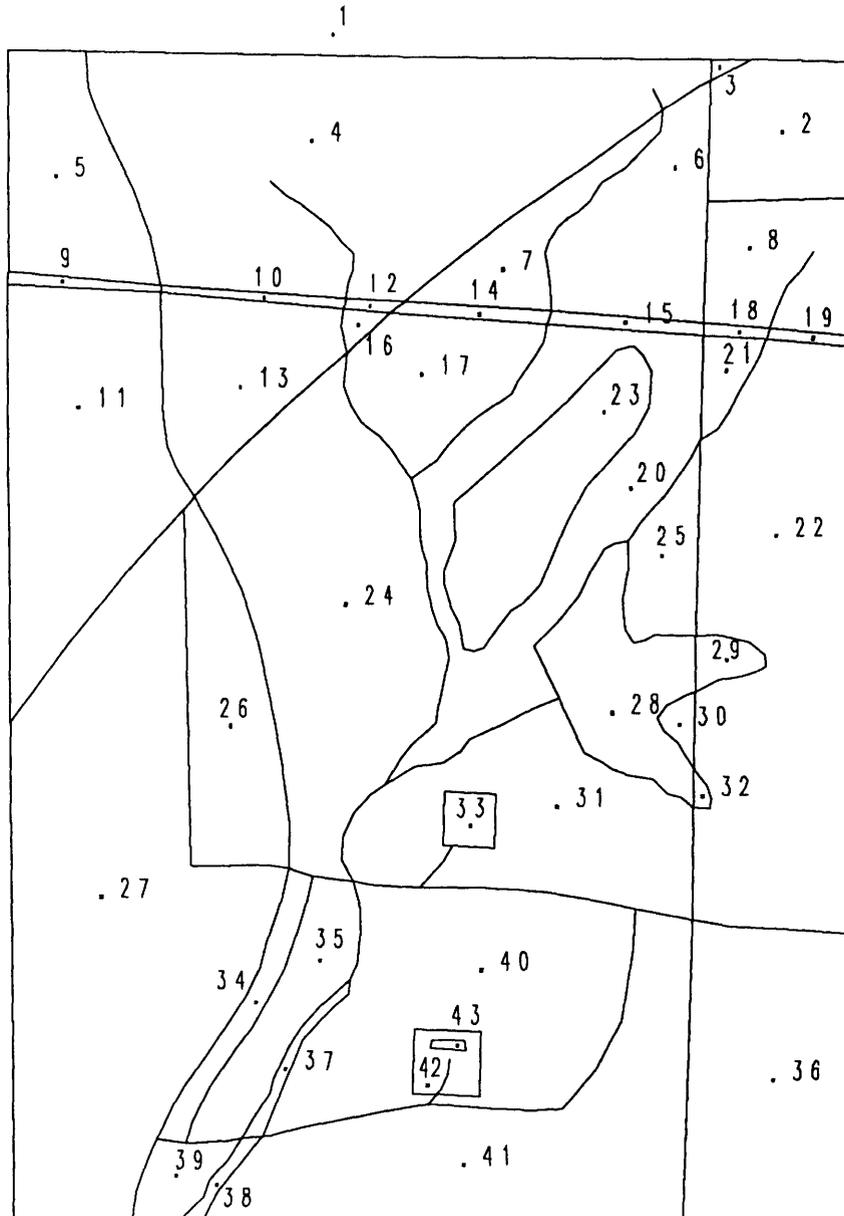
6. DLG–O+ RELATIONAL TABLES FOR USE WITH DLG–E DATA

Explanations of the eight relational tables designed for use with DLG–E data are presented. Definitions of the fields (domains) of the tables are given, distinguishing key fields, foreign ID fields, and "other" fields. The information provided in this section is necessary for the reader to understand the case examples which follow.

This section presents the design of a set of DLG–O+ tables or "flat files" for use in implementing DLG–E features, nonspatial (nonlocational) attributes and values, and nontopological relationships. In a DLG–O+ data set, DLG–E data are separated into spatial and nonspatial components. A DLG–O file, without attributes or text, carries the spatial information. DLG–O+ flat files carry the nonspatial information. This organization is much like that employed by a number of currently available commercial geographic information systems. ARC/INFO, for example, stores spatial data in ARC files and nonspatial data in related INFO (a commercial relational data base management system) files.

The following named tables have been specified for use with DLG–E data:

1. Feature Object table
2. Entity Label table
3. Attribute Definition table
4. Relationship Definition table
5. Attribute Value table
6. Name/Text table
7. Attribute Assignment table
8. Relationship Tuple table

THE USE AND STRUCTURE OF "OBJECT" KEYS AND FOREIGN IDENTIFIERS

In a DLG–O file, each topological object has an associated key by which it may be uniquely identified and referenced. In the tables presented below, each feature object instance, attribute value (including name/text) instance (or set--see below), entity label, attribute value assignment, and relationship tuple instance (or set) also has such a key. When referenced from other records, these keys are termed "foreign identifiers" (foreign ID). In the tables, a given foreign ID field may reference more than one type of object, attribute value, or relationship instance. For this reason, the structure of these keys and foreign ID's must be identical.

Each object key/foreign ID begins with a single letter indicating object type, followed by a five-digit integer unique within that object type and data set. The following letters, used throughout the remainder of this section to refer to object types, tables, and types of foreign identifiers, indicate object type:

"A" indicates an Area (polygon),
"C" indicates a Chain,
"N" indicates a Node,
"P" indicates a Point,
"F" indicates a Feature object,
"E" indicates an Entity label,
"V" indicates an Attribute value,
"T" indicates a Name/Text,
"S" indicates an Attribute assignment, and
"R" indicates a Relationship tuple.

The first four object types are the topological objects in the DLG–O file; the five digit integers identifying those objects are the same as the "element internal ID" numbers in the DLG–O Area, Line, and Node Identification records. The remaining six "object" types are represented by the records of the tables of the same name. Note that attribute labels and relationship labels also have unique keys (in the Attribute Definition and Relationship Definition tables, respectively), but these are referenced from specific foreign ID fields reserved just for them (in the V, T, and R tables). These keys therefore need not have the same structure as the "object" keys.

MINIMUM FOUR-TABLE SET PLUS FOUR

A minimum set of tables, designed to carry all the nonspatial components of the DLG–E model could consist of just four tables. Two tables, (1) Attribute Definition and (2) Relationship Definition, carry definitional data, and two tables, (3) Attribute Value and (4) Relationship Tuple, carry instance data. The Attribute Definition table would carry a record for each unique attribute label (term) in the data set (with special records for "Entity Label" and "Comment"). The Attribute Value table carries the actual attribute values (as well as entity labels, names, and comment text). In order to interpret the attribute values correctly, each Attribute Value record carries the foreign ID of the appropriate Attribute

Definition record. Likewise, the Relationship Definition table carries a record for each unique relationship in the data set (with a special record for an "Attributed by" relationship). The Relationship Tuple table carries the actual pair-wise object-to-object instances of these relationships.

For efficiency (e.g., DLG–O+ must implement these tables as fixed-length fields and records) and other reasons, additional tables are developed here. To the minimum four, four tables are added: (5) Entity Label, (6) Name/Text, (7) Attribute Assignment, and (8) Feature Object. No new information is handled by these tables, but rather information which might have been carried in the minimum table set is separated out and placed in the additional tables. The Entity Label and Name/Text tables contain, in essence, special case records from the Attribute Value table. The Attribute Assignment table contains all the "Attributed by" records from the Relationship Tuple table. The Feature Object table summarizes certain feature object data.

The reason for adding the Name/Text table is for storage efficiency. When implementing tables within a fixed-length record environment, the length of the Value field in Attribute Value table would have to be set to the longest name or text string value. Instead we will remove those names and long text strings and keep the Value field only large enough to handle single numbers and short alphanumeric codes (e.g., 24 bytes). The Name/Text table has the identical structure as the Attribute Value table, but with a much larger value field for handling names and other long textual attribute values.

The reason for adding the Entity Label, Attribute Assignment, and Feature Object tables is for clarity. To have a more explicit structural equivalence to components of the DLG–E data model and the entity/attribute feature definition model, Entity Labels are distinguished from Attributes (by the Entity Label table), and Entities and Attributes are distinguished from Relationships (by the Attribute Assignment table). And finally the Feature Object table provides feature objects with their own "starting place" access table with records keyed by feature object ID (without this table, feature objects would be the only "objects" without a table explicitly keyed to their ID's).

A DESCRIPTION OF FOLLOWING SUBSECTIONS

The remainder of this section consists of three subsections.

