DATA DICTIONARY AND FORMATTING STANDARD FOR DISSEMINATION OF GEOTECHNICAL DATA

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ABSTRACT

The Consortium of Organizations for Strong-Motion Observation Systems (COSMOS) and the Pacific Earthquake Engineering Research Center (PEER) Lifelines Program have sponsored a project to develop a pilot system for archiving and web dissemination of geotechnical data collected and stored by various agencies and companies. Part of the scope of this effort was the development of a data dictionary and formatting standard. This paper presents the data model along with the basic structure of the data dictionary tables for this pilot system.

INTRODUCTION

Following the invited workshop on Archiving and Web Dissemination of Geotechnical Data (COSMOS PEER, 2001), discussions of available geotechnical databases provided a framework for developing a pilot project for archiving and web dissemination of geotechnical data. The main purpose of the project is to allow geotechnical information

offered by various agencies or companies to be discovered and accessed through a single virtual data center interface. The project, sponsored by the Consortium of Organizations for Strong-Motion Observation Systems (COSMOS) and by the Pacific Earthquake Engineering Research Center Lifelines Program (PEER) is to link databases from various agencies such as the California Department of Transportation (CalTrans), the California Geological Survey (CGS), the U.S. Geological Survey (USGS) and Pacific Gas and Electric (PG&E). The scope of this virtual data center project consists of three main tasks: 1) define appropriate geotechnical data user scenarios, 2) develop a data model and data dictionary and, 3) develop and implement the pilot system architecture based on user needs. In Task 1, the user scenarios survey of various agencies, practitioners and researchers provided the necessary guidance to develop a system that would satisfy most users and participating agencies.

DATA DICTIONARY

Information to be shared among different systems has to be standardized using a common data model with an associated data dictionary. The data model defines the information content, structure, and relationships of the data, and the data dictionary specifies the meaning of the various attributes. Several data dictionaries have been developed for geotechnical databases with different contents and structures to suit the needs of the users of those databases. For the development of the data dictionary for the pilot virtual data center, a review of some of the existing data dictionaries provided the framework for the current design. It was decided to use the data dictionary developed for the National Geotechnical Experimentation Sites (NGES) program (Benoît et al. 1994) as a starting point. The NGES data dictionary was modeled after existing standards and databases such as those drawn by the Association of Geotechnical Specialists (AGS, 1992) in the United Kingdom for the electronic transfer of geotechnical data in ground investigations. The content of the NGES data dictionary was based on actual test results, available ASTM standards, and input from various experts in laboratory and in situ testing. Unlike other systems such as the AGS, which was initially designed for use by consultants and contractors to develop proposals and bids, the design of the NGES data dictionary aimed at providing research quality information with a high level of detail to users of the experimental test sites and test results.

Although current development is for a pilot system, the data dictionary for this project is designed to be expandable to allow the virtual data center to link to multiple databases with diverse structures. After the review of the NGES and other data dictionaries, it was concluded that a new approach had to be undertaken to ensure the requirement for flexibility and expandability to satisfy the needs of the geotechnical profession based on results from the user scenarios survey. Such a system would allow for archiving, exchange and sharing of reliable and complete geotechnical information with maximum compatibility. It would also have the capability to provide users with data in tabular, graphical and/or image form.

The data model used for this pilot system is shown in Figure 1 as an entity-relationship diagram. A series of entities was developed for the pilot system data dictionary. Those

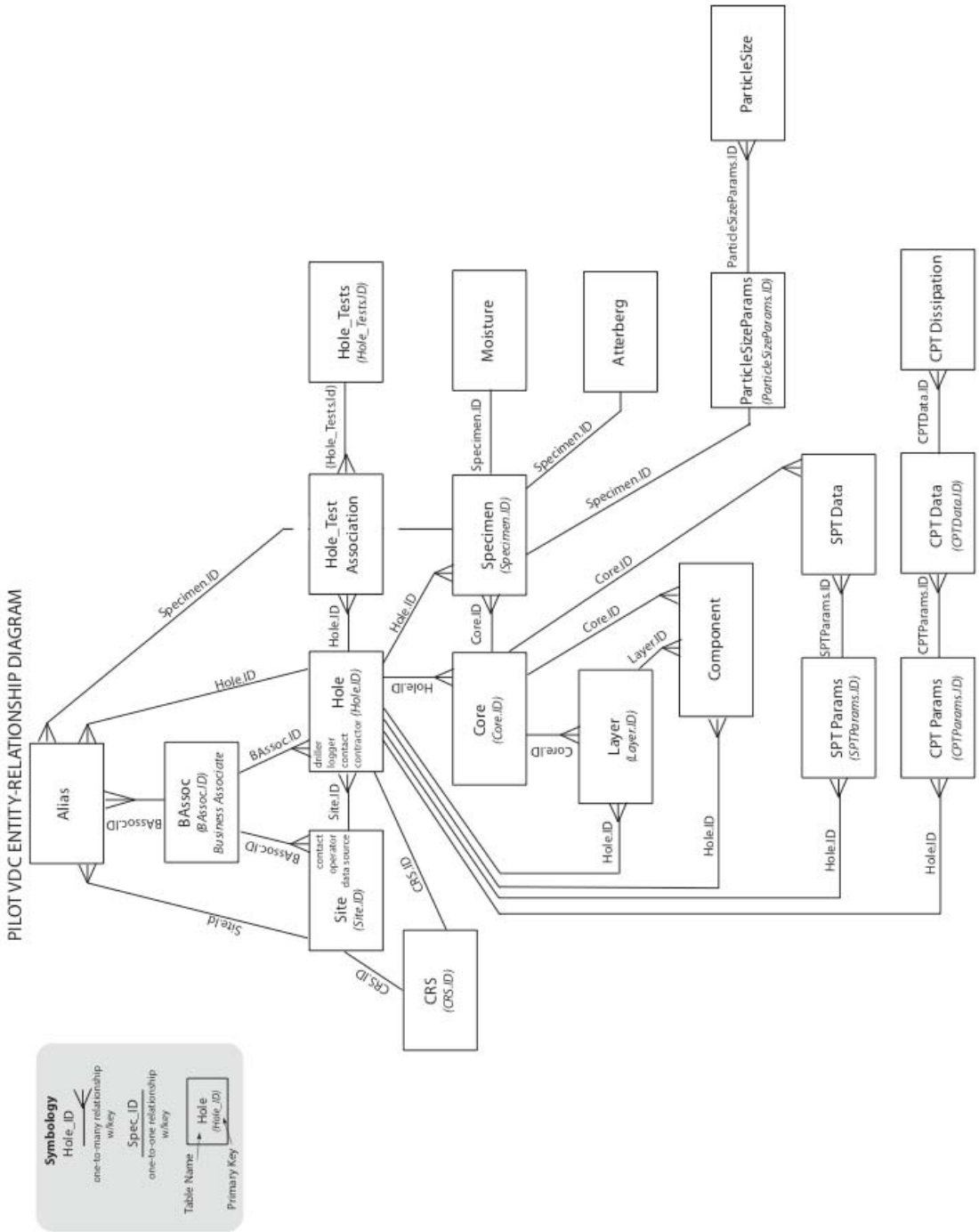

Figure 1. Entity-Relationship Diagram for Pilot Virtual Data Center

include information about the site, the boreholes, and the testing associated with the boreholes or soundings and/or the samples recovered from the boreholes. The entities can be thought of as tables within a relational database system (RDBMS), but no such RDBMS needs to exist in actuality. The relational database at the geotechnical virtual data center repository (GVDC), in fact only stores a subset of attributes from a few of the entities in the data model.

The GVDC does not contain the data itself, but only stores sufficient metadata for identification and querying purposes, along with the appropriate URL that points to the actual data, which resides in XML files generated by the data providers. The following 20 entities are part of the current pilot system.

