1 Introduction

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1.0 GENERAL

The California Department of Transportation (Caltrans) manages more than 50,000 miles of California's highway and freeway lanes, provides inter-city rail services, permits more than 400 public-use airports and special-use hospital heliports, and works with local agencies. Caltrans mission is to provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

Land surveyors play a key role in accomplishing Caltrans mission. Land surveying is fundamental to all civil engineering work. Surveying provides the geospatial foundation and continuity for the planning, design, property acquisition, construction, operations and maintenance of capital improvement projects. Geospatial survey data includes, but is not limited to: roadway layout, boundary, land descriptions, imagery, and geodetic control data. Survey data is used on every project to identify project location, and legal boundaries of specific state rights of way, adjoining properties, and others (third parties). In most cases, land surveyors provide the initial information necessary to properly identify project needs associated with initiation of a project, including but not limited to: existing mapping (as-built plans, right of way maps, county assessor maps), assessor parcels & boundaries, area calculations, current topography or photo imagery, current and third-party ownerships (utilities, railroads), and jurisdictional boundaries (city, county, tribal).

The Caltrans Surveys Manual (Surveys Manual) is maintained by the Headquarters' Office of Land Surveys, formerly the Office of Geometronics, for use by surveyors and others performing work on the California State Highway System (SHS). This document establishes uniform policies and standards to deliver quality work products by Caltrans Land Surveys functions and others (local agencies, consultants, etc.) working on the SHS. It is neither intended as, nor does it establish, a legal standard for these functions. The individual chapters of the Surveys Manual are meant to stand alone, yet they are tied to each other in the development of a transportation project.

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1.2 PURPOSE

The Surveys Manual establishes policies and procedures for Caltrans Land Surveys functions in accordance with Caltrans Director's Policies (DP) and Deputy Directives (DD).

The primary purpose of the Surveys Manual is to:

- Provide a standard for statewide uniformity in surveying.
- Establish and maintain survey standards.
- Improve the overall efficiency of Caltrans' survey functions.
- Provide a primary reference source for Caltrans surveying policies, safety, standards, and information.

The Surveys Manual also serves to:

- Provide a reference for new employee orientation.
- Provide source material for training
- Help employees in other units gain a better understanding of surveying and its relationship to other Caltrans activities.

The standards, policies, and procedures established and discussed in this document are for the information and guidance of the officers and employees of Caltrans and its transportation partners. Instructions given are subject to change as conditions and experience require. Special situations may call for deviation from policies and procedures, subject to approval by Caltrans as described in this manual.

1.2-1 Scope

The Surveys Manual is not intended as a textbook or a substitute for surveying knowledge, experience, or professional judgment. It includes techniques as well as graphs and tables not ordinarily found in textbooks. These are intended as aids in the quick solutions of field and office problems. Except for new technologies, no attempt is made to detail surveying techniques. For these, standard textbooks or equipment manuals should be used.

All licensed Land Surveyors working in support of Caltrans must adhere first and foremost to the California Business and Professions Code §8700 -§8805 (Professional Land Surveyors Act).
https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=BPC&division=3.&title=&part=&chapter=15.&article

It is not intended that any standard of conduct or duty toward the public shall be created or imposed by the publication of this manual. Statements for the duties and responsibilities of any given classification of employees mentioned herein refer only to duties or responsibilities owed by these employees to their supervisors. However, in their official contacts, employees should recognize the need for good relations with the public.

1.2-2 Form

The loose-leaf form of this manual was chosen because it makes it easier to revise and expand. New instructions or updates will be issued as sheets in the format of this manual and made available on-line on the Caltrans website:
http://www.dot.ca.gov/hq/row/landsurveys/SurveysManual/Manual_TOC.html

New instructions or updates may consist of additional sheets or new sheets to be substituted for those superseded. Users of this manual should utilize the most recent version available on-line on the Caltrans website.

1.2-3 Updates

Each chapter and sub-chapter of the manual is published so that it stands alone in the manual. When updating chapters, the updates will be either by sub-chapter, or the entire chapter will be updated. The process of updating a chapter in the manual was established to solicit the input from subject matter experts (SME) among the Caltrans districts and divisions, academia, as well as other transportation partners.