Full Descriptions of DLG–O+ Tables for Use with DLG–E:

Five numbered items describe each of the eight tables:

1. Name of Table;
2. Purpose - a brief summary description;
3. Key field:
   Name - always the name of the table followed by "Key,"
   Unique? - "YES" or "NO" (if "NO" (for Attribute Value, Name/Text, Attribute Assignment, and Relationship Tuple tables), then a secondary field named "Order Sequence Number" is concatenated with the key field to provide a unique key for each record), and
   Construction - "[object type letter]" + 5 digits, except for the Attribute Definition and Relationship Definition tables;
4. Foreign ID field(s) - for each foreign ID field, its full name is given followed by a description, including purpose and what records (by object type if appropriate) may be referenced; and
5. Other fields - for each of the remaining fields, its full name is given followed by a description, including purpose and a definition of possible data item contents.

Table/Field Summary:

For each table, a FORTRAN record format is given (these are what have been used for this example only--other formats may be developed for more voluminous datasets). Then for each field, its full name is equated to a short three- to five-character mnemonic and its byte (column) position within the record. This summary is meant to provide a user with the means to read individual records in the case examples (section B.7) and to allow short field names to be used in discussions which follow (and in programming languages).

Foreign ID's Pointing to "Object" Keys:

This subsection presents a discussion of how the records of the various DLG–O+ tables interrelate through the use of foreign ID's. Specifically, for each table (except the Entity Label, Attribute Definition, and Relationship Definition tables, which do not have foreign ID fields), each foreign ID field is related to the key field(s) of other table records to which the foreign ID may refer.

<u>Full Descriptions of DLG-O+ Tables for Use with DLG-E</u>

1. Name of Table: **Feature Object**

2. Purpose: This table provides a summary of the information carried in the other tables about each feature object.

3. Key field name: Feature Object Key
   Unique?: YES.
   Construction: "F" + 5 digits.

4. Foreign ID field(s):

   Primary Entity Label - this field carries the foreign ID of the primary entity label (in the Entity Label table) of this object. Usually one and only one entity label is assigned a given feature object. If no entity label is assigned to a feature object, this field shall be null. If more than one entity label is assigned a given feature object, one of the labels must be chosen as the "primary" label.

5. Other fields:

   (a) Dimensionality -- indicates the spatial dimension of the feature object; must be one of the following characters:
       "0" (point features),
       "1" (linear features),
       "2" (areal features),
       "M" (mixed), or
       "U" (unknown).

   (b) Composition -- indicates the type of objects which comprise this feature object. This is defined by the object type code of those objects recorded as second tuple elements in Relationship Tuple records with the defined relationship being "Composed of" and this feature object as first tuple element. In addition to the type codes F, A, P, N, and C, the contents of this field may be:
       "S" to indicate a mixed spatial object (A, P, N, and C type objects) composition,
       "M" to indicate a mixed feature and spatial object composition (F plus A, P, N, and/or C type objects), or
       "U" for unknown composition.

   (c) Contiguous? -- indicates whether the objects which comprise this feature are spatially contiguous or disjoint. The contents of this field may be "Y" (yes, they are contiguous), "N" (no), or "U" (unknown).

   (d) Number of Unique Relationships -- this is defined as the number of unique Relationship Tuple Keys of all Relationship Tuple records with this feature object as the first tuple element.

   (e) Number of Relationship Tuple records -- the actual number of Relationship Tuple records with this feature object as the first tuple element.

   (f) Number of Entity Labels Assigned -- indicated by the number (normally one) of Attribute Assignment records with an entity label assigned to this feature object.

   (g) Number of Attribute Values (or Value Sets) Assigned -- indicated by the number of Attribute Assignment records with Attribute Value foreign ID's (one ID may reference one Attribute Value record or a set of records with the same key representing an attribute value set) assigned to this feature object.

   (h) Number of Name/Text Strings (or String Sets) Assigned -- indicated by the number of Attribute Assignment records with Name/Text foreign ID's (one ID may reference one Name/Text record or a set of records with the same key representing a name/text string set) assigned to this feature object.

==

1. Name of Table: **Entity Label**

2. Purpose: This table serves to store the actual entity labels associated with feature objects. There is one record in this table for each unique entity label assigned to one or more of feature objects.

3. Key field name: Entity Label Key
   Unique?: YES--as opposed to Attribute Value records, each of which may carry an individual value of a multivalued attribute value set, Entity Label records must always be referenced individually.
   Construction: "E" + 5 digits.

4. Foreign ID field: none.

5. Other fields:

   (a) Entity Label -- the actual alphanumeric text which is a feature/entity term (e.g., "Road").

   (b) Definition Authority - Source of the definition for this feature/entity term (e.g., "USGS/NMD, DLG–E").

===

1. Name of Table: **Attribute Definition**

2. Purpose: This table provides the means for interpreting attribute values in the Attribute Value and Name/Text tables.

3. Key field name: Attribute Definition Key.
   Unique: YES.
   Construction: "AD" + 4 digits.

4. Foreign ID field(s): none.

5. Other fields:

   (a) Attribute Label - Name given to this attribute (e.g., "Width").
   Note that if the minimum table set were used, "Entity Label" would be a special reserved attribute label indicating that the Attribute Value field is to be read as a feature/entity term; an Entity Label table, if present, obviates the need for this special attribute label.

   (b) Attribute Definition Authority - Source of the definition for this attribute (e.g., "USGS/NMD, DLG–E").

   (c) Attribute Value Format - How to read the values assigned to this attribute; must be one of the following (Note: coding should follow ISO-6093, etc. standards):
   A ("printable" ASCII characters)
   I (implicit-point--integer),
   R (explicit-point unscaled--real without exponent),
   S (explicit-point scaled--real with exponent),
   B (bitfield data), or
   C (character-mode bitfield).

   (d) Attribute Value Measurement Units (e.g., "meters") - this field may be null for nonnumeric attribute values.

Further Comments:

   The Attribute Definition table will carry one record for each defined nonlocational attribute used in the DLG–E data set. The meaning of the actual labels (in the Attribute Label field) and values (in the Attribute Value and Name/Text tables--see below) are defined by some authority (e.g., USGS/NMD, DLG–E), but this meaning is not repeated here. The Attribute Authority field is meant as a reference for such definition.

   Note also that a given attribute label, including "Entity Label," is not necessarily unique. Different authorities may be used to define feature/entity terms or different meanings to attributes of the same name. The combination of attribute label and attribute authority is what makes an attribute unique.

===

1. Name of Table: **Relationship Definition**

2. Purpose: provides information for interpreting Relationship Tuple records.

3. Key field name: Relationship Definition Key
   Unique?: yes.   Construction: "RD" + 2 digits.

4. Foreign ID field(s): none.

5. Other fields:

   (a) Relationship Label - Name given to this relationship (e.g., "Composed of"). Note that in the minimum table set, a special relationship label, "Attributed by," is reserved to relate Attribute Value records to their owner(s) (objects, attribute values, or relationships)--it is not used when an Attribute Assignment table is present.

   (b) Reverse Relationship Label - Name given to the reverse relationship (e.g., "Part of"). Note that if the relationship is symmetrical (the order of the elements of the tuple is not significant), this name would be the same as the forward Relationship Label.

   (c) Relationship Authority - Source of the definition for this relationship (e.g., "USGS/NMD, DLG–E").

   (d) Domain of the First Tuple Element - indicates what type of objects may participate as the first element in the Relationship Tuple table. One of the single character "object" type codes listed above is carried in this field. In the minimum table set, this be may be F, V, or R. However, when an Attribute Assignment table is present, only feature objects may be first tuple elements; this field will always carry "F." It is therefore unnecessary, but we keep it for compatibility with the minimum table set and for future expansion.

   (e) Domain of the Second Tuple Element - indicates what type of objects may participate as the second element in the Relationship Tuple table. In the minimum table set, the following single character "object" type codes may be present in this field: P, N, C, A, F, V, or R. When an Attribute Assignment table is present, only true object codes (P, N, C, A, and F) may be present.

   (f) Ordered? - must be Y (yes), N (no) or E (either).

   (g) Directed? - this field is important only with Ordered relationships; if Y (yes), then the order of second tuple elements indicates a "ground" direction important to the composition of the real-world entity represented by the first tuple element (e.g., a Stream has a direction of flow).

   (h) Flag Field Meaning - this defines the meaning of the contents of the flag field in the Relationship tuple records (e.g., a negative sign in the field indicates the coordinate string of the referenced chain is to be reversed for this relationship).

==

1. Name of Table: **Attribute Value**

2. Purpose: This table serves to store the actual attribute values of attributes associated with (1) feature objects, (2) other attribute values, or (3) relationships.

3. Key field name: Attribute Value Key
   Unique?: NO--a set of attribute values (one value per record) may be referenced as a whole (by one foreign identifier) if needed and there is no need to reference each individual value of the set.
   To produce a unique key for the Attribute Value records, the Order Sequence Number field (5.(b) below) is concatenated to the Attribute Value Key field.
   Construction: "V" + 5 digits.

4. Foreign ID field:

   Attribute Definition Key (to the Attribute Definition table).

5. Other field:

   (a) Attribute Value -- the actual attribute value data item (as a set of bytes, which are to be interpreted per the Attribute Value Format field of the referenced Attribute Definition record).

   (b) Order Sequence Number - if the value is part of a set (and the records have the same Attribute Value Key), this field provides sequencing data (an integer from 1 to N, the number of values in the set). Also, this field concatenated with the Attribute Value Key field yields a unique key for an individual record.

==

1. Name of Table: **Name/Text**

2. Purpose: This table serves to store the actual "long" alphanumeric attribute values of attributes associated with (1) feature objects, (2) other attribute values, or (3) relationships. Examples of these "long" attribute values are those assigned to the attributes labeled "Name" or "Comment" (in the Attribute Label field of the Attribute Definition table).

3. Key field name: Name/Text Key
    Unique?: NO--a set of alphanumeric strings (one string per record) may be referenced as a whole (by one foreign identifier) if needed and there is no need to reference each individual string of the set. In this manner, for example, a single attribute may be valued by a very long text passage entered as a set of text lines, one line per Feature Name/Text record, and the entire record set would be identified by a single key shared by all the records of the set. To produce a unique key for the Name/Text records, the Order Sequence Number field (5(b) below) is concatenated to the Name/Text Key field.
    Construction: "T" + 5 digits.

4. Foreign ID field:

    Attribute Definition Key (to the Attribute Definition table).

5. Other fields:

    (a) Name/Text String -- the actual alphanumeric text string comprising the value of the referenced Attribute (e.g., Name).

    (b) Order Sequence Number - if the string is part of a set, this field provides sequencing data (an integer from 1 to N, the number of strings in the set). Also, this field concatenated with the Name/Text Key field yields a unique key for an individual record.

==

1. Name of Table: **Attribute Assignment**

2. Purpose: This table provides the means by which (1) attribute values, and (2) names/text, are assigned to (a) feature objects, (b) relationships (as instanced in the Relationship Tuple records), (c) attribute assignments (as instanced in the records of this table), (d) other attribute values, and (e) other feature names/text. This table also provides the means by which entity labels are assigned to only feature objects.

3. Key field name: Attribute Assignment Key
    Unique?: NO--a set of tuples (one pair per record) may be referenced as a whole (by one foreign identifier) if needed and there is no need to reference each individual record of the set.
    To produce a unique key for the Attribute Assignment records, the Order Sequence Number field (5 below) is concatenated to the Attribute Assignment Key field.
    Construction: "S" + 5 digits.

4. Foreign ID field(s):

    (a) Element ID - the Feature Object, Relationship Tuple, Attribute Assignment, Attribute Value, or Feature Name/Text record key of the element to which the attribute is assigned.

    (b) Attribute ID - the Attribute Value, Name/Text, or Entity Label record key of the value(s), name/text, or entity label assigned to the element identified by the Element ID.

5. Other field:

    Order Sequence Number - if an Attribute Assignment record is part of a set (with a common Attribute Assignment Key), this field provides sequencing data (an integer from 1 to N, the number of records in the set). Also, this field concatenated with the Attribute Assignment Key field yields a unique key for an individual record.

==

1. Name of Table: **Relationship Tuple**

2. Purpose: This is an object linkage table. Feature and topological objects are related to feature objects through named relationships (defined in the Relationship Definition table).

3. Key field name: Relationship Tuple Key
    Unique?: NO--a set of tuple records may and should be referenced as a whole (by one foreign identifier) if the set of Second Tuple Elements instance a one-to-many relationship to the feature object identified in the First Tuple Element.
    To produce a unique key for the Relationship Tuple records, the Order Sequence Number field (5(b) below) is concatenated to the Relationship Tuple Key field.
    Construction: "R" + 5 digits.

4. Foreign ID field(s):

    (a) Relationship Definition Key - to the Relationship Definition Table.

    (b) First Tuple Element - the feature object ID of the first element in this relationship tuple.

    (c) Second Tuple Element - the object (feature or topological) ID of the second element of this relationship tuple.

5. Other fields:

    (a) Flag - this field may be used to attach a simple qualifier to this relationship. For example, a sign may be included in this field to indicate the direction of a chain coordinate string included in a linear feature.

    (b) Order Sequence Number - if a set of Second Tuple Elements (in records with identical Relationship Tuple Keys) instance a one-to-many relationship to the feature object identified in the First Tuple Element and the relationship is an ordered one, this field provides sequencing data (an integer from 1 to N, number of records in the set), and when concatenated with the Relationship Tuple Key field yields a unique key for an individual record.

Table/Field Summary

The following summarizes the record layout of each table, including a FORTRAN record format and an itemized field list. For each field, a short mnemonic is given as well as the full field name and fixed field byte positions within the record.

Feature Object Table:
((A1,I5),1X,(A1,I5),1X,I1,1X,A1,1X,A1,1X,I2,1X,I3,1X,I1,1X,I2,1X,I2)

Mnemonic	Cols.	Full Field Name
FKEY	1- 6	Feature Object Key
PEID	8-13	Primary Entity Label Foreign ID
DIMN	15	Dimensionality
COMP	17	Composition
CNTG	19	Contiguous?
NREL	21-22	Number of Relationships
NRTR	24-26	Number of Relationship Tuple Records
NELB	28	Number of Entity Labels Assigned
NAVS	30-31	Number of Attribute Value(Set)s Assigned
NNTS	34-34	Number of Name/Text String(Set)s Assigned

Entity Label Table:
((A1,I5),1X,A22,1X,A8)

Mnemonic	Cols.	Full Field Name
EKEY	1- 6	Entity Label Key
ELABL	8-29	Entity Label
EAUTH	31-38	Definition Authority

Attribute Definition Table:
((A2,I4),1X,A36,1X,A8,1X,A1,1X,A8)

Mnemonic	Cols.	Full Field Name
ADKEY	1- 6	Attribute Definition Key
ALABL	8-43	Attribute Label
AAUTH	45-52	Attribute Definition Authority
AVFMT	54	Attribute Value Format
UNITS	56-63	Attribute Value Measurement Units

Relationship Definition Table:
((A2,I4),2X,A22,1X,A24,1X,A5,1X,A1,1X,A1,1X,A1,1X,A1,1X,A56)

Mnemonic	Cols.	Full Field Name
RDKEY	1- 6	Relationship Definition Key
RLABL	9-30	Relationship Label
REVLB	32-55	Reverse Relationship Label
RAUTH	57-61	Relationship Definition Authority
DOMN1	63	Domain, First Tuple Element
DOMN2	65	Domain, Second Tuple Element
ORD	67	Ordered?
DIR	69	Directed?
MNG	71-126	Flag Meaning

Attribute Value Table:
((A1,I5),1X,(A2,I4),1X,A18,1X,I3)

Mnemonic	Cols.	Full Field Name
VKEY	1- 6	Attribute Value Key
ADID	8-13	Attribute Definition Foreign ID
AVAL	15-32	Attribute Value (Note: actual format of this field is in the AVFMT field in the Attribute Definition table.)
SEQN	34-36	Order Sequence Number

Name/Text Table:
((A1,I5),1X,(A2,I4),1X,A60,1X,I3)

Mnemonic	Cols.	Full Field Name
TKEY	1- 6	Name/Text Key
ADID	8-13	Attribute Definition Foreign ID
TEXT	15-74	Name/Text String
SEQN	75-77	Order Sequence Number

Attribute Assignment Table:
((A1,I5),1X,(A1,I5),1X,(A1,I5),1X,I3)

Mnemonic	Cols.	Full Field Name
SKEY	1- 6	Attribute Assignment Key
EFID	8-13	Element (object types F, E, V, T, R, S) Foreign ID
AFID	15-20	Attribute ("object" types E, V, T) Foreign ID
SEQN	22-24	Order Sequence Number

Relationship Tuple Table:

((A1,I5),1X,(A2,I4),1X,(A1,I5),1X,(A1,I5),1X,A1,1X,I3)

Mnemonic	Cols.	Full Field Name
RKEY	1- 6	Relationship Tuple Key
RDID	8-13	Relationship Definition Foreign ID
E1ID	15-20	First Tuple Element (object type F) Foreign ID
E2ID	22-27	Second Tuple Element (types F, P, N, A, C) Foreign ID
FLAG	29	Flag
SEQN	31-33	Order Sequence Number

<u>Foreign ID's Pointing to "Object" Keys</u>

The following diagrams are meant to show how the contents of foreign identifier fields in the DLG–O+ table records point to the key fields of other records. The Feature Object table is a special case in that many of its fields (with the exception of Primary Entity ID field--PEID) do not necessarily point other records, but they do provide counts and other summary information about the records in other tables (namely the Attribute Assignment and Relationship Tuple tables).

An attempt has been made to illustrate cross-references between fields of the different tables by listing the fields of a given table first, followed by a listing of the fields of each of the tables to which the records of the first table may point. Exact field-to-field references are shown by using different highlighting techniques (i.e. **bold**, *italics*, <u>underline</u>, and shadow).

Feature Object Table:
 FKEY **PEID** *DIMN* *COMP* *CNTG* *NREL* *NRTR* <u>NELB</u> <u>NAVS</u> <u>NNTS</u>

 Entity Label Table:
 EKEY ELABL EAUTH

 Relationship Tuple Table:
 RKEY RDID **E1ID** E2ID FLAG SEQN

 <u>Attribute Assignment Table</u>:
 SKEY <u>BFID</u> AFID SEQN

PEID (Feature Object table) points to **EKEY** (Entity Label table).

DIMN COMP CNTG NREL NRTR summarize information in those *Relationship Tuple Table* records where **E1ID** = **FKEY**.

<u>NELB</u> <u>NAVS</u> <u>NNTS</u> count the number of unique SKEY values in those <u>Attribute Assignment Table</u> records where <u>BFID</u> = **FKEY**.

Relationship Tuple Table:
 RKEY *RDID* **E1ID** <u>E2ID</u> FLAG SEQN

 Relationship Definition Table:
 RDKEY RLABL REVLB RAUTH DOMN1 DOMN2 ...

 Feature Object Table:
 FKEY PEID DIMN COMP CNTG ...

 Node, Area, and Line Id Records in DLG–O file:
 <u>(Record Type, Element ID number)</u> ...

RDID points to *RDKEY* (Relationship Definition table).

E1ID points to **FKEY** (Feature Object table).

E2ID may point to <u>FKEY</u> (Feature Object table), or to <u>Record Type + Element ID number</u> in a DLG–O Node, Line, or Area Id Record.

Attribute Assignment Table:
  SKEY   EFID   <u>AFID</u>   SEQN

    Feature Object Table:
    FKEY   PEID   DIMN   COMP   CNTG   ...

    Relationship Tuple Table:
    RKEY   RDID   E1ID   E2ID   FLAG   SEQN

    Attribute Assignment Table (other records):
    SKEY   EFID   AFID   SEQN

    Attribute Value Table:
    <u>**VKEY**</u>   ADID   AVAL   SEQN

    Name/Text Table:
    <u>**TKEY**</u>   ADID   TEXT   SEQN

    Entity Label Table:
    <u>**EKEY**</u>   ELABL   EAUTH

    EFID may point to any of the key fields (i.e. **FKEY, RKEY, SKEY, VKEY, TKEY,** or **EKEY**) of the six tables listed.

    <u>AFID</u> may point to <u>VKEY</u>, <u>TKEY</u>, or <u>EKEY</u>.

Attribute Value Table:
  VKEY   *ADID*   AVAL   SEQN

    Attribute Definition Table:
    ADKEY ALABL AAUTH AVFMT UNITS

    ADID points to *ADKEY* (Attribute Definition table).

Name/Text Table:
  TKEY   *ADID*   TEXT   SEQN

    Attribute Definition Table:
    ADKEY ALABL AAUTH AVFMT UNITS

    ADID points to *ADKEY* (Attribute Definition table).

7. CASE EXAMPLES

Several examples illustrate how the source, product specification, and representation rules work together to produce digital representations of features in the DLG–O+ data set. The examples lead the reader through many of the relational tables, showing how information is stored and linked.

This section presents a number of individual cases illustrating how DLG–E features are represented in the DLG–E example data set. Feature instances, summarized in section 4, have been extracted from the source materials in section 2 based upon the feature and attribute definitions in appendix A and the DLG–E feature data specifications in section 3. The representations of these feature instances, also based on rules in section 3, have been implemented using the DLG–O+ relational tables defined in section 6, and an associated DLG–O file as plotted in section 5. As can be seen, all parts of this appendix are required to follow the examples in this section.

In pursuing a given example, the reader is encouraged to gather in front of him or her the source graphic (page B-3), the graph plots (pages B-20 and B-21), and the five full DLG–O+ relational tables below (pages B-33 through B-37). The Table/Field Summary (pages B-28 through B-30) can serve as reference for the full field names of the tables.

Each of the examples presents one primary feature instance from the source graphic and follows its representation through the DLG–O+ relational tables and the DLG–O chain and area plots. In the process, related feature instances, where found, are also discussed. In this manner, instances of both the Road and Underpass features are included in the first example; instances of the Stream/River, Shoreline, and Junction features are presented in the second example; and instances of the Reservation and Boundary Line features are covered in the third example.

As discussed in section 6, the DLG–O+ relational tables make extensive use of "object" keys and foreign ID's. Each of the table records has its object key by which it can be referenced by foreign ID's in other table records (see pages B-30 to B-31). When discussing the case examples, the primary focus is on feature instances. As such, the path through the relational tables begins with a record in the Feature Object table, and following the foreign ID pointers, proceeds as follows:

1. The Feature Object record contains the key value ("F" + ID number) for the instance and points to its Entity Label (i.e. feature term) in the Entity Label table (as well as summarizes related records in the Attribute Assignment and Relationship Tuple tables);

2. The Attribute Assignment table assigns Attribute Value and Name/Text records to the feature object (and to other "objects" (e.g., other attribute values) as well);

3. The Attribute Value and Name/Text records contain actual values and text strings; each of these records points to its Attribute Label (i.e. attribute term) and associated value format in a record of the Attribute Definition table.

4. The Relationship Tuple records relate objects in the DLG–O file (points, nodes, chains, and areas), as well as other feature objects, if appropriate, to feature objects. Each Tuple record also points to a Relationship Definition table record which defines which relationship is being instanced.

FULL DLG–E EXAMPLE DATA SET TABLES

Five of the eight DLG–O+ relational tables defined for DLG–E data are relatively brief for the DLG–E example data set. The Entity Label, Attribute Definition, Relationship Definition, Attribute Value, and Name/Text tables are included here in their entirety for use by each of the examples to follow. For the Feature Object, Attribute Assignment, and Relationship Tuple tables, those records (and only those records) pertaining to the actual case examples will be presented within the context of the discussion of the example. Note: the column headings in each of the example tables are the field mnemonics presented in the Table/Field Summary in section 6 (pages B-28 to B-30).

Entity Label Table (in its entirety):

EKEY	ELABL	EAUTH
E00001	NAMED FEATURE	USGS/NMD
E00002	ROAD	USGS/NMD
E00003	RAILWAY	USGS/NMD
E00004	STREAM	USGS/NMD
E00005	LAKE	USGS/NMD
E00006	SPRING	USGS/NMD
E00007	DAM	USGS/NMD
E00008	SHORELINE	USGS/NMD
E00009	JUNCTION	USGS/NMD
E00010	NATION	USGS/NMD
E00011	STATE/TERRITORY	USGS/NMD
E00012	COUNTY	USGS/NMD
E00013	DOMAIN	USGS/NMD
E00014	PUBLIC SURVEY DOMAIN	USGS/NMD
E00015	RIDGE	USGS/NMD
E00016	CEMETERY	USGS/NMD
E00017	INSTITUTIONAL SITE	USGS/NMD
E00018	RESERVATION	USGS/NMD
E00019	BRIDGE	USGS/NMD
E00020	BUILDING	USGS/NMD
E00021	UNDERPASS	USGS/NMD
E00022	TRAIL	USGS/NMD
E00023	FORD	USGS/NMD
E00024	BOUNDARY LINE	USGS/NMD

This table is a list of the 24 DLG–E features (types, not instances) found in the contrived source materials. Each feature instance is represented by a feature object. Each Feature Object record contains a pointer to one record in the Entity Label table, indicating which type of feature is being instanced. The Attribute Assignment table also contains records which relate Entity Labels to Feature Objects (as such these records are redundant when only one Entity Label is assigned to a given Feature Object).