Entities with a subset of attributes stored in the GVDC RDBMS	**Entities with attributes given in XML to the end user by the data provider**
Business Associate	Alias
Site	Core
Coordinate Reference System	Layer
Hole	Component
Hole Test Association	Specimen
Hole Tests	Moisture
	Atterberg
	Particle Size Parameters
	Particle Size
	Standard Penetration Test Parameters
	Standard Penetration Test Data
	Cone Penetration Test Parameters
	Cone Penetration Test Data
	Cone Penetration Dissipation Test

The data model itself is implemented in XML, which is provided to the end user by the data provider. Within the XML file, relationships among the entities shown in Figure 1 are defined via keys and/or the XML structure itself. The entity that sits at the top level of the context hierarchy is the Site, which is defined as a collection of holes and samples obtained at a common place. To fully describe the sampling stations and stratigraphy at a given Site, the Hole, Core, Layer, Component and Specimen entities were defined to allow completeness and flexibility. Figure 2 shows those relationships along with definitions for each of those entities. At each site can be a collection of holes from which layers and components are defined and where cores are obtained for laboratory testing. Cores may be sub-sampled into specimens (and specimens further sub-sampled) for specific tests. A Hole is broadly defined as a single sampling station or profile, from which earth materials are collected or described, or earth material properties are measured. Furthermore, this term is used to represent the sample collecting activity as well as the sampling station. Therefore, in addition to a

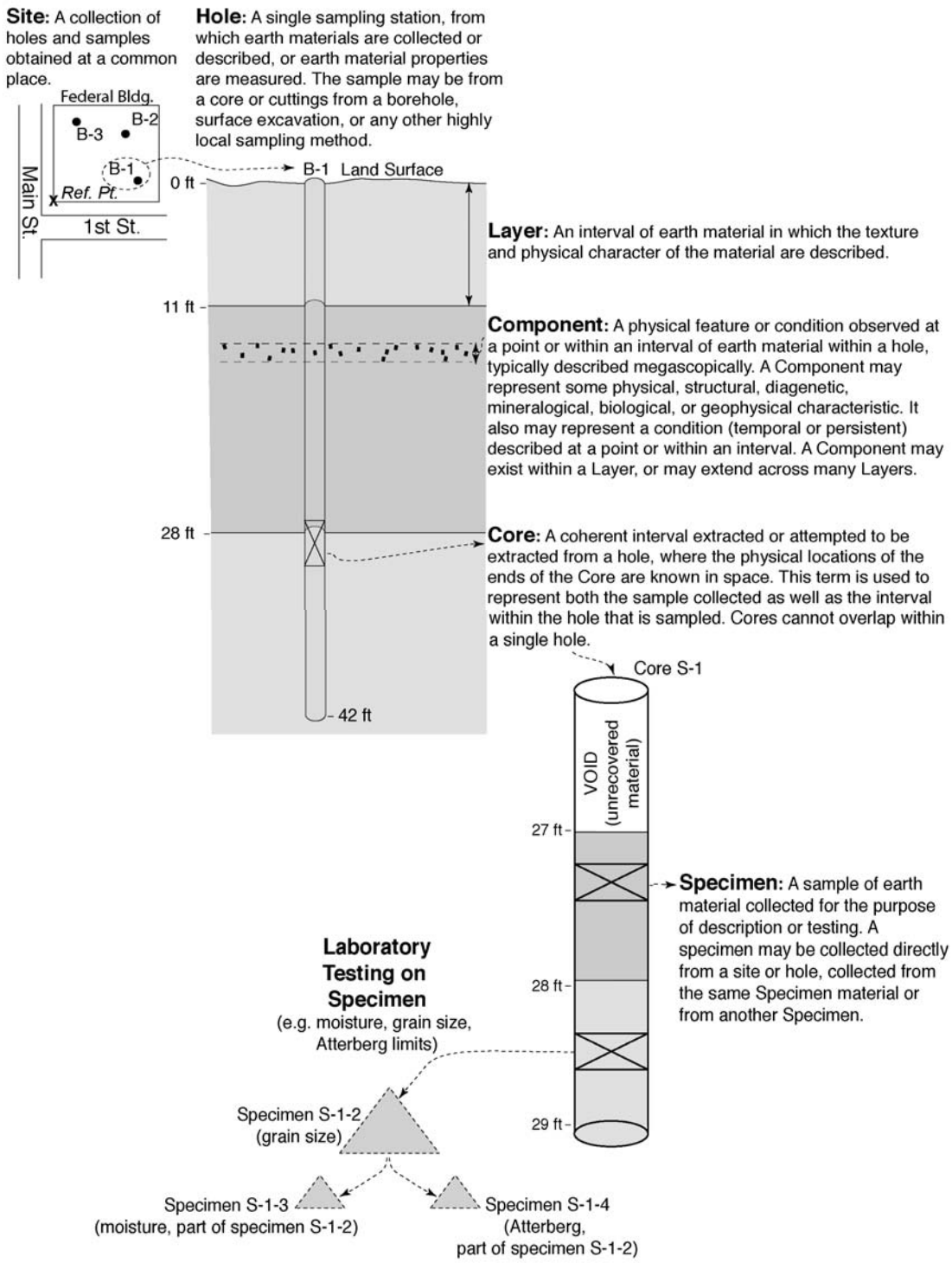

Figure 2. Relationships Among Site, Hole, Core, Layer, Component and Specimen Objects

conventional borehole, a Hole could represent sampling or measurements from an outcrop or surface excavation, a cone penetration test (CPT) sounding, or a geophysical profile. The relationships among the entities clearly provide the data suppliers and the users with the necessary information to track the results from the initial site investigation to the final results.

Only a limited number of entities for laboratory and in situ tests were generated for this pilot project. For some of these tests, the metadata that provides descriptive, non-quantifiable contextual information about the tests are included in a separate entity from the entities that contain the test results. Table 1 gives an example of the attributes defined for the Cone Penetration Test. Three entities are defined: 1) Cone Penetration Test Parameters, 2) Cone Penetration Test Data, and 3) Cone Penetration Test Dissipation Data. The first entity contains the metadata for the CPT test, whereas the second entity provides the actual data obtained from a CPT sounding (e.g. tip resistance and sleeve friction for each depth interval). The third entity provides for pore pressure measurements at different time intervals at a specific testing depth. In future expansions of the data model, additional entities can be defined to accommodate other types of data collected during a CPT test (e.g. wave form data from a seismic cone).

Dictionary tables like those in Table 1 were constructed for each of the entities in the data model and form the basis for the development of the XML schema. These tables and those for the remaining entities are given in Appendix A. These tables are solely informative while the schema is the normative document. The tables only list part of the information for each entity. The schema provides all necessary details including key fields, data types, units of measure, ranges of acceptable values, enumerated lists, and whether certain attributes are required or not. The mandatory attributes provide the necessary level of completeness of the data for conventional geotechnical practice. Optional attributes increase the completeness of the data and provide additional information for more in-depth analysis of the results.

Figure 3 shows an example of the schema for the Site entity, derived from the online documentation, including both the XML instance representation as well as the schema component representation. The complete schema developed from this pilot dictionary is an extensive interactive online document with multiple links and pop-up windows providing definitions of the various attributes. A link to the complete geotechnical schema is available at the following web address:

http://www.cosmos-eq.org

As an example, Appendix B shows how the Site data dictionary table is translated into the XML schema.

Table 1. Data Dictionary Tables for Cone Penetration Test

Cone Penetration Test Parameters	The cone penetration test (CPT) consists in determining the resistance to penetration of a conical pointed penetrometer into subsurface soils. Standard testing procedures are described in ASTM D 5778. Relevant testing parameters are described in this table.

Name	**Definition**
Hole	The hole, of which these CPT parameters are a part. The CPT parameters must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Cone Type	The type of cone penetrometer used for testing. The following provides a list of available cone penetrometers: a) mechanical cone, b) electric cone, c) piezocone, d) seismic piezocone, e) lateral stress cone, f) dynamic cone, g) acoustic cone, h) resistivity cone, i) vibratory cone, j) miniature cone, or k) other.
Cone Manufacturer	The business name of the company manucturing the cone penetrometer. For example, Fugro, Hogentogler, Delft, etc.
Tip Area	The conical base area of the penetrometer tip. Typical values are 10 cm2 and 15 cm 2
Tip Apex Angle	The apex angle of the conical point of the penetrometer tip. The standard value is 60 degrees.
Friction Sleeve Area	The surface area of the friction sleeve located immediately behind the penetrometer tip. Typical values are 150 cm2 for the 10 cm2 and 200 cm2 for the 15 cm2.
Distance Tip to Sleeve	The distance between the tip and the center of the friction sleeve.
Piezocone Type	The type of Piezocone is defined in part by the position of the filter element. The types in use are the following: a) Type 1 (on the tip apex or at the midface on the tip), b) Type 2 (at the shoulder or behind the tip), c) Type 3 (above the friction sleeve), or d) other.
Porous Element Type	The type of material used as porous filter element. The following materials are typically used: a) plastic, b) sintered bronze, c) sintered steel, d) ceramic, or e) other.
Saturation Fluid	The fluid used to saturate the porous filter element. The following deaired fluids are typically used: a) water, b) glycerin, c) silicon oil, or d) other.
Saturation Method	A description of the procedure used to saturate the porous filter element.
Net Area Ratio Correction	The correction necessary to adjust the penetration cone resistance due to penetration water pressures acting behind the cone tip. The net area ratio correction, a, is applied to the cone resistance qc which becomes the corrected total cone resistance qt. The value a is dimensionless.
Push Rod Type	The type of pushing rods used for CPT penetration. Standard nomenclature can be used such as A-rod or N-rod.
Friction Reducer	A description of the type, size and location of the friction reducer behind the base of the cone should be reported if used.
Penetration Rate	The rate of advance of the penetrometer. Rate should be between 20 +/- 5 mm/second.
Tip Load Cell Capacity	The capacity of the tip load cell.

Sleeve Load Cell Capacity	The capacity of the sleeve load cell.
Surface Load Cell Capacity	The capacity of the surface load cell.
Pore Pressure Load Cell Capacity	The capacity of the pore pressure load cell.
Last Calibration Date	The date of the last calibration of the penetrometer. Specify which components were calibrated.
Remarks	A text descriptor providing additional information relevant to the CPT parameters and equipment especially if those differ from standard requirements.
Date Last Updated	The date of the last update to the data in this table

Cone Penetration Test Data	The cone penetration test (CPT) consists in determining the resistance to penetration of a conical pointed penetrometer into subsurface soils. Standard testing procedures are described in ASTM D 5778. Cone Penetration data are presented in this table.

Name	**Definition**
Cone Penetration Test Parameters	The Cone Penetration Test Parameters, of which these CPT data are a part. The CPT data must be related to a Cone Penetration Test Parameters. This value is a foreign key that should select an instance of Cone Penetration Test Parameters based on the Id value of the Cone Penetration Test Parameters.
Tip Depth	The depth of measurement at the penetrometer tip.
Tip Resistance	The end-bearing component of penetration resistance in units of stress referred to as qc (uncorrected for net area ratio).
Friction Sleeve Resistance	The friction component of penetration resistance in units of stress developed on a friction sleeve refereed to as fs.
Penetration Pore Pressure	Fluid pressure measured using the piezocone penetration test.
Inclination	Inclination of the penetrometer during advance in degrees.
Remarks	A text descriptor providing additional information relevant to the CPT data and results.
Date Last Updated	The date of the last update to the data in this table

Cone Penetration Test Dissipation Data	During cone penetration testing it is possible to conduct dissipation tests to evaluate the hydraulic conductivity of soils. The process consists in stopping the penetrometer advance at the depth of interest and observing the pore pressure decay with time. Standard testing procedures are described in ASTM D 5778. Cone Penetration dissipation data are presented in this table.

Name	**Definition**
Cone Penetration Test Data	The Cone Penetration Test Data, of which these CPT dissipation data are a part. The CPT dissipation data must be related to a Cone Penetration Test Data. This value is a foreign key that should select an instance of Cone Penetration Test Data based on the Id value of the Cone Penetration Test Data.
Tip Depth	The depth of dissipation measurement at the penetrometer tip.
Penetration Pore Pressure	Fluid pressure measured using the piezocone during the dissipation test.
Elapsed Time	Elapsed time of reading for dissipation measurement.
Remarks	A text descriptor providing additional information relevant to the CPT dissipation data, results and procedures.
Date Last Updated	The date of the last update to the data in this table

CONCLUSIONS

A data dictionary was devised for use with a pilot system for archiving and web dissemination of geotechnical data. The tables for the pilot system are easily expandable and designed to encourage data providers to contribute new as well as legacy data to the geotechnical virtual data center. This pilot system will be reviewed to obtain input and consensus of the geotechnical community.

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Figure 3. Schema Example for Site

Element: Site

Name	Site
Type	siteTableType
Nillable	no
Abstract	no
Documentation	The Site is a collection of holes and samples obtained at a common place. It is a direct parent of Hole, and offers the top level of the context hierarchy.

XML Instance Representation

```
<Site
 id=" keyid [0..1] ? "
 modver="1.0 [0..1]">
   <ID> codeSysElAttType </ID> [1] ?
   <Name> nameSysElAttType </Name> [0..1] ?
   <Alias> nameSysElAttType </Alias> [0..*] ?
   <Type> extSiteTypeEnum </Type> [0..1] ?
   <Organization> simpleRefType </Organization> [0..1] ?
   <Contact> simpleRefType </Contact> [0..1] ?
   <SiteAddressLocation> [0..1] ?
      <Address> xsd:string </Address> [0..*] ?
      <City> xsd:string </City> [0..1] ?
      <State> stateCodeEnum </State> [0..1] ?
      <County> xsd:string </County> [0..1] ?
      <Country> countryCodeEnum </Country> [0..1] ?
   </SiteAddressLocation>
   <LocationReferencePoint> xsd:string </LocationReferencePoint> [0..1] ?
   <Quadrangle> xsd:string </Quadrangle> [0..1] ?
   <PLSS> legalLocType </PLSS> [0..1] ?
   <Location> survLocType </Location> [0..*] ?
   <LocationMethod> extLocMethodEnum </LocationMethod> [0..1] ?
   <LocationAccuracy> extLocAccuracyEnum </LocationAccuracy> [0..1] ?
   <DataSource> xsd:string </DataSource> [0..1] ?
   <LastUpdated> xsd:string </LastUpdated> [0..1] ?
   <Hole> holeTableType </Hole> [1..*] ?
</Site>
```

Element: Organization - Microsoft Internet Expl...

Element: Organization

A reference to a business associate that is the owner at the Site. Details about the business associate may, if desired, be carried in the dictionary portion or this exchange file, or may obtainable through a service.

Close

Schema Component Representation

```
<xsd:element name="Site" type=" siteTableType "/>
```

Figure 3. Schema Example for Site (continued)

Complex Type: siteTableType

Parent type:	None
Direct sub-types:	None

Name	siteTableType
Abstract	no
Documentation	The Site is a collection of holes and samples obtained at a common place. It is a direct parent of Hole, and offers the top level of the context hierarchy.

XML Instance Representation

```
<...
 id=" keyid [0..1] ? "
 modver="1.0 [0..1]">
   <ID> codeSysElAttType </ID> [1] ?
   <Name> nameSysElAttType </Name> [0..1] ?
   <Alias> nameSysElAttType </Alias> [0..*] ?
   <Type> extSiteTypeEnum </Type> [0..1] ?
   <Organization> simpleRefType </Organization> [0..1] ?
   <Contact> simpleRefType </Contact> [0..1] ?
   <SiteAddressLocation> [0..1] ?
      <Address> xsd:string </Address> [0..*] ?
      <City> xsd:string </City> [0..1] ?
      <State> stateCodeEnum </State> [0..1] ?
      <County> xsd:string </County> [0..1] ?
      <Country> countryCodeEnum </Country> [0..1] ?
   </SiteAddressLocation>
   <LocationReferencePoint> xsd:string </LocationReferencePoint> [0..1] ?
   <Quadrangle> xsd:string </Quadrangle> [0..1] ?
   <PLSS> legalLocType </PLSS> [0..1] ?
   <Location> survLocType </Location> [0..*] ?
   <LocationMethod> extLocMethodEnum </LocationMethod> [0..1] ?
   <LocationAccuracy> extLocAccuracyEnum </LocationAccuracy> [0..1] ?
   <DataSource> xsd:string </DataSource> [0..1] ?
   <LastUpdated> xsd:string </LastUpdated> [0..1] ?
   <Hole> holeTableType </Hole> [1..*] ?
</...>
```

Figure 3. Schema Example for Site (continued)

- Schema Component Representation

```
<xsd:complexType name="siteTableType">
  <xsd:sequence>
    <xsd:element name="ID" type=" codeSysElAttType "/>
    <xsd:element name="Name" type=" nameSysElAttType " minOccurs="0"/>
    <xsd:element name="Alias" type=" nameSysElAttType " minOccurs="0" maxOccurs="unbounded"/>
    <xsd:element name="Type" type=" extSiteTypeEnum " minOccurs="0"/>
    <xsd:element name="Organization" type=" simpleRefType " minOccurs="0"/>
    <xsd:element name="Contact" type=" simpleRefType " minOccurs="0"/>
    <xsd:element name="SiteAddressLocation" minOccurs="0">
      <xsd:complexType>
        <xsd:sequence>
          <xsd:element name="Address" type=" xsd:string " minOccurs="0" maxOccurs="unbounded"/>
          <xsd:element name="City" type=" xsd:string " minOccurs="0"/>
          <xsd:element name="State" type=" stateCodeEnum " minOccurs="0"/>
          <xsd:element name="County" type=" xsd:string " minOccurs="0"/>
          <xsd:element name="Country" type=" countryCodeEnum " minOccurs="0"/>
        </xsd:sequence>
      </xsd:complexType>
    </xsd:element>
    <xsd:element name="LocationReferencePoint" type=" xsd:string " minOccurs="0"/>
    <xsd:element name="Quadrangle" type=" xsd:string " minOccurs="0"/>
    <xsd:element name="PLSS" type=" legalLocType " minOccurs="0"/>
    <xsd:element name="Location" type=" survLocType " minOccurs="0" maxOccurs="unbounded"/>
    <xsd:element name="LocationMethod" type=" extLocMethodEnum " minOccurs="0"/>
    <xsd:element name="LocationAccuracy" type=" extLocAccuracyEnum " minOccurs="0"/>
    <xsd:element name="DataSource" type=" xsd:string " minOccurs="0"/>
    <xsd:element name="LastUpdated" type=" xsd:string " minOccurs="0"/>
    <xsd:element name="Hole" type=" holeTableType " maxOccurs="unbounded"/>
  </xsd:sequence>
  <xsd:attribute name="id" type=" keyid " use="optional"/>
  <xsd:attribute name="modver" type=" xsd:string " fixed="1.0"/>
</xsd:complexType>
```

REFERENCES

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Benoît, J., Sawyer, S. M., Adams, M. and de Alba, P. A. (1994). "National Geotechnical Experimentation Sites: Central Data Repository - User Manual." *U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA-RD-94-071*, December, 152 p.

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Appendix A

DATA DICTIONARY TABLES

Alias	An alternate name for another object. The alternate name is defined within a context, or naming system.

Name	Definition
Aliased Object	The foreign key reference to the object which is aliased.
Name	A name for this object. This name does not need to be unique within the naming system.
Naming System	A list of names, or a method for developing a list of names, from which Name is developed.

Atterberg Limits	The consistency of plastic soils defined in terms of shrinkage, plastic and liquid limits.

Name	Definition
Specimen	The specimen, of which these Atterberg limits test results are a part. The Atterberg limits test results must be related to a Specimen. This value is a foreign key that should select an instance of Specimen based on the Id value of the Specimen.
Liquid Limit	The water content of a soil at the arbitrary boundary between the semi-liquid and plastic states, generally expressed in percent.
Liquid Limit Method	The name of the method used to determine the liquid limit. Methods include the Liquid Limit Device and the Fall Cone.
Preparation Method	The name of the method used to prepare the specimen for the liquid limit test. Methods include the Dry and Wet preparation.
Plastic Limit	The water content of a soil at the arbitrary boundary between the plastic and semi-solid states, generally expressed in percent.
Shrinkage Limit	The maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass, generally expressed in percent.
Shrinkage Limit Method	The name of the method used to determine the shrinkage limit. Methods include the use of mercury or wax.
Natural Water Content	The water content of a soil in it's natural in situ moisture condition, generally expressed in percent.
Remarks	A text descriptor providing additional information relevant to the Atterberg Limit test.

Business Associate	The information about a business associate. The business associate may be a person, company, group, agency, or any other person or collection of persons that is related to the object.

Name	**Definition**
Name	A common name for this business associate. This name does not need to be unique within the naming system.
Naming System	A list of names, or a method for developing a list of names, from which Name is developed.
Type	The type of Business Associate. This should be one of the following: {company, person, consultant, work group, agency, other}.
Street Address	The street portion of the address. This may be multiple lines.
City	The name of the city where the Business Associate address is located.
State	The name of the state where the Business Associate address is located.
Postal Code	The postal code, appropriate to the given country, where the Business Associate address is located.
Country	The name of the country where the Business Associate Address is located.
Phone Number	The phone number of the Business Associate. The phone number is qualified by the type of phone number (eg, fax, voice, voice mail, mobile) and the nature (business or personal).
Email	The email address of a Business Associate.
Associated With	The company or group that this Business Associate is associated with. If the Business Associate is an employee, for example, the associate with would be the company which employs her. This is a foreign key to another instance of business associate. It is not required that the other instance be instantiated.
Contact	A foreign key to another Business Associate who serves as a contact for this Business Associate.

Component	A physical feature or condition observed at a point or within an interval of earth material within a hole, typically described megascopically. A Component may represent a notable textural or lithologic feature within a layer, or some other physical, structural, diagenetic, mineralogical, biological, or geophysical characteristic. It also may represent a condition (temporal or persistent) described at a point or within an interval. A Component may exist within a Layer, or may extend across many Layers.

Name	**Definition**
Hole	The hole, of which this Component is a part. A Component must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Core	The core, of which this component is a part. A component may or may not be related to a Core. If used, this value should select an instance of Core based on the Id value of the Core.
Layer	The layer, of which this Component is a part. A Component may or may not be related to a layer. If a part of a Layer, this value should select an instance of Layer based on the Id value of the Layer.
Source	The data source or kind of sample used to describe the Component and its location. This should be one of the following:{Core, CPT, Cuttings, Geophysical Log, Estimate, Multiple Sources, Outcrop, Other}.
Component Top	The measured depth at the top of the Component The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Component Base	The measured depth to the base of the Component. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}
Classification System	The name of the classification system used to describe the Component, if applicable (e.g. Munsell color). This is expected to be a foreign key to an instance, however there is no requirement that the instance exist.
Type	The type of Component being described (e.g, color, roundness, sorting, structural, physical, lithologic, diagenetic, mineralogic, fossil). This is expected to be a foreign key to an instance, however there is no requirement that the instance exist.
Description	A name or description of the Component. This can be an element of a classification system, and/or be restricted to a certain type of Component, or be a general text descriptor.
Abundance	A description of the relative pervasiveness of the Component within the interval defined by the Component top and Component base. This is a text descriptor and should provide some definition, such as: {pervasive (>50%), abundant (30-50%), common (15-30%, few (5-15%), rare (1-5%),trace}.

Core	An interval of earth materials, extracted or attempted to be extracted from a hole or site, using a specific type of sampling device, and where the physical locations of the ends of the Core are known in space. This term is used to represent both the sample collected as well as the interval within the hole that is sampled. If a physical sample of material is recovered from the interval, it is contained within the interval and is coherent, meaning that the material represents the relative position and properties of the strata or geological material in its in-situ condition. Material collected from a Core may be a) tested as a whole, b) further sub-sampled for geotechnical lab tests, c) described in detail, or d) subjected to geophysical tests, such as density scans, etc. Cores cannot overlap within a single hole.

Name	**Definition**
Name	A common name for the Core. This name does not need to be unique within the naming system.
Naming System	A list of names or a method for developing a list of names.
Hole	The hole, of which this Core is a part. A Core must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Core Top	The measured depth to the top of the Core. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Core Base	The measured depth to the lowermost boundary of the Core. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Sample Top	The inferred measured depth to the top of any sample recovered from the Core. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Sample Base	The inferred measured depth to the base of any sample recovered from the Core. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Sampling Method	The name of the sampling method used to obtain a Core. Sampling methods can be one of the following: a) undisturbed sampling by Shelby tube or Piston sampler, b) disturbed sample by split-spoon, c) block sample, d) disturbed sample by other methods, e) rotary drill cored sample, or f) other sampling method.
Date	The date and time when the Core was sampled at the site.
Sample Length	The length of material recovered (solid or unconsolidated) from the cored interval using one of the sampling methods.
Remarks	A text descriptor providing additional information relevant to the Core. Examples of this could be drill rig behavior, driller's comments, and drill time through the layer.

Cone Penetration Test Data	The cone penetration test (CPT) consists in determining the resistance to penetration of a conical pointed penetrometer into subsurface soils. Standard testing procedures are described in ASTM D 5778. Cone Penetration data are presented in this table.

Name	**Definition**
Cone Penetration Test Parameters	The Cone Penetration Test Parameters, of which these CPT data are a part. The CPT data must be related to a Cone Penetration Test Parameters. This value is a foreign key that should select an instance of Cone Penetration Test Parameters based on the Id value of the Cone Penetration Test Parameters.
Tip Depth	The depth of measurement at the penetrometer tip.
Tip Resistance	The end-bearing component of penetration resistance in units of stress referred to as q_c (uncorrected for net area ratio).
Friction Sleeve Resistance	The friction component of penetration resistance in units of stress developed on a friction sleeve refereed to as f_s.
Penetration Pore Pressure	Fluid pressure measured using the piezocone penetration test.
Inclination	Inclination of the penetrometer during advance in degrees.
Remarks	A text descriptor providing additional information relevant to the CPT data and results.
Date Last Updated	The date of the last update to the data in this table.

Cone Penetration Test Dissipation Data	During cone penetration testing it is possible to conduct dissipation tests to evaluate the hydraulic conductivity of soils. The process consists in stopping the penetrometer advance at the depth of interest and observing the pore pressure decay with time. Standard testing procedures are described in ASTM D 5778. Cone Penetration dissipation data are presented in this table.

Name	**Definition**
Cone Penetration Test Data	The Cone Penetration Test Data, of which these CPT dissipation data are a part. The CPT dissipation data must be related to a Cone Penetration Test Data. This value is a foreign key that should select an instance of Cone Penetration Test Data based on the Id value of the Cone Penetration Test Data.
Tip Depth	The depth of dissipation measurement at the penetrometer tip.
Penetration Pore Pressure	Fluid pressure measured using the piezocone during the dissipation test.

Elapsed Time	Elapsed time of reading for dissipation measurement.
Remarks	A text descriptor providing additional information relevant to the CPT dissipation data, results and procedures.
Date Last Updated	The date of the last update to the data in this table.

Cone Penetration Test Parameters	The cone penetration test (CPT) consists in determining the resistance to penetration of a conical pointed penetrometer into subsurface soils. Standard testing procedures are described in ASTM D 5778. Relevant testing parameters are described in this table.

Name	**Definition**
Hole	The hole, of which these CPT parameters are a part. The CPT parameters must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Cone Type	The type of cone penetrometer used for testing. The following provides a list of available cone penetrometers: a) mechanical cone, b) electric cone, c) piezocone, d) seismic piezocone, e) lateral stress cone, f) dynamic cone, g) acoustic cone, h) resistivity cone, i) vibratory cone, j) miniature cone, or k) other.
Cone Manufacturer	The business name of the company manucturing the cone penetrometer. For example, Fugro, Hogentogler, Delft, etc.
Tip Area	The conical base area of the penetrometer tip. Typical values are 10 cm^2 and 15 cm^2
Tip Apex Angle	The apex angle of the conical point of the penetrometer tip. The standard value is 60 degrees.
Friction Sleeve Area	The surface area of the friction sleeve located immediately behind the penetrometer tip. Typical values are 150 cm^2 for the 10 cm^2 and 200 cm^2 for the 15 cm^2.
Distance Tip to Sleeve	The distance between the tip and the center of the friction sleeve.
Piezocone Type	The type of Piezocone is defined in part by the position of the filter element. The types in use are the following: a) Type 1 (on the tip apex or at the midface on the tip), b) Type 2 (at the shoulder or behind the tip), c) Type 3 (above the friction sleeve), or d) other.
Porous Element Type	The type of material used as porous filter element. The following materials are typically used: a) plastic, b) sintered bronze, c) sintered steel, d) ceramic, or e) other.
Saturation Fluid	The fluid used to saturate the porous filter element. The following deaired fluids are typically used: a) water, b) glycerin, c) silicon oil, or d) other.
Saturation Method	A description of the procedure used to saturate the porous filter element.
Net Area Ratio Correction	The correction necessary to adjust the penetration cone resistance due to penetration water pressures acting behind the cone tip. The net area ratio correction, a, is applied to the cone resistance q_c which becomes the corrected total cone resistance q_t. The value a is dimensionless.

Push Rod Type	The type of pushing rods used for CPT penetration. Standard nomenclature can be used such as A-rod or N-rod.
Friction Reducer	A description of the type, size and location of the friction reducer behind the base of the cone should be reported if used.
Penetration Rate	The rate of advance of the penetrometer. Rate should be between 20 +/- 5 mm/second.
Tip Load Cell Capacity	The capacity of the tip load cell.
Sleeve Load Cell Capacity	The capacity of the sleeve load cell.
Surface Load Cell Capacity	The capacity of the surface load cell.
Pore Pressure Load Cell Capacity	The capacity of the pore pressure load cell.
Last Calibration Date	The date of the last calibration of the penetrometer. Specify which components were calibrated.
Remarks	A text descriptor providing additional information relevant to the CPT parameters and equipment especially if those differ from standard requirements.
Date Last Updated	The date of the last update to the data in this table.

CRS	A coordinate reference system for which a set of coordinates is given. This object contains information that will either reference a standard CRS, or will define a local coordinate system particular to a site/ project.

Name	**Definition**
Name	A common name for the CRS. This name does not need to be unique within the naming system.
Naming System	A list of names or a method for developing a list of names.
EPSG Code	The standard code for a well-known CRS, as defined and maintained by the European Petroleum Survey Group (EPSG).
URL	The Uniform Resource Locator for a dictionary entry to the standard CRS.
Type	The type of CRS. Values are {geographic, projected, vertical, engineering}.
Project Origin	A foreign key to the Project for which this CRS is a local, engineering CRS. This value indicates that the Project has defined a Location Reference Point, which is to be used as the origin for this CRS.
Origin	A description of a point which serves as the origin of the CRS. This is an alternative to the Project Origin, which uses a Location Reference Point as the origin.
North Direction	The direction that is assumed to be north in the engineering CRS. This is one of {true north, magnetic north, projected north, unknown}.

X Axis Azimuth	The rotation from the north direction of the X-axis. The rotation is positive clockwise. If the x-axis is due east, the value would be 90 deg.
X Axis Description	A description of the X-axis. If the X Axis Azimuth is not given, then a textual description of the direction of the X-axis should be given.
Y Axis Rotation	The Y axis is assumed to be rotated 90 deg from the X axis. The rotation may either be {clockwise, counter clockwise}. The usual value is counter clockwise.

Hole	A single sampling station, from which earth materials are collected or described, or earth material properties are measured. The sample may be from a core or cuttings from a borehole, surface excavation, or any other highly local sampling method. This term is used to represent the sample collecting activity as well as the sampling station.

Name	**Definition**
Name	A common name for the hole. This name does not need to be unique within the naming system.
Naming System	A list of names or a method for developing a list of names.
Site	The Site of which this hole is a part. A hole must be related to a Site This value is a foreign key that should select in instance of Site based on the Id value of the Site.
Type	The primary or current type of sampling station/hole. This is used to supply more specificity to the Site Type. Value should be one of the following: {see Hole Type sheet}.
Driller	The business associate that drilled the hole. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Logger	The business associate that logged the hole. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Start Date	The starting date of the collection activity for this hole.
End Date	The ending date of the collection activity for this hole.
Elevation	Elevation of the hole at the depth datum. Elevations are positive upward, measured from the elevation datum.
Elevation Datum	The name of the elevation datum.
Map Projection	The map projection used to give the X and Y locations of the location reference point.
Location X	The first coordinate for the location of the location reference point. In the US, this would be the Easting.
Location Y	The second coordinate for the location of the location reference point. In the US, this would be the Northing.

Local CRS	A description of the local coordinate system which applies to local x,y coordinates. This is expected to be a foreign key to an instance, however there is no requirement that the instance exist.
Geodetic Datum	The geographic coordinate system used to give the latitude and longitude of the location reference point.
Latitude	The latitude of the location reference point, given in the Geodetic Datum CRS.
Longitude	The longitude of the location reference point, given in the Geodetic Datum CRS.
Local X	The X location (first coordinate value) in the local CRS.
Local Y	The Y location (second coordinate value) in the local CRS.
Depth Datum	The datum from which depths are measured. If no value is given, it is assumed that the datum is the ground level.
Bottomhole depth	The measured depth of the hole at its deepest point. The depth is measured from the depth datum, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Inclination	The variation from the vertical of the hole. The inclination must be a positive value. If no inclination is given, the hole is interpreted to be vertical, or a hole survey object (not yet defined) exists which describes the path of the hole.
Surface Geology	The surficial geologic unit at the location of this hole. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Location Method	A description of the method by which the location reference point coordinates were obtained. This should be one of the following: {DGPS, Estimated from Well ID, GPS, Digitized from existing map, LORAN, Posted to map from description, Unknown - from owner/operator, Unknown - from 3rd party}.
Location Accuracy	An estimate of the accuracy of the location reference point. This should be one of the following: {0.3 m (~1/100 sec), 3 m (~1/10 sec), 15 m (~1/2 sec), 30 m (~1 sec), 90 m (~3 sec), <150 m (~5 sec), 300 m (~10 sec), 800 m (~1 min), >800 m (>~1 min)}.

Hole_Test_Assoc	The studies and analyses that are performed at a Hole and that may be available for direct access through the Geotechnical Virtual Data Center.

Name	**Definition**
Hole	The hole, of which this Hole Data is a part. Hole Data must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Hole Tests	The Hole Tests of which this Hole Data is a part. Test must be related to a Hole Tests. This value is a foreign key that should select an instance of Hole Tests based on the Id value of the Hole Tests.
Parent	The Parent Hole Tests of which this Hole Data is a part. Parent must be related to a Hole Tests. This value should be the Parent attribute of the Hole Tests associated with this instance of Hole Data.

Grandparent	The Grandparent Hole Tests of which this Hole Data is a part. Grandparent must be related to a Hole Tests. This value should be the Grandparent attribute of the Hole Tests associated with this instance of Hole Data.
Top Depth	The measured depth to the uppermost or shallowest extent of the Hole Data. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Bottom Depth	The measured depth to the lowermost extent of the Hole Data. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
XML File Name	A URL of the XML file that contains the results of this hole data that resides with the data provider. If this attribute is NULL, then the hole data exists, but is not available for download from the data provider.
Reference	A reference to a publication or publications, and/or to a URL that reports the hole data results, its implications, and the methods by which the data were obtained.
Contact	The business associate to which inquiries about this Hole Data may be addressed. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Remarks	

Hole Tests	The studies and analyses that are performed at a Hole and that may be available for direct access through the Geotechnical Virtual Data Center.

Name	**Definition**
ID	A simple name for the Hole Test. This value is intended to be a primary key for referencing this data instance.
Parent	A higher-level classification to which this Study Type belongs.
Grandparent	A higher-level classification to which the Parent belongs.
Description	A description of the Study Type.
Reference	A reference to a publication or publications, and/or to a URL that describe the study or analysis and/or provides standard procedures for performing the study or analysis.
InQuery	A flag that signifies whether the Geotechnical Virtual Data Center web site will query on this field.

Layer	An interval of earth material in which the texture and physical character of the material are described. The layer is usually defined in terms of a scientific or vernacular classification system. No layers in a given hole defined within one classification system may overlap.

Name	**Definition**
Hole	The hole, of which this layer is a part. A layer must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Core	The core, of which this layer is a part. A layer may or may not be related to a core. If used, this value should select an instance of Core based on the Id value of the Core.
Source	The data source or kind of sample used to describe the layer and define its boundaries. This should be one of the following:{Core, CPT, cuttings, Geophysical Log, Estimate, Multiple Sources, Outcrop, Other}.
Layer Top	The measured depth to the top of the layer. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Layer Base	The measured depth to the lowermost boundary of the layer. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers}.
Classification System	The name of the classification system used to describe the layer. This can be a scientific system such as USCS, USDA, or AASHTO, or a local, custom system. This is expected to be a foreign key to an instance, however there is no requirement that the instance exist.
Primary Classification	The value used as a primary description for the layer. This is intended to be an element of the classification system.
Secondary Classification	The value used to describe a part of the layer considered to be a secondary component of the layer. This is intended to be an element of the classification system and is only relevant if the primary classification attribute exists. The value may be qualified by the measured or estimated percentage of the layer for which this classification is relevant.
Tertiary Classification	The value used to describe a portion of the layer considered to be a minor component of the layer. This is intended to be an element of the classification system and is only relevant if the secondary classification attribute exists. The value may be qualified by the measured or estimated percentage of the layer for which this classification is relevant.
Description	A text descriptor for the layer. This can be used to provide additional descriptive information about the layer, or can be used In lieu of the primary, secondary, or tertiary classifications.
Remarks	A text descriptor providing information relevant to the layer interval, but not specifically relevant to a description of the layer itself. Examples of this could be drill rig behavior, driller's comments, and drill time through the layer.
Grain Size	The average or representative grain size of the material in the layer. This can be represented as a quantity of grain diameter (usually mm or phi), or as a text descriptor. If a text descriptor, a definition or reference to a classification system should be defined.

Bedding	A description of the representative bedding thickness and character within the layer, if observed. This is a text descriptor and should provide a definition of the descriptor as: massive, thickly bedded (> dm), medium bedded (cm-dm), thinly bedded (< cm), laminated}.
Basal Contact	A description of the nature of the lowermost boundary of the layer, if observed. This can be a text descriptor or member of a list as: {sharp, broken, clear, diffuse, erosional, gradational, irregular, wavy, undulating, inclined, angular unconformity, faulted, uncertain, incised}.

Natural Moisture Content	The in situ natural moisture or water content of geologic materials.

Name	**Definition**
Specimen	The specimen, of which this Natural Moisture Content is a part. The Natural Moisture Content must be related to a Specimen. This value is a foreign key that should select an instance of Specimen based on the Id value of the Specimen.
Natural Moisture Content	The water content of a soil in it's natural in situ moisture condition. The water content is the ratio of the mass of water contained in the pore spaces of soil or rock material, to the solid mass of particles in that material, generally expressed in percent.
Remarks	A text descriptor providing additional information relevant to the moisture content determination.

Particle Size Data	The distribution of particle sizes in soils as determined by sieve analysis and/or hydrometer analysis.

Name	**Definition**
Specimen	The specimen, of which this Particle Size Data analysis is a part. The Particle Size analysis must be related to a Specimen. This value is a foreign key that should select an instance of Specimen based on the Id value of the Specimen.
Particle Size Parameters	The Particle Size Parameters, of which these Particle Size Data are a part. The Particle Size Data must be related to the Particle Size Parameters. This value is a foreign key that should be an instance of Particle Size Parameters based on the Id value of the Particle Size Parameters.
Sieve or Particle Size	The sieve opening or the size of the soil particles.
Percent Passing	The percentage of soil passing or finer by weight or mass for each sieve or size of soil particle.
Remarks	A text descriptor providing additional information relevant to the particle size analysis of the soil specimen.

Particle Size Parameters	The distribution of particle sizes in soils as determined by sieve analysis and/or hydrometer analysis. Relevant parameters and summary results are presented in this table.

Name	Definition
Specimen	The specimen, of which this Particle Size analysis is a part. The Particle Size analysis must be related to a Specimen. This value is a foreign key that should select an instance of Specimen based on the Id value of the Specimen.
D10	Grain diameter corresponding to 10 percent passing.
D50	Grain diameter corresponding to 50 percent passing.
Uniformity	A coefficient describing the degree of uniformity of the grain size distribution. This coefficient is defined as the ratio of D60 over D10.
Curvature	A coefficient describing the degree of curvature of the grain size distribution. This coefficient is defined as the ratio of (D30)2 over (D60 times D10).
Percent Fines	The percentage of fines by weight passing the No. 200 sieve (finer than 0.075 mm).
Remarks	A text descriptor providing additional information relevant to the particle size analysis of the soil specimen.

Site	A collection of holes and samples obtained at a common place.

Name	Definition
Name	A common name for the Site. This name does not need to be unique within the naming system.
Naming System	A list of names or a method for developing a list of names.
Type	Primary purpose for data collection at the Site. This should be one of the following: {see Site Types sheet}
Address	The physical address for the site.
City	The name of the city where the site is located.
State	The name of the state where the site is located.
Zip	The zip (or postal code) where the site is located.
County	The name of the county where the site is located.
Country	The name of the country where the site is located.

Quadrangle	The name of the USGS 7.5' quadrangle where the site is located.
PLSS	The Public Land Survey System township, range, section, and quarter-quarter section where the site is located.
Organization	The manager, operator or owner of the Site. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Contact	A name to contact for more information about the Site. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.
Location Reference Point	A description of a point at the Site which represents the location of the Site. The location given in other attributes will be the location of this point. In general, a local CRS (coordinate reference system) for locating other objects at the site will use this as the origin.
Map Projection	The map projection used to give the X and Y locations of the location reference point
Location X	The first coordinate for the location of the location reference point. In the US, this would be the Easting.
Location Y	The second coordinate for the location of the location reference point. In the US, this would be the Northing.
Geodetic Datum	The geographic coordinate reference system used to give the latitude and longitude of the location reference point.
Latitude	The latitude of the location reference point, given in the Geodetic Datum CRS.
Longitude	The longitude of the location reference point, given in the Geodetic Datum CRS.
Location Method	A description of the method by which the location reference point coordinates were obtained. This should be one of the following: {DGPS, Estimated from Well ID, GPS, Digitized from existing map, LORAN, Posted to map from description, Unknown - from owner/operator, Unknown - from 3rd party}.
Location Accuracy	An estimate of the accuracy of the location reference point. This should be one of the following: {0.3 m (~1/100 sec), 3 m (~1/10 sec), 15 m (~1/2 sec), 30 m (~1 sec), 90 m (~3 sec), <150 m (~5 sec), 300 m (~10 sec), 800 m (~1 min), >800 m (>~1 min)}.
Data Source	The name of the original source of data obtained for this Site. This could be the data provider itself, or another business associate that released the information to the data provider. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.

Specimen	A sample of earth material collected for the purpose of description or testing. A specimen may be collected directly from a site or hole, collected from the same Specimen material or from another Specimen.

Name	Definition
Name	A common name for the Specimen. This name does not need to be unique within the naming system.
Naming System	A list of names or a method for developing a list of names.
Hole	The hole, of which this Specimen is a part. A specimen must be related to a hole, either through this attribute or through Core. This value should select an instance of Hole based on the Id value of the Hole. Note: if Specimen comes from a Core, then the Core attribute must be populated and a value for Hole is not required.
Core	The Core, of which this Specimen is a part. A Specimen may or may not be related to a Core. If used, this value should select an instance of Core based on the Id value of the Core.
Layer	The layer, of which this Specimen is a part. A Specimen may or may not be related to a Layer. If a part of a Layer, this value should select an instance of Layer based on the Id value of the Layer.
Part of Specimen	The Specimen of which this Specimen is a part. If this Specimen is a split of a previously collected Speciment or resampled for a different test, this attribute should be populated. If used, this value should select an instance of Specimen based on the Id value of the Specimen.
Specimen Top	The measured depth to the top of the Specimen. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers, lab technicians}.
Specimen Base	The measured depth to the lowermost boundary of the Specimen. The depth is measured from the depth datum of the hole, and is positive downward, as measured along the hole alignment. The value may also be qualified by who measured the depth {loggers, drillers, lab technicians}.
Sampling Method	The name of the sampling method used to obtain a Specimen. Sampling methods should be one of the following: {Block sample, Bulk sample, Core plug, Other, Split-core section, Whole-core section}.
Lithology Classification System	The name of the classification system used to describe the lithology of the Sample. This can be a scientific system such as USCS, USDA, or AASHTO, or a local, custom system. This is expected to be a foreign key to an instance, however there is no requirement that the instance exist.
Primary Lithology	The value that describes the primary lithology of the Specimen. This is intended to be an element of the classification system.
Test	The name of the test for which the Specimen was collected. This is intended to be a name from an enumerated list, and should be one of those listed on the Tests worksheet.
Collector	The business associate that collected the Specimen. This is intended to be a foreign key to a possible database entry, although there is no expectation that this entry will actually exist.

Date	The date and time when the Specimen was obtained from the cored interval or other specimens.
Remarks	A text descriptor providing additional information relevant to the Specimen.

Standard Penetration Test Data	The standard penetration test (SPT) involves driving a split-spoon sample barrel into the ground from the bottom of a borehole by dropping a 140 lb (63.5 kg) hammer a height of 30 inches (0.76 m). From the test, a penetration resistance or blowcount (N) is obtained which equals the number of blows to drive the sampler over the depth interval between 6 and 18 inches (150 to 450 mm). The N-value is reported in blows per foot (blows per 300 mm). Standard testing procedures are described in ASTM D 1586. SPT results are presented in this table.

Name	**Definition**
Hole	The hole, of which these SPT data are a part. The SPT data must be related to a hole. This value is a foreign key that should select an instance of Hole based on the Id value of the Hole.
Core	The core, of which these SPT are a part. The SPT data must be related to a Core. This value is a foreign key that should select an instance of Core based on the Id value of the Core.
SPT Parameters	The SPT Parameters, of which these SPT data are a part. The SPT data must be related to the SPT Parameters. This value is a foreign key that should select an instance of SPT Parameters based on the Id value of the SPT Parameters.
Blows First	The number of blows required to drive the split-spoon sampler for the first 6 inch (150 mm) increment. This first increment is considered the seating drive. Penetration is stopped and often noted as "refusal" if the number of blows reaches 50 for any of the 6 inch (150 mm) increment or if there is no observed advance during the application of 10 successive blows or if the total number of blows have reached 100.
Blows First Penetration	Penetration for first increment. Complete increment is 6 inch (150 mm). Partial increment should be recorded to the nearest inch (25 mm).
Blows Second	The number of blows required to drive the split-spoon sampler for the second 6 inch (150 mm) increment. Penetration is stopped and often noted as "refusal" if the number of blows reaches 50 for any of the 6 inch (150 mm) increment or if there is no observed advance during the application of 10 successive blows or if the total number of blows have reached 100.
Blows Second Penetration	Penetration for second increment. Complete increment is 6 inch (150 mm). Partial increment should be recorded to the nearest inch (25 mm).
Blows Third	The number of blows required to drive the split-spoon sampler for the third 6 inch (150 mm) increment. Penetration is stopped and often noted as "refusal" if the number of blows reaches 50 for any of the 6 inch (150 mm) increment or if there is no observed advance during the application of 10 successive blows or if the total number of blows have reached 100.
Blows Third Penetration	Penetration for third increment. Complete increment is 6 inch (150 mm). Partial increment should be recorded to the nearest inch (25 mm).

Blows Fourth	The number of blows required to drive the split-spoon sampler for the fourth 6 inch (150 mm) increment if a 24 inch (600 mm) sampler is used. Penetration is stopped and often noted as "refusal" if the number of blows reaches 50 for any of the 6 inch (150 mm) increment or if there is no observed advance during the application of 10 successive blows or if the total number of blows have reached 100.
Blows Fourth Penetration	Penetration for fourth increment. Complete increment is 6 inch (150 mm). Partial increment should be recorded to the nearest inch (25 mm).
N Value	The uncorrected SPT N-Value is defined as the sum of second and third increments (from 6 to 18 inches - 150 to 450 mm). Deviation from this definition occurs if penetration is stopped due to any of the 6 inch (150 mm) increment reaching 50 blows or if there is no observed advance during the application of 10 successive blows or the total number of blows have reached 100. Such deviations should be reported as number of blows for each complete 6 inch increment or number of blows for each partial increment. Partial increments should be reported to the nearest inch (25 mm).
N Value Top Depth	The measured depth associated with the beginning of the interval of penetration for the reported N Value.
N Value Base Depth	The measured depth associated with the end of the interval of penetration for the reported N Value.
Measured Energy	The measured energy ratio expressed as a percentage.
Remarks	A text descriptor providing additional information relevant to the Standard Penetration Test of the soil specimen.
Date Last Updated	The date of the last update to the data in this table.

Standard Penetration Test Parameters	The standard penetration test (SPT) involves driving a split-spoon sample barrel into the ground from the bottom of a borehole by dropping a 140 lb (63.5 kg) hammer a height of 30 inches (0.76 m). From the test, a penetration resistance or blowcount (N) is obtained which equals the number of blows to drive the sampler over the depth interval between 6 and 18 inches (150 to 450 mm). The N-value is reported in blows per foot (blows per 300 mm). Standard testing procedures are described in ASTM D 1586. Relevant testing parameters are described in this table.

Name	**Definition**
Sampler Length	The length of the split-spoon sampler barrel. Standard lengths are 18 inches (450 mm) and 24 inches (600 mm).
Sampler Internal Diameter	The inside diameter of the split-spoon sampler.
Liner	The use of a liner to produce a constant inside diameter is permitted and should be noted.

Basket	The use of a basket retainer is permitted and should be noted.
Hammer Mass	The hammer mass used to drive the split-spoon sampler. The standard mass is 140 lb (63.5 kg).
Hammer type	The type of hammer or drive-weight assembly used for the sampling and penetration. Typical hammer types include the following: a) donut, b) safety, or c) other.
Hammer Release	The mechanism used to lift and drop the hammer or drive-weight assembly. Typical hammer release mechanisms include the following: a) rope and cathead, b) trip, c) semi-automatic, d) automatic, or e) other.
Drop Height	The hammer drop height for SPT penetration. The standard procedure requires a drop of 30 inches (0.76 m).
Rod Type	The type of sampling rods used for SPT penetration. Standard nomenclature can be used such as A-rod or N-rod.
Rod External Diameter	The external diameter of the sampling rods used for SPT penetration.
Rod Weight	The drive rod weight per unit length (typically given per meter or per foot).
Cathead diameter	The diameter of the cathead used to pull the rope attached to the hammer. Typical diameters range from 6 to 10 inches (150 to 250 mm).
Rope Turns Number	The number of rope turns on the cathead for performing the SPT. Maximum allowed number of turns is 2 1/4.
Energy	A description of the equipment used to measure energy during the SPT penetration.
Remarks	A text descriptor providing additional information relevant to the SPT parameters and equipment especially if those differ from standard requirements.
Date Last Updated	The date of the last update to the data in this table.

Appendix B

Sample Mapping: Table to XML for Site

An example mapping is shown that takes the information from the Site table, and encodes it into XML schema, and is expressed in an XML file.

The schema is shown below:

```
<xsd:element name="Site" type="siteTableType">
              <xsd:annotation>
                <xsd:documentation>
The Site is a collection of holes and samples obtained at a common place.
It is a direct parent of Hole, and offers the top level of the context
hierarchy.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>

<xsd:complexType name="siteTableType">
              <xsd:annotation>
                <xsd:documentation>
The Site is a collection of holes and samples obtained at a common place.
It is a direct parent of Hole, and offers the top level of the context
hierarchy.
                </xsd:documentation>
              </xsd:annotation>
  <xsd:sequence>
    <xsd:element name="ID" type="codeSysElAttType">
              <xsd:annotation>
                <xsd:documentation>
A code or simple name for a Site. This value is intended to be a foreign
key for referencing this data instance.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="Name" type="nameSysElAttType" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
A common name for the Site. This name does not need to be unique within
the naming system.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="Alias" type="nameSysElAttType" minOccurs="0"
maxOccurs="unbounded">
              <xsd:annotation>
                <xsd:documentation>
Zero or more alternate names for the Site. This name does not need to be
unique within the naming system. This element is useful if the Site has
different names in different databases, or if it is known in the industry
by different names.
```

```
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="Type" type="extSiteTypeEnum" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
Primary purpose for data collection at the Site. These values are from an
enumerated list, and may be extended using Other: xx method.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="Organization" type="simpleRefType" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
A reference to a business associate that is the owner at the Site.
Details about the business associate may, if desired, be carried in the
dictionary portion or this exchange file, or may obtainable through a
service.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="Contact" type="simpleRefType" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
A reference to a business associate that is the contact at the site, at
the time of data collection. There is no expectation that the site
contact will be the same at a later date.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
<xsd:element name="SiteAddressLocation" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
The geopolitical location (state, city, county, country) of the Site,
with the address added to the sequence of values. In geotechnical
sampling, a site can often be located with a simple address.
                </xsd:documentation>
              </xsd:annotation>
 <xsd:complexType>
  <xsd:sequence>
    <xsd:element name="Address" type="xsd:string" minOccurs="0"
maxOccurs="unbounded">
              <xsd:annotation>
                <xsd:documentation>
The physical address for the site. The site may be located by giving an
address.
                </xsd:documentation>
              </xsd:annotation>
      </xsd:element>
    <xsd:element name="City" type="xsd:string" minOccurs="0">
              <xsd:annotation>
                <xsd:documentation>
The name of the city where the site is located.
                </xsd:documentation>
```

```
            </xsd:annotation>
      </xsd:element>
    <xsd:element name="State" type="stateCodeEnum" minOccurs="0">
            <xsd:annotation>
              <xsd:documentation>
The name of the state where the site is located. The state is given as
the two character postal code.
              </xsd:documentation>
            </xsd:annotation>
      </xsd:element>
    <xsd:element name="County" type="xsd:string" minOccurs="0">
            <xsd:annotation>
              <xsd:documentation>
The name of the county where the site is located.
              </xsd:documentation>
            </xsd:annotation>
      </xsd:element>
    <xsd:element name="Country" type="countryCodeEnum" minOccurs="0">
            <xsd:annotation>
              <xsd:documentation>
The name of the country where the site is located. Either the two or
three character ISO code may be used. For the United States, the
appropriate codes would be US or USA.
              </xsd:documentation>
            </xsd:annotation>
      </xsd:element>
  </xsd:sequence>
 </xsd:complexType>
```

A sample of an XML file instantiated from the above schema is shown below:

```
 <Site>
    <ID codeSpace="USGS_ID">Lonr C_31861788_bD19</ID>
    <Name namingSystem="USGS_PostgreSQL_name">15</Name>
    <Name namingSystem="USGS_common_name">Long Beach - Pier C</Name>
    <Alias namingSystem="USGS_Abbreviation">LBPC</Alias>
    <Alias namingSystem="USGS_Other_ID">Long Beach-4</Alias>
    <Type>geotechnical</Type>
    <Organization>CalWaterRep</Organization>
    <Contact>Dan Ponti</Contact>
    <SiteAddressLocation>
      <Address>Street address if known</Address>
      <City>Long Beach</City>
      <State>CA</State>
      <County>Los Angeles</County>
      <Country>US</Country>
    </SiteAddressLocation>
    <LocationReferencePoint>Western end of Pier C Container facility,
adjacent to Channel Two</LocationReferencePoint>
    <Quadrangle>LONG BEACH</Quadrangle>
    <PLSS xsi:type="USLegal">
      <Township>5S</Township>
      <Range>13W</Range>
```

```
      <Section>3</Section>
      <PrincipalMeridian>San Bernardino Base and
Meridian</PrincipalMeridian>
    </PLSS>
    <Location>
      <CRS>NAD83</CRS>
      <LatitudeValue uom="deg">33.77095</LatitudeValue>
      <LongitudeValue uom="deg">-118.22052</LongitudeValue>
    </Location>
         <!--  Can also include a non-lat/lon location, if desired.
    <Location>
      <CRS>UTM 11N / NAD83</CRS>
      <Easting uom="m">386982.7</Easting>
      <Northing uom="m">3737429</Northing>
    </Location>
          -->
    <LocationMethod>GPS</LocationMethod>
    <LocationAccuracy>3 m</LocationAccuracy>
    <DataSource>USGS</DataSource>
    <LastUpdated>2002-08-29</LastUpdated>
    <Hole>. . .
      information about Holes, Cores, Specimen, etc are also included.
</Site>
```