DATA ELEMENT STANDARD

NUMBER: 4	SUPERSEDES: N/A

SUBJECT **Location Specification – Coordinates**	EFFECTIVE DATE: 10/27/2021	NUMBER OF PAGES: 1 of 6
THIS STANDARD APPLIES TO **Caltrans Employees, Contractors & Consultants**	REVISION NUMBER: 1	LAST REVIEWED: N/A
REFERENCE	APPROVED SIGNATURE Chad Baker Chad Baker (Oct 27, 2021 18:21 PDT)	

PURPOSE:

This standard defines how coordinate pairs are represented in corporate datasets and database systems within Caltrans. Coordinates pairs (herein referred to as coordinates), such as a latitude and longitude, X and Y, or Northing and Easting, are required to determine a specific location relative to the origin of the system being used (datum). Valid location data improves efficiency and decision making. In addition, staff will save time in having access to reliable, consistent data for use.

The scope of this standard applies to data stored in database systems (corporate datasets) intended to be used for geographic querying and visualization of the data. Coordinates may be collected for many reasons, using varying equipment and procedures. This standard is not intended to address activities required to be performed under the direction of licensed professionals, data collection methodologies, or equipment recommendations. For specific guidance on these topics, staff should consult with the Headquarters Office of Land Surveys, District Land Surveys, or the Headquarters Office of Photogrammetry and Preliminary Investigations as well as Section 8726 of the California Business and Professions Code.

GENERAL INFORMATION:

Coordinate values are used to reference the physical locations of projects, assets and other points of interest relative to a reference system (datum). Caltrans typically collects, stores and uses the data as follows:

1. Field: Point positions may be collected using field methods from smartphones and hand-held GPS devices, to survey-grade devices and procedures.
2. Digitization: Coordinates are collected by loading an appropriate base map or image into a Geographical Information System (GIS) or similar application and selecting specific locations. These positions may even be obtained using products such as Google Earth.

3. Geocoding: The computing of geographic coordinates for place names, street addresses and codes (e.g., zip codes) based upon a reference dataset

To properly report the accuracy of the positions being collected, it is important that the reporting party understand the device and method that was used. In the case of digitizing positions, it is also important to understand the accuracy and datum of the parent system. Uncorrected GPS positions, such as using a cell phone, typically have an accuracy of plus or minus 10 meters (33 feet), which would be reported to 4 decimal places of latitude/longitude per Table 1 below. Survey grade positions are often within 2 centimeters when properly collected and processed, which would then be reported to 6 or 7 decimal places as shown in Table 1. If a reporting party is unsure of the accuracy of the data based on the methods, device and procedures used, it is recommended that they consult with a Caltrans Professional Land Surveyor for guidance.

Coordinate values will be stored in a manner that represents the precision of known values plus one unknown value (significant figures). To illustrate Table 1 depicts the approximate relationship of geographic coordinates to significant figures on the ground.

Table 1 – Approximate Relationship of Geographic Coordinates
Significant Figures to Ground Distances

Decimal Places	Degrees	Distance (metric)	Distance (imperial)
0	1.0	111 km	68.9 miles
1	0.1	11.1 km	6.89 miles
2	0.01	1.11 km	3640 feet
3	0.001	111 m	364.1 feet
4	0.0001	11.1 m	36.41 feet
5	0.00001	1.11 m	3.641 feet
6	0.000001	0.111 m	0.364 feet
7	0.0000001	1.11 cm	0.036 feet
8	0.00000001	1.11 mm	0.003 feet

The distance between two meridians of longitude that are one degree apart depends on the radius of the circle of latitude where the distance is computed Table 2 below depicts the varying length of a degree of longitude at various latitudes common in California.

Table 2 – Length of a Degree of Longitude at Intervals of Latitude common in California

Latitude	1 Degree of Longitude (km)	1 Degree of Longitude (miles)
35	91.1	56.6
36	90.0	55.9
37	88.9	55.2
38	87.7	54.5
39	86.5	53.7
40	85.2	52.9
41	84.0	52.2

DEFINITIONS:

Latitude[1]: The angular distance of a location North or South of the earth's equator, usually expressed in degrees, minutes and seconds. Locations North of the equator are considered positive values, locations South of the equator are considered negative values. Values range from -90 degrees (South Pole) to zero (Equator) to +90 degrees (North Pole). Latitude values in California are positive.

Longitude: The angular distance of a location East or West of the datum Prime Meridian at Greenwich, England, usually expressed in degrees, minutes, and seconds. Locations East of the Prime Meridian are considered positive values, locations West of the Prime Meridian are considered negative values. Values range from -180 degrees (International Date Line) to zero (Prime Meridian) to +180 degrees (International Date Line). Positive and negative 180 degrees are the same meridian, commonly known as the International Date Line. Longitude values in California are negative.

Coordinate system: A coordinate system is a method to identify the location of a point on the earth. Most coordinate systems use two numbers, a coordinate, to identify the location of a point. Coordinates are based upon a datum. Both coordinate values are required to form the coordinates of a location.

Datum: In surveying and geodesy, a datum is a coordinate system with a reference surface upon which locations are based. Many datums reference an ellipsoid, a mathematical approximation of the Earth's surface. Positional coordinates are related to a datum by measurements. Horizontal datums define the point of origin and other parameters of a coordinate system. Vertical datums are used to represent the elevation of point relative to a known surface. Coordinates are often based upon a projection referenced to a datum.

[1] Different types of latitude include geographic and geocentric. For more information, refer to the following link:
https://www.britannica.com/science/latitude

STANDARD:

Coordinate data shall follow the data specification as follows:

1. A coordinate pair are intended to represent a singular point location.

2. A datum should be chosen based on the intended use of the data to meet business requirements and any considerations related to interoperability with other use cases such as in design or survey field collection. For a list of suggested datums, please refer to the Metadata section of this document referenced below. For a specific datum recommendation, please consult with a California licensed Professional Land Surveyor.

3. Coordinates shall be stored in decimal degrees per the data specification (i.e. 38.579529, -121.505904).

METADATA:

The following GIS specific metadata element must be completed for all datasets containing coordinate information:

Metadata Element	Description
METHODOLOGY	Description of how the data was collected, produced, and processed. Note any assumptions made or known data issues. Include a description on how the coordinate values were determined as part of the methodology metadata field. This would include what equipment was used if the values were field collected or the map scale and base map source (imagery, street layer, etc.). Collection method must be one of the following (pick lowest entry on list below when multiple entries apply): • Survey - Values collected through a field survey under the direction of a

	California Licensed Professional Land Surveyor • Mobile - Values collected in the field using a handheld device • Digitized - Values derived by selecting points on an orthophoto, Linear Referencing System (LRS) tool, or other base map • Unknown - Used only if upgrading an existing database and how the coordinate values were determined is unknown Example: "Collection equipment used: 2019 iPad, Collection method: Mobile"
GIS_COORDINATE_SYSTEM_EPSG	EPSG code from: https://spatialreference.org/ref/epsg/ Suggested datums: EPSG 4326 (WGS84) EPSG 4269 (NAD83) EPSG 2766 – 2771 (NAD83-HARN California Zones 1-6)

REFERENCES:

Please refer to the following attachments for more details:

- Caltrans Latitude/Longitude Data Specification
- Caltrans Data Documentation Package
- US EPA Latitude/Longitude Data Standard[2]
- California Business and Professions Code Section 8726
- Caltrans Survey Manual – Accuracy Specifications

FINANCIAL IMPACT:

Some programs and/or database systems may require additional resources to meet these requirements. For example, data values which are not stored according to this standard may need to be updated.

Some database systems may need to be modified to meet this new standard. For example, system updates may be needed to create fields to store all required fields.

[2] https://www.epa.gov/geospatial/latitudelongitude-data-standard

Training may be required for new and current staff to prepare them for meeting these new requirements. For example, data custodians and staff may need training on best practices to preserve data quality and accuracy.

Some project reports may need to be updated to incorporate all required fields. As a result, some programs may require additional resources to update and maintain their revised report templates.