Attribute Definition Table (in its entirety):

ADKEY	ALABL	AAUTH	AVFMT	UNITS
AD0001	ACCESS RESTRICTION	USGS/NMD	A	
AD0002	NAME	USGS/NMD	A	
AD0003	ROUTE DESIGNATOR	USGS/NMD	A	
AD0004	OPERATIONAL STATUS	USGS/NMD	A	
AD0005	ROAD CLASS	USGS/NMD	A	
AD0006	TRAFFIC DIRECTION	USGS/NMD	A	
AD0007	NUMBER OF LANES OR TRACKS	USGS/NMD	I	
AD0008	RAILWAY GAUGE	USGS/NMD	A	
AD0009	HYDROGRAPHIC CATEGORY	USGS/NMD	A	
AD0010	WATER CHARACTERISTIC	USGS/NMD	A	
AD0011	MATERIAL COMPOSITION	USGS/NMD	A	
AD0012	SPILLWAY ELEVATION	USGS/NMD	I	FEET
AD0013	DELINEATION STATUS	USGS/NMD	A	
AD0014	FIPS CODE IDENTIFIER FIRST	USGS/NMD	A	
AD0015	FIPS CODE IDENTIFIER SECOND	USGS/NMD	A	
AD0016	ORIGIN OF SURVEY NAME	USGS/NMD	A	
AD0017	RANGE	USGS/NMD	A	
AD0019	TOWNSHIP	USGS/NMD	A	
AD0020	INSTITUTIONAL FUNCTION	USGS/NMD	A	
AD0021	RESERVATION TYPE	USGS/NMD	A	
AD0022	RESERVATION USE STATUS	USGS/NMD	A	
AD0023	COVERING	USGS/NMD	A	
AD0024	NUMBER OF DECKS	USGS/NMD	I	
AD0025	ANGLE OF ORIENTATION	USGS/NMD	I	DEGREES
AD0026	BUILDING CLASS	USGS/NMD	A	
AD0027	TRAIL TYPE	USGS/NMD	A	
AD0029	ROUTE TYPE	USGS/NMD	A	
AD0030	COMMENT	USGS/NMD	A	

This table contains a record for each unique Attribute Label term used in the DLG–E example data set. Each Attribute Value and Name/Text record contains a pointer to a record in this table, indicating which Attribute is being valued. Also, the AVFMT field in this table indicates how to read the AVAL field in the Attribute Value record, and for numeric attribute values, the UNITS field indicates the units of measure.

Relationship Definition Table (in its entirety):

RDKEY	RLABL	REVLB	RAUTH	DOMN1	DOMN2	ORD	DIR	MNG
RD0001	Composed of	Part of	DLG–E	F	P	N	N	
RD0002	Composed of	Part of	DLG–E	F	N	N	N	
RD0003	Composed of	Part of	DLG–E	F	C	N	N	
RD0004	Composed of	Part of	DLG–E	F	A	N	N	
RD0005	Composed of	Part of	DLG–E	F	F	N	N	
RD0006	Composed of	Part of	DLG–E	F	C	Y	N	F1
RD0007	Composed of	Part of	DLG–E	F	F	Y	N	
RD0008	Composed of	Part of	DLG–E	F	C	Y	Y	F1
RD0009	Composed of	Part of	DLG–E	F	F	Y	Y	F1
RD0010	Bounded by	Bounds	DLG–E	F	F	E	Y	F2
RD0011	Vert. relates	Vert. related by	DLG–E	F	F	Y	N	O1
RD0013	Flows to	Flows from	DLG–E	F	F	N	Y	
RD0014	Connects to	Connects to	DLG–E	F	F	E	Y	

Each Relationship Tuple record contains a pointer to a record in this table indicating what relationship is being instanced. The relationships are those listed as "nontopological" in table 4 in "Concepts of DLG–E Design," page 5, with added distinctions made to the "composed of/part of" relationship (by object types, ordering of members of a relationship tuple set, and "ground" significance of direction).

Note that the Flag Meaning field (MNG) has been shortened to allow listing here. The following explains how the Flag Meaning field (MNG) indicates the meaning of the Relationship Tuple record FLAG and/or SEQN field contents:

F1   Flag Meaning #1

"+"   in the FLAG field of the Relationship Tuple record indicates that the direction defined by the order of the coordinates of the one-dimensional object referenced by E2ID (chain for RD0006 and RD0008, and feature for RD0009) matches the direction of the feature object referenced by E1ID.

"-"   in the FLAG field indicates that the direction defined by the order of the coordinates of the one-dimensional object referenced by E2ID is the opposite of the direction of the feature object referenced by E1ID.

F2   Flag Meaning #2

"+"   in the FLAG field of the Relationship Tuple record indicates that the direction of the one-dimensional feature object referenced by E2ID is clockwise around the bounded two-dimensional feature object referenced by E1ID (area is to the right).

"-"   in the FLAG field indicates that the direction of the one-dimensional feature object referenced by E2ID must be reversed to allow the bounded object referenced by E1ID to be to the right.

O1   Order Meaning #1

"1"   in the SEQN field of the Relationship Tuple record indicates that the feature object referenced by E2ID is the "above" feature.

"2"   in the SEQN field indicates that the E2ID feature is "below."

Attribute Value Table (in its entirety):

VKEY	ADID	AVAL	[SEQN is not used]
V00001	AD0001	NONE	
V00004	AD0004	OPERATIONAL	
V00005	AD0005	1ST	
V00006	AD0006	TWO WAY	
V00007	AD0007		2
V00014	AD0007		4
V00031	AD0003	US63	
V00041	AD0006	ONE WAY	
V00052	AD0003	I-44	
V00061	AD0005	2ND	
V00087	AD0003	ROUTE CC	
V00115	AD0003	ROUTE 2	
V00121	AD0027	UNKNOWN	
V00124	AD0007		1
V00126	AD0008	STANDARD	
V00129	AD0003	#UNSPECIFIED	
V00131	AD0005	3RD	
V00141	AD0009	PERENNIAL	
V00147	AD0009	INTERMITTENT	
V00162	AD0010	UNSPECIFIED	
V00163	AD0011	EARTHEN	
V00165	AD0012		974
V00166	AD0013	DEFINITE	
V00167	AD0010	FRESH	
V00174	AD0014	34	
V00176	AD0015	101	
V00178	AD0015	102	
V00179	AD0016	USGLO	
V00180	AD0017	39E	
V00182	AD0019	6S	
V00184	AD0017	40E	
V00189	AD0020	EDUCATION	
V00190	AD0022	STATE	
V00192	AD0023	NOT COVERED	
V00194	AD0024		1
V00195	AD0026	1	
V00196	AD0025		0
V00204	AD0013	INDEFINITE	
V00231	AD0021	PARK	
V00240	AD0029	ALTERNATE	
V00241	AD0029	UNSPECIFIED	

This table contains a record for each unique attribute value assigned (by the Attribute Assignment table) to ore or more feature objects or to other attribute values. The ADID field points to an Attribute Definition record indicating how to read the value.

Name/Text Table (in its entirety):

TKEY	ADID	TEXT	[SEQN is not used]
T00001	AD0002	BISHOP AVENUE	
T00002	AD0002	#UNKNOWN	
T00003	AD0002	UNITED STATES OF AMERICA	
T00004	AD0002	SPOONER COLLEGE	
T00010	AD0002	LANE SPRINGS STATE PARK	
T00011	AD0002	EAST FORK LAKE	
T00012	AD0002	MEMORIAL DRIVE	
T00014	AD0030	From the County Engineer	
T00015	AD0030	From local residents and businessmen	
T00016	AD0030	From the Highway Department	
T00017	AD0030	From Park Admin Office: trail is part of the park.	
T00152	AD0002	MIDDLE FORK	
T00158	AD0002	EAST FORK	
T00160	AD0002	MILL CREEK	
T00173	AD0002	MISSOURI	
T00175	AD0002	PHELPS	
T00177	AD0002	DENT	
T00187	AD0002	PEA RIDGE	
T00188	AD0002	#UNSPECIFIED	
T00244	AD0002	#NOT APPLICABLE	

This table contains a record (with ADID = "AD0002") for each unique name assigned (by the Attribute Assignment table) to a feature object. Special records with the contents of the TEXT field beginning with "#" are used to indicate the status of assigning a name, rather than a name itself (an actual name is not recorded).

This table also contains comments (ADID = "AD0030") which may be assigned to any nontopological "object." In the DLG–E example data set, three such records indicate the source of an attribute value assignment, and a fourth comments a relationship tuple record.

ROAD AND UNDERPASS EXAMPLE

U.S. 63 is a feature instance running north-south through the source graphic. The contrived field notes indicate that the route is actually Alternate U.S. 63. This instance is obviously a road, but along its length, some of its attribute values (e.g., number of lanes) change. Each of the coherent parts of Alternate U.S. 63 with consistent attribute values is therefore recorded as an individual road feature instance. There are four such road instances, with object ID's F00001 through F00004. Feature object F00005, composed of F00001 through F00004 (the Relationship Tuple set with RKEY = "R00005" tells us this), represents the entire length of Alternate U.S. 63. Since the representation rules for "Road" (EKEY = "E00002") dictate that a road instance can only be composed of chains or areas, however, F00005 is classified as a "Named Feature" (EKEY = "E00001") instance instead.

The first road feature object (F00001) of Alternate U.S. 63 is also related to other feature objects through Relationship Tuple records (with RKEYs = "R00064" and "R00065" directly to F00057, F00058, F00006, and F00007, and with RKEY = "R00008" indirectly to F00008). All Feature Object records related to this example then are as follows:

Feature Object Table (road and underpass example):

FKEY	PEID	DIMN	COMP	CNTG	NREL	NRTR	NELB	NAVS	NNTS
F00001	E00002	1	C	Y	1	4	1	6	1
F00002	E00002	1	C	Y	1	1	1	6	1
F00003	E00002	1	C	Y	1	1	1	6	1
F00004	E00002	1	C	Y	1	1	1	6	1
F00005	E00001	1	F	Y	1	4	1	0	1
F00006	E00002	1	C	Y	1	7	1	5	1
F00007	E00002	1	C	Y	1	7	1	5	1
F00008	E00001	1	F	N	1	2	1	3	0
F00057	E00021	0	N	Y	2	3	1	0	0
F00058	E00021	0	N	Y	2	3	1	0	0

F00005 and F00008 are both one-dimensional "Named Features" consisting of individual "Road" feature objects. F00005 is contiguous and is composed of an ordered set (but with no ground significance to the order). Its one-dimensional road feature objects (F00001 through F00004) consist of ordered sets of chains (also with no ground significance to the order). F00008 on the other hand, representing I-44, is composed of a noncontiguous, unordered set consisting of F00006 (east-bound lanes) and F00007 (west-bound lanes). Each of these objects consists of an ordered set of chains, with ground significance (traffic travels in the direction specified by the order of the coordinates of the chains, as modified by the FLAG field). F00057 and F00058 are zero-dimensional "Underpass" features (EKEY = "E00021") each composed of a node. F00001 is vertically related to (placed above) F00006 and F00007 at these underpass features (U.S. 63 passes over I-44). The Relationship Tuple records related to this example then are:

Relationship Tuple Table (Road and Underpass Example):

RKEY	RDID	E1ID	E2ID	FLAG	SEQN
R00001	RD0006	F00001	C00007	+	1
R00001	RD0006	F00001	C00011	+	2
R00001	RD0006	F00001	C00040	+	3
R00001	RD0006	F00001	C00047	-	4
R00002	RD0006	F00002	C00062	-	1
R00003	RD0006	F00003	C00073	+	1
R00004	RD0006	F00004	C00077	-	1
R00005	RD0007	F00005	F00001	+	1
R00005	RD0007	F00005	F00002	+	2
R00005	RD0007	F00005	F00003	+	3
R00005	RD0007	F00005	F00004	+	4
R00006	RD0008	F00006	C00012	+	1
R00006	RD0008	F00006	C00018	+	2
R00006	RD0008	F00006	C00020	-	3
R00006	RD0008	F00006	C00026	+	4
R00006	RD0008	F00006	C00029	-	5
R00006	RD0008	F00006	C00031	-	6
R00006	RD0008	F00006	C00032	-	7
R00007	RD0008	F00007	C00027	+	1

RKEY	RDID	E1ID	E2ID	FLAG	SEQN
R00007	RD0008	F00007	C00024	+	2
R00007	RD0008	F00007	C00016	+	4
R00007	RD0008	F00007	C00022	+	3
R00007	RD0008	F00007	C00014	-	5
R00007	RD0008	F00007	C00010	+	6
R00007	RD0008	F00007	C00008	+	7
R00008	RD0005	F00008	F00006		1
R00008	RD0005	F00008	F00007		2
R00060	RD0002	F00057	N00012		
R00061	RD0002	F00058	N00016		
R00064	RD0011	F00057	F00001		1
R00064	RD0011	F00057	F00007		2
R00065	RD0011	F00058	F00001		1
R00065	RD0011	F00058	F00006		2

Specifically, to trace the attribution of Alternate U.S. 63 (F00005):

1. S00010 assigns T00001, the name "Bishop Avenue"
2. Names (AD0002) and "Number of Lanes" (AD0007) change over the length of Alternate U.S. 63, so these attributes are valued at the road feature instance level represented by objects F00001 through F00004.
   a) V00007, valuing "Number of Lanes" at 2, is assigned to F00001, F00003, and F00004 (by S00008, S00025, and S00033 respectively).
   b) V00014, valuing "Number of Lanes" at 4, is assigned to F00002 by S00017.
   c) F00002 is named "Memorial Drive" (S00011 assigning T00012). S00271 identifies the source for naming F00002 "Memorial Drive" by assigning a comment (T00015--"From local residents and businessmen") to S00011.
3. The following attribute values are assigned to the road feature instances (objects F00001 through F00004):
   a) V00001, which values "Access Restriction" (AD0001) as "None."
   b) V00004, which values "Operational Status" (AD0004) as "Operational."
   c) V00005, which values "Road Class" as "1st."
   d) V00006, which values "Traffic Direction" as "Two way."
   e) V00031, which values "Route Designator" as "US63."
4. S00261 further attributes V00031 ("US63") by assigning V00240, which values "Route Type" (AD0029) as "Alternate."
5. S00273 further comments on the source of "Alternate" by assigning T00016 ("From the Highway Department") to S00261.

The Attribute Assignment records listed below also include records for feature objects representing I-44 (F00006, F00007, and F00008) and for the two Underpass features (no attribute values are assigned, just the E00021 entity label). The Attribute Assignment records related to this example then are as follows:

Attribute Assignment Table (Road and Underpass Example):

[Note: to save space, the records are listed here in two columns; there are only three fields per record (SEQN is not used).]

SKEY	EFID	AFID	SKEY	EFID	AFID
S00001	F00001	E00002	S00026	F00004	E00002
S00002	F00001	V00001	S00028	F00004	T00002
S00003	F00001	T00002	S00033	F00004	V00007
S00005	F00001	V00004	S00034	F00005	E00001
S00006	F00001	V00005	S00035	F00001	V00031
S00007	F00001	V00006	S00036	F00006	E00002
S00008	F00001	V00007	S00037	F00006	V00001
S00009	F00002	E00002	S00038	F00006	T00002
S00010	F00005	T00001	S00040	F00006	V00004
S00011	F00002	T00012	S00041	F00006	V00005
S00017	F00002	V00014	S00042	F00006	V00041
S00018	F00003	E00002	S00043	F00006	V00007
S00020	F00003	T00002	S00044	F00007	E00002
S00025	F00003	V00007	S00046	F00007	T00002

SKEY	EFID	AFID		SKEY	EFID	AFID
S00050	F00007	V00041		S00281	F00002	V00006
S00051	F00007	V00007		S00282	F00002	V00031
S00052	F00008	E00001		S00283	F00003	V00001
S00053	F00008	V00052		S00284	F00003	V00004
S00248	F00057	E00021		S00285	F00003	V00005
S00249	F00058	E00021		S00286	F00003	V00006
S00261	V00031	V00240		S00287	F00003	V00031
S00262	V00052	V00241		S00288	F00004	V00001
S00271	S00011	T00015		S00289	F00004	V00004
S00272	S00261	T00016		S00290	F00004	V00005
S00274	F00008	V00006		S00291	F00004	V00006
S00275	F00008	V00014		S00292	F00004	V00031
S00278	F00002	V00001		S00293	F00007	V00001
S00279	F00002	V00004		S00294	F00007	V00004
S00280	F00002	V00005		S00295	F00007	V00005

STREAM/RIVER, SHORELINE, AND JUNCTION EXAMPLE

Mill Creek is a "Stream/River" (EKEY = "E00004") feature instance discernible on the source graphic, beginning north of I-44 at the discharge of an intermittent pond. It proceeds as an intermittent stream until a point near Pea Ridge. As Mill Creek continues southward, it becomes wide enough to be displayed as an areal feature (a water body bounded by a "Shoreline" (EKEY = "E00008")). This water body flows "out" of the map area at the south neatline. The indication of the direction of stream flow is carried by the modified (by the FLAG field) order of coordinates of the chains comprising the stream/river feature objects. When a stream is represented by an area, however, a "Junction" (EKEY = "E00009") feature object is often required to participate with the areal stream object in a "Flows to/flows from" relationship.

The following Feature Object records relate to this Mill Creek example:

Feature Object Table:

FKEY	PEID	DIMN	COMP	CNTG	NREL	NRTR	NELB	NAVS	NNTS
F00022	E00004	2	A	Y	3	4	1	1	0
F00023	E00004	1	C	Y	1	2	1	1	0
F00024	E00004	1	C	Y	1	1	1	1	0
F00025	E00004	1	C	Y	1	1	1	1	0
F00026	E00004	1	C	Y	1	4	1	1	0
F00032	E00001	M	F	Y	1	5	1	0	1
F00036	E00009	1	C	Y	1	1	1	0	0
F00037	E00008	1	C	Y	1	4	1	1	0

Feature Object F00032, classified as a "Named Feature" (EKEY = "E00001"), represents all of Mill Creek within the source map. It is composed of five stream/river feature objects differentiated from one another based upon (a) composition (chains vs. areas), (b) attribute values (perennial vs. intermittent), and (c) junctions with other stream/river objects. F00022 represents the areal part of Mill Creek; F00023, the linear part downstream from the junction with East Fork; F00024, the perennial part upstream from East Fork; F00025, the intermittent part downstream from Middle Fork; and F00026 represents Mill Creek upstream from Middle Fork.

Feature Object F00022, the areal part of Mill Creek, is composed of two DLG–O areas. It is bounded, to the right, by (relationship RD0010) feature object F00037, representing a shoreline feature instance composed of ordered chains. F00022 also flows into (relationship RD0013) object F00036, representing a junction feature instance.

Objects F00023, F00024, F00025, and F00026 are each composed of an ordered set of chains (actually F00024 and F00025 consist of only one chain each). The order of the coordinates of these chains, as modified by the FLAG field ("+" or "-"), represents the direction of stream flow.

The Relationship Tuple records related to this example are as follows:

Relationship Tuple Table (Stream/River, etc., example):

RKEY	RDID	E1ID	E2ID	FLAG	SEQN
900022	RD0004	F00022	A00037		1
R00022	RD0004	F00022	A00038		2
R00023	RD0008	F00023	C00093	-	1
R00023	RD0008	F00023	C00065	+	2
R00024	RD0008	F00024	C00057	+	
R00025	RD0008	F00025	C00043	-	
R00026	RD0008	F00026	C00038	+	1
R00026	RD0008	F00026	C00034	+	2
R00026	RD0008	F00026	C00017	+	3
R00026	RD0008	F00026	C00009	+	4
R00032	RD0009	F00032	F00022	-	1
R00032	RD0009	F00032	F00023	-	2
R00032	RD0009	F00032	F00024	-	3
R00032	RD0009	F00032	F00025	-	4
R00032	RD0009	F00032	F00026	-	5
R00037	RD0006	F00036	C00108	+	1
R00038	RD0013	F00022	F00036		
R00039	RD0006	F00037	C00078	-	1
R00039	RD0006	F00037	C00071	+	2
R00039	RD0006	F00037	C00102	-	3
R00039	RD0006	F00037	C00107	+	4
R00040	RD0010	F00022	F00037	+	

The attribution of Mill Creek, by Attribute Assignment records, is as follows:

1. F00032 is named "Mill Creek" by S00177 assigning T00160.
2. Through S00140, S00144, and S00148, respectively, F00022, F00023, and F00024 are assigned V00141, which values "Hydrographic category" (AD0009) as "Perennial."
3. Through S00152 and S00156, F00025 and F00026 are assigned V00147, which values "Hydrographic category" (AD0009) as "Intermittent."
4. F00037, representing the shoreline of F00022, is assigned (by S00189) V00166, which values "Delineation Status" (AD0013) as "Definite."

Attribute Assignment Table (Stream/River, etc., example, in two columns):

SKEY	EFID	AFID	SKEY	EFID	AFID
S00139	F00022	E00004	S00152	F00025	V00147
S00140	F00022	V00141	S00155	F00026	E00004
S00143	F00023	E00004	S00156	F00026	V00147
S00144	F00023	V00141	S00176	F00032	E00001
S00147	F00024	E00004	S00177	F00032	T00160
S00148	F00024	V00141	S00187	F00036	E00009
S00151	F00025	E00004	S00188	F00037	E00008
			S00189	F00037	V00166

RESERVATION AND BOUNDARY LINE EXAMPLE

Lane Spring State Park is a feature instance which illustrates some interesting cases. The park is composed of two separate areal parts (one area is in the middle of the map, and the second area, labeled "LS SP," is at the lower edge of the map). These two areas are connected by a trail which is also part of the park (see the contrived field notes). The trail and the two areas are each represented by a "Reservation" (EKEY = "E00018") feature object. Lane Spring State Park as a whole is represented by a "Named Feature" (EKEY = "E00001") object composed of the three reservation objects. The trail is also represented by a separate "Trail" (EKEY = "E00022") object. It is debatable as to whether or not the additional reservation object was needed for the trail, or if Lane Spring State Park could be composed of the two areal reservation objects and the trail object directly.

As represented per DLG–E specifications (section 3), a reservation feature instance is bounded by a "Boundary Line" (EKEY = "E00024") feature. In this case, the boundary of Lane Spring State Park is not represented by a single feature object (either basic or higher level) because an attribute value changes, it is not contiguous, and there is no name attribute. The park is thus bounded by three boundary line feature objects.

The following eight feature object records are related to this example:

Feature Object Table (Reservation and Boundary Line example):

FKEY	PEID	DIMN	COMP	CNTG	NREL	NRTR	NELB	NAVS	NNTS
F00018	E00022	1	C	Y	1	1	1	2	1
F00048	E00018	2	A	Y	2	12	1	2	0
F00049	E00018	2	A	Y	2	2	1	2	0
F00050	E00001	M	F	Y	1	3	1	0	1
F00061	E00024	1	C	Y	1	5	1	1	0
F00066	E00024	1	C	Y	1	1	1	1	0
F00075	E00018	1	C	Y	1	1	1	2	1
F00076	E00024	1	C	Y	1	16	1	1	0

Feature object F00050 represents Lane Spring State Park. It is composed of a contiguous set of three reservation feature objects (F00048, F00049, and F00075). F00048 and F00049 are each composed of a contiguous set of DLG areas (ten areas for F00048 and only one for F00049). F00075 is composed of one chain. That same chain (C00075) comprises feature object F00018, representing a trail feature instance. F00048 is bounded by two boundary line objects (F00066 and F00076), differentiated by the attribute "Delineation Status" (AD0013). F00049 is bounded by object F00061. Each boundary line object (F00061, F00066, and F00076) is composed of a contiguous ordered set of chains. Note that there is no ground significance to the composition order of the coordinates of the boundary objects (as defined by FLAG modified chain coordinate order), BUT when these objects participate in a "Bounded by/Bounds" (RD0010) relationship, the direction does have ground significance that indicates to which side of the boundary the bounded feature instance lies.

The following Relationship Tuple records relate to this example:

Relationship Tuple Table (Reservation and Boundary Line example):

RKEY	RDID	E1ID	E2ID	FLAG	SEQN
R00018	RD0008	F00018	C00075	+	
R00051	RD0004	F00048	A00026		1
R00051	RD0004	F00048	A00024		2
R00051	RD0004	F00048	A00017		3
R00051	RD0004	F00048	A00020		4
R00051	RD0004	F00048	A00031		5
R00051	RD0004	F00048	A00032		6
R00051	RD0004	F00048	A00023		7
R00051	RD0004	F00048	A00025		8
2R00051	RD0004	F00048	A00029		9
R00051	RD0004	F00048	A00028		10
R00052	RD0004	F00049	A00039		
R00053	RD0005	F00050	F00048		1
R00053	RD0005	F00050	F00049		2
R00053	RD0005	F00050	F00075		3
R00068	RD0006	F00061	C00077	+	1
R00068	RD0006	F00061	C00076	+	2
R00068	RD0006	F00061	C00074	+	3
R00068	RD0006	F00061	C00072	-	4
R00068	RD0006	F00061	C00078	+	5
R00073	RD0006	F00066	C00063	+	
R00081	RD0010	F00048	F00066	+	1
R00081	RD0010	F00048	F00076	+	2
R00082	RD0010	F00049	F00061	+	
R00088	RD0003	F00075	C00075		
R00089	RD0006	F00076	C00041	+	1
R00089	RD0006	F00076	C00039	-	2

RKEY	RDID	E1ID	E2ID	FLAG	SEQN
R00089	RD0006	F00076	C00033	+	3
R00089	RD0006	F00076	C00026	+	4
R00089	RD0006	F00076	C00029	-	5
R00089	RD0006	F00076	C00036	+	6
R00089	RD0006	F00076	C00044	+	7
R00089	RD0006	F00076	C00049	-	8
R00089	RD0006	F00076	C00055	-	9
R00089	RD0006	F00076	C00060	-	10
R00089	RD0006	F00076	C00068	-	11
R00089	RD0006	F00076	C00091	-	12
R00089	RD0006	F00076	C00090	-	13
R00089	RD0006	F00076	C00089	-	14
R00089	RD0006	F00076	C00066	-	15
R00089	RD0006	F00076	C00064	-	16

The attribution of F00050, the entire state park, is implemented as follows:

1. S00227 assigns T00010 (Name text = "Lane Spring State Park").
2. S00273 assigns a comment (T00017, "From Park Admin. Office: trail is part of the park") to R00088, the Relationship Tuple record which defines the composition of F00075, the trail part of F00050.

The attribution of the basic park feature instances (F00048, F00049, F00075) is implemented as follows:

1. S00224, S00296, S00298 assigns V00231, which values "Reservation Type" (AD0021) as "Park."
2. S00225, S00297, S00299 assigns V00190, which values "Reservation Use Status" (AD0022) as "State."

The attribution of the boundary line objects is implemented as follows:

1. S00253 and S00266 assign V00166, which values "Delineation Status" (AD0013) as "Definite," to F00061 and F00076 respectively.
2. S00255 assigns V00204, which values "Delineation Status" (AD0013) as "Indefinite," to F00061.

The following Attribute Assignment records relate to this example:

Attribute Assignment Table (Reservation and Boundary Line example):

SKEY	EFID	AFID	SKEY	EFID	AFID
S00104	F00018	E00022	S00253	F00061	V00166
S00105	F00018	T00002	S00254	F00066	E00024
S00106	F00018	V00121	S00255	F00066	V00204
S00107	F00018	V00006	S00257	F00075	E00018
S00218	F00048	E00018	S00265	F00076	E00024
S00222	F00049	E00018	S00266	F00076	V00166
S00224	F00048	V00231	S00273	R00088	T00017
S00225	F00048	V00190	S00296	F00049	V00231
S00226	F00050	E00001	S00297	F00049	V00190
S00227	F00050	T00010	S00298	F00075	V00231
S00252	F00061	E00024	S00299	F00075	V00190

APPENDIX C

DLG–E DATA MODEL IMPLEMENTED WITHIN THE SPATIAL DATA TRANSFER SPECIFICATION

Section

APPENDIX C

DLG-E DATA MODEL IMPLEMENTED WITHIN
THE SPATIAL DATA TRANSFER SPECIFICATION

This appendix describes how the components of the DLG-E data model may be implemented within SDTS. Since SDTS is still undergoing review, several implementation issues are yet "to be resolved" (TBR). Therefore, the content of this appendix should not be considered to be final.

In the section of the main text entitled "A New Design," a framework for translating a set of data requirements into data model/structure/format constructs was presented. Levels were defined which can serve as steps in the translation process. The first two levels, defining a data reality and a data model are covered in the section "Concepts of the DLG–E Design." This section, in conjunction with SDTS, is the next step in completing the translation process through the remaining two levels, data structure and file structures.

Before proceeding with the data structure step, the implementation of DLG-E within SDTS requires an initial "data mapping" step at the data model component level. This process must occur for any agency or user-defined data model or structure to conform to SDTS. SDTS has its own set of data model components. The components of DLG-E must first be mapped into SDTS model components. Only then can an SDTS data structure and file structure be selected.

1. DATA MODEL COMPONENT MAPPINGS

For the most part, DLG-E data model components have direct counterparts in SDTS. SDTS is more comprehensive in that it deals with graphic vector data and raster data, as well as topologically structured vector data. The DLG-E model is a clear topological vector data subset of SDTS. In only a few cases do the definitions of SDTS components need to be qualified to match DLG-E.

The data mappings outlined here do not include global (that is, header) data. The DLG-E data model does not explicitly include them. Following the data model mappings, actual file structures will be outlined that will include SDTS global modules.

Summary of data mapping equivalence table, DLG-E and SDTS model components:

DLG-E Objects	SDTS Objects
Feature object	Feature implemented as a composite object
Linear graph/spatial objects	
Node	Node
Chain	Chain
Polygon	T-Polygon
Point	Entity point (qualified as wholly contained within one area) - TBR

DLG-E Attributes	SDTS Attributes
Locational	Location coordinates (often termed spatial addresses)
Nonlocational	
of feature object	Attribute related to composite object
of attribute value	Secondary attributes

DLG-E Relationships	SDTS Components
Topological	
Point-within-area	Attribute with polygon foreign ID as attribute value - TBR
All others	Included in node, chain, and t-polygon object definitions and defined relations

Nontopological

Feature composed
  of element

Composite-composed of-element relation;
element ID's in the composite object record

All others

TBR

2. MAPPING DLG–E TO AN SDTS DATA STRUCTURE

SDTS has two possible data structure forms from which to choose: vector and raster. Because the DLG-E model is fundamentally vector, that form will be outlined here.

IMPLEMENTING DLG–E WITHIN THE SDTS VECTOR FORM

The following table summarizes the modules and vector-based object representations that might be used in the DLG-E Implementation.

Module Type	Object Representation	Representation Code
Point-node	Entity point	PG (TBR)
	Area point	PA
	Node	PN
Line	Complete chain	LE
Polygon	T-polygon	PC
Composite	Composite object	FF
Attribute primary	Attribute primary module defines the primary attributes associated with a spatial element or object.	
Attribute secondary	Attribute secondary module defines the secondary attributes associated with values of primary attributes.	

The headings in the sections below have the following meaning:

MNEMONIC: Four-character mnemonic. The mnemonic will be left adjusted in the column for field name‾ and right adjusted for subfield names. Mnemonics for primary field names will be flagged with an "*."

FULL NAME: The full name of the field or subfield as used in the SDTS module specifications.

DLG–E Point Within the SDTS Point-Node Module

FIELD/SUBFIELD

MNEMONIC	FULL NAME (plus description if appropriate)
*PNTS	Point-node
OBRP	Object representation ("PG" Entity point - TBR)
OBID	Object ID
SADR	Spatial address (locational coordinates)
ARID	Area ID (TBR)

DLG–E Node Within the SDTS Point-Node Module

FIELD/SUBFIELD

MNEMONIC	FULL NAME (plus description if appropriate)
*PNTS	Point-node
OBRP	Object representation ("PN" node)
OBID	Object ID
SADR	Spatial address (locational coordinates)
LNID	Line ID (This is a repeating field containing the ID's of the chains bounded by the node.)

DLG–E Chain as Carried Within the SDTS Line Module

FIELD/SUBFIELD

MNEMONIC	FULL NAME (plus description if appropriate)
*LINE	Line
OBRP	Object representation ("LE" complete chain)
OBID	Object ID
PIDL	Polygon ID left
PIDR	Polygon ID right
SNID	Startnode ID
ENID	Endnode ID
SADR	Spatial address (This is a repeating field containing the coordinates of the chain. The order of the instances of this field indicates the construction of the line in terms of vertices.)

DLG–E Polygon as Carried Within the SDTS Polygon Module

FIELD/SUBFIELD

MNEMONIC	FULL NAME (plus description if appropriate)
*POLY	Polygon
OBRP	Object representation ("PC" T-polygon)
OBID	Object ID
LFID	Chain foreign ID (This is a repeating field for carrying the chain ID's bounding the area.)

DLG–E Feature Object as Carried Within the SDTS Composite Module

FIELD/SUBFIELD

MNEMONIC	FULL NAME (plus description if appropriate)
*COMP	Composite
OBRP	Object representation ("FF")
OBID	Object ID
ATID	Attribute ID (This is a repeating field containing the ID's of the primary attribute records associated with this feature object.)
FRID	Foreign ID (This is a repeating field containing the ID's of the objects [other features, points, nodes, chains, and/or area] that are a part of this feature.)
*ATPR	Attribute Primary (This is a separate module defining the primary attributes associated with, in this case, a feature object.)

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