Once a chapter has been identified to be updated, the following steps are taken:

1. Review current chapter to determine information that is still relevant and can be used in the updated chapter.
2. Research of the identified subject matter from sources such as academic publications, Federal Highway Administration (FHWA), National Geodetic Society (NGS), other state Department of Transportations (DOTs), and private industry.
3. Develop draft document with updated information.
4. Distribute draft document to district SME's with comment due date.
5. Review comments from SME's. Incorporate pertinent information into the draft document. Develop a comment resolution spread sheet to document what information was included and which was discarded and why.
6. Send the final draft document to the Surveys Management Board (SMB) for final review, comment, and approval.

7. Final approved document is accepted and a Manual Change Transmittal document is signed by the Chief, Office of Land Surveys.
8. Final document is published on the Caltrans internet and intranet websites.

The publishing date of any changes is indicated on the table of contents and any sub-chapters that were updated. All remaining sub-chapters not edited will keep their original publishing date. There may be multiple publishing dates within a single chapter, reflecting when each sub-chapter was last updated.

1.2-4 Plain Language

This manual is being edited to meet "plain language" guidelines when the contents of each chapter are updated. The use of plain language does not change the meaning or validity of any parts that do not use plain language. The terms "Caltrans" or "Department" may be used throughout this document and are synonymous.

1.2-5 Use of the English and Metric Units

The Surveys Manual is written for projects that will be designed and built using U.S. Customary (English) units. Directors Policy 15-R1 and Deputy Directive Number 12-R1, both effective October 2006, state that Caltrans has adopted the use of the U.S. Customary (English) units as its preferred system of units and measures. All projects designed and constructed in English units shall follow the standards in this manual. The Metric standards contained in earlier versions of the manual, and related publications, will continue to be used only if the specific project was granted a waiver to be delivered in Metric units.

Geodetic surveys performed to the standards set by the National Geodetic Survey, or in compliance with California Public Resources Code Section 8801-8902 may be performed in metric units, and the resulting data converted to customary units[1] for project development.
https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=PRC&division=8.&title=&part=&chapter=&article

[1] **See Chapter 4.1-1 Policy**

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1.3 ORGANIZATION

1.3-1 Headquarters – Office of Land Surveys

The Office of Land Surveys (OLS) resides at Headquarters and is responsible for developing and recommending policy, guidance and tools, training, measuring and monitoring, and quality improvement. These actions are in collaboration with other Headquarters divisions and are elements of the corporate activity cycle.

OLS provides guidance and assistance to the Caltrans Land Surveys functions in the districts and other divisions on all matters relating to land surveying, as well as acting as a liaison with other public agencies, the private sector, and professional societies. This includes the functions of land surveying, right of way engineering, photogrammetry, and structure preliminary investigations.

Specific OLS responsibilities include:

- Provide technical expertise, training, and support for Caltrans Land Surveys activities.
- Evaluate, procure, deploy, and maintain cost-effective surveying systems for statewide use.
- Develop and review Caltrans standards, specifications, policies, and procedures for Land Surveys products and services.
- Identify and address problems affecting Land Surveys functions.
- Develop and provide effective solutions, and facilitate the exchange of solutions.
- Coordinate Caltrans investigations and evaluations of new technology systems that are directly applicable to Land Surveys functions.
- Review relinquishment and vacation submittals and prepare requests for resolution by the California Transportation Commission.
- Coordinate Caltrans participation in statewide geodetic issues and basic control surveys.
- Function as Caltrans focal point with external organizations on land surveying issues.

1.3-2 Office of Photogrammetry

The Office of Photogrammetry and Preliminary Investigations (OoP-PI), in partnership with the districts and others, is responsible for the following:

- Provides photogrammetry products for Caltrans use: aerial photography, aerial photography reproductions, photogrammetric digital topographic maps, digital photography, orthophotography, digital terrain data including terrain modeling data, inventory photography and raster imagery.
- Provide coordination of Caltrans photogrammetry activities.
- Provide technical expertise, training, and assistance for Caltrans photogrammetry operations.
- Develop, establish, and maintain standards for photogrammetry products produced by and for Caltrans.
- Develop and administer "blanket" photogrammetry-related service contracts for departmental use – aerial photography, aerial photography reproduction and digital map compilation.
- Manage and provide public access to the Caltrans aerial imagery library – an archive of aerial photography procured by Caltrans and other cooperative agencies dating back to the 1950's.
- Evaluate, develop, and procure cost-effective, new-technology photogrammetry equipment and systems.
- Review Bridge Site Data Submittals from districts for completeness and accuracy.
- Perform site investigations and field surveys for bridges and retaining walls when requested.
- Prepare background mapping with topographic elements and project alignments for Foundation Plans.

1.3-3 District/ Region Land Surveys

The work performed by Caltrans is distributed among twelve districts. Each district has one or more Land Surveys office or branch. Each local office performs or oversees the Land Surveys functions assigned within the district. In two areas, the districts have been combined into regions. The three northern districts (1, 2. and 3) have been organized into the North Region, and three districts in the center of the state (5, 6, and 10) have been organized as the Central Region. The organizational structure of the Land Surveys functions varies throughout the state and may reside under the reporting structure of various divisions. In some cases, the Land Surveys functions may be split between two different divisions.

Whether part of a region or district, Land Surveys performs the same basic functions. The three primary functions of Land Surveys are: Field Surveys, Office Surveys, and Right of Way Engineering. Variations in assignments may occur based upon a local district's organizational structure and business practices.

The Division of Human Resources (DHR) maintains the latest guidance on use of the civil service classifications, licensure requirements, supervisory ratios, and leadwork. Refer to DHR guidance when developing duty statements, staffing plans and organization charts.

The following are descriptions of the general tasks performed under each function.

1.3-3.a Field Surveys

The Field Surveys unit is responsible for work performed by the survey crews. A Senior-level field supervisor typically manages several survey crews, each supervised by a Party Chief. The Party Chief is responsible for supervising the survey crew, defined as a group of three or more persons (including the Party Chief) that determines the position of set or found surveying points and monuments, topographic features, or fixed works in the field by taking measurements and recording the related information.

The field surveyors will perform all control, engineering, and right of way field surveys required for project delivery. They will also stake all lines and grades needed for construction surveys. See Surveys Manual Chapters 9, 10, 11, and 12 for more details.

Daily survey party reports shall be maintained by the Party Chief. The electronic form can be found on the Caltrans Electronic Forms System (CEFS). The form number is SUR101 and the form name is Survey Party Report. https://forms.dot.ca.gov/

1.3-3.b Office Surveys

The Office Surveys unit provides direct support to the Field Surveys unit. The Senior-level surveyor supervisor manages a unit of professional and technical staff. When a request for field work is submitted to Land Surveys, Office Surveys performs all of the preliminary research and creates the field binder. The field package may include the electronic files that can be loaded into the field data collectors, as well as prints of any required mapping, or any other information that will allow the Field Survey crew to efficiently perform the requested work. Office Surveys maintains the records of district survey control monuments, records of survey, and previous work performed in the area.

When the survey crews finish an assignment and return their data, Office Surveys will process and package the field data into a final product for the requestor. In the case of a control survey, Office Surveys will review the control network adjustment, and add the data to the district files. If needed, they will prepare legally required record documents. For engineering surveys, Office Surveys will produce digital terrain models and contour maps of the project, in both digital and hard copy formats.

When performing right of way surveys, Office Surveys will adjust the survey network, and deliver the point coordinates along with monument descriptions and notes to the requesting unit.

During construction surveys, Office Surveys will verify all files and calculations delivered by the project engineer, create a file with all of the field notes needed by Field Surveys, and provide up to date control information. Office Surveys is responsible for maintaining the archives of all survey work performed in the district.

Each local office has a District Photogrammetry Coordinator (DPC). The DPC coordinates all photogrammetry related activities within the district. The DPC also maintains the local photogrammetry library. See Survey Manual Chapter 13 (Photogrammetry) for more details.

1.3-3.c Right of Way Engineering

The Right of Way Engineering (RWE) unit prepares maps and legal descriptions for acquisition and disposal of right of way and prepares, maintains and updates record maps for the Right of Way division and other Caltrans units. The Senior-level RWE supervisor manages a unit of professional and technical staff, in close coordination with the district Right of Way division.

The RWE work for specific projects begins with collection of information necessary for location of property lines. It continues through preparation and delivery of maps, descriptions, and documents to the district Right of Way appraisal, acquisition, condemnation, and/or vouchering sections. It ends with relinquishment and vacation of superseded highways and collateral facilities, disposal of excess lands, new or updated right of way record maps, and in cooperation with the Surveys Office, preparation of final monumentation maps.

1.4 PARTICIPATIVE MANAGEMENT

Participative management is defined as an attitude or philosophy of management which results in maximum team effort and effective lines of communication. This management style must carry with it recognition that employees have a great deal to contribute to the organization in terms of creative ideas, problem perceptions, suggestions for improvement, etc. Participative management neither abdicates management's responsibilities nor reduces its authority. Each level of headquarters and district management still bears responsibility for and has the appropriate authority to make those decisions necessary for goal attainment.

Caltrans uses the practice of participative management, through various management sponsored working groups, to bring together district and headquarters staff to resolve issues and improve functional management.

1.4-1 Surveys Management Board

The Surveys Management Board (SMB) is one of several Project Delivery management boards; e.g., Design, Right of Way, Construction, Environmental, etc. The SMB includes all executive and supervising-level managers over Caltrans District/Division Land Surveys functions, and is chaired by the Office of Land Surveys. The purpose of the SMB is to provide a forum of leadership and quality management for communicating and resolving survey issues that will continuously improve the functional management of the statewide surveying program to support Caltrans Mission, Vision and Goals. As necessary, the SMB will sponsor and charter quality teams or focus groups to evaluate and make recommendations and develop action plans to institutionalize policies and procedures, performance standards and goals, etc.

1.4-2 Functional Council

The Right of Way Engineering Functional Council (RWEFC) is sponsored and chartered by the SMB and is one of several standing functional councils that also support the Right of Way Management Board; e.g., Appraisals, Acquisition, Utilities, etc. RWEFC members include Senior-level supervisors over RWE in all Caltrans districts/divisions.

The purpose of the RWEFC is to provide a forum for identifying, communicating and recommending resolutions of RWE issues that improve the functional management of the statewide surveying program to support Caltrans' Mission, Vision, and Goals. It will respond to and consult upon matters referred to it by the SMB, other functional councils and customers.

1.4-3 Process Improvement Teams/User Groups

As necessary, the SMB will sponsor and charter process improvement teams to work with the Office of Land Surveys to evaluate and make recommendations on specific issues for Board action. Districts and other divisions may choose to form their own task forces consisting of district and/or headquarters personnel, as needed, to address local and cross-functional issues.

Functional user groups provide opportunities for informal networking and peer to peer collaboration to share common problems, solutions, best practices and lessons learned. The Office of Land Surveys subject matter experts and functional staff typically monitor user group exchanges and provide technical support and documentation.

1.4-4 Surveys Program Review

The Office of Land Surveys, in coordination with the District Land Surveys functions, conducts biennial Surveys Program Review meetings. The purpose of the Surveys Program Review Meetings is to perform quality management assurance activities as a division/district-region team effort to help assure that quality management practices are in place, functioning and effective. Activities performed are intended to: 1) cause continuous improvement in policies and procedures related to Caltrans Strategic Goals and Values, 2) foster state-wide standardization and exchange of best practices, methods and procedures, and 3) identify and discuss Surveys and Right of Way Engineering issues and concerns.

1.5 PROJECT MANAGEMENT

Formal project management begins when a Caltrans project manager is named and secures a project expenditure authorization. The project manager develops a Project Management Plan (PMP) that establishes a project delivery schedule for all tasks needed to deliver a project. Project Managers ensure that functional units are resourced to perform assigned tasks, and verifies that the project is on schedule.

The Land Surveys functional manager, a Supervising-level manager, is responsible for the providing the equipment, training, and supervision of the assigned task managers. They ensure that the Land Surveys services and deliverables meet the needs and time frames of customers and stakeholders, and that the services and deliverables comply with all applicable standards, quality, regulations, and policies

Land Surveys is a key member of the Project Development Team (PDT) which serves as the steering committee for the project throughout the project development process.

1.5-1 Project Workplans and Milestones

Caltrans uses the *Workplan Standards Guide* (refer to most current version) to guide the project management process for the delivery of capital projects. The *WSG* has two major components: the Work Breakdown Structure (WBS) and project milestones.

The WBS codes and milestones are combined with cost estimates, developed from work estimating norms, to become the project management plan. The plan has all of the elements needed to deliver a project, including cost, schedule, and quality standards. All work performed on a capital project will be done in conformance with the plan. Each plan is created and maintained by a project manager.

1.5-2 Task Management

Caltrans general policy on task management is contained in Deputy Directive 93 (R). In conjunction with the project manager, Land Surveys utilizes task management to effectively deliver capital projects. Task management is defined as the assignment of individuals (Task Managers) to manage the production and completion of a discrete deliverable, or work package, for a project within a defined schedule and budget.

Task Managers are responsible for the scheduling and delivery of a specific component or task described in the *Workplan Standards Guide*. Task Managers are typically staffed at the Senior-level. A task manager may delegate the authority to perform tasks to a subordinate, but cannot delegate the responsibility to deliver the assigned task.

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1.6 QUALITY MANAGEMENT

A quality project is defined as the fulfillment of project responsibilities in the delivery of timely and cost effective products and services in a manner that meets or exceeds specifications and the expectations of the customer. Foremost among these is the use of uniform quality expectations, assignment of accountability, and enhancement of communications to achieve the highest levels of quality practicable, improve delivery reliability, effective use of resources, and provide for continuous product improvement.

1.6-1 Quality Management Practices

Caltrans general policy on quality management is contained in Deputy Directive 23 (R).

Quality Management Practices are all the implementing agency's systematic activities used to direct, control, and coordinate the development of a quality project.

Quality Control (QC) – is the methods, means, or procedures used by a supplier to monitor and assess products or services to ensure that the final product will fulfill the established quality requirements.

Quality Assurance (QA) – is the performance of all the planned and systematic activities that provide confidence that the product requirements will be fulfilled.

Quality Management Assurance (QMA) – is the performance of all planned systematic activities by the owner/operator that verifies the implementing agency's QA plan effectiveness and precedes the owner/operator approval.

1.6-2 Quality Management Plan

The Quality Management Plan (QMP) is a document prepared by the implementing agency that describes by who, what, when, and how QC and QA activities will be performed for each project component as specified in the quality assurance program. The QMP consists of:

- A description of the final product to be delivered to the customer
- The standards to be used to deliver the product
- List of required Quality elements (checklists)
- The expected time (costs) required for each task
- The schedule for delivery
- The identity of the Task Manager (by name or position) who will be responsible for each task needed for the final deliverable
- The identity of the manager responsible for Quality Assurance

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1.7 RECORDS MANAGEMENT

Caltrans general policy on records is contained in Deputy Directive 55 (DD-55-R2) which is titled “Management of Information Assets and Records”. It states the policy as: “Caltrans Managers and staff are accountable for the cost effective management, maintenance, confidentiality, integrity, and the availability of the Department’s Information Assets and Records.”

Survey records are one of the most important products produced during the course of any surveying activity. A surveying activity is not complete until it is fully documented and the documentation is properly stored. The survey record constitutes a permanent record of surveying activities and should be in a form that can easily be interpreted by anyone having knowledge of surveying.

The producing, compiling, and storing of survey records is the final step for any surveying activity or product. This is arguably the most important step as it assures the integrity of the surveying work is documented and the surveying work can be reviewed, retraced, recovered, and/or recreated. Additionally, the survey records may become evidence in a legal proceeding.

Each district is responsible for providing a pubic counter where authorized Caltrans land surveying records can be retrieved for internal and external customers requesting access.

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1.8 RESEARCH AND INNOVATION

Rapid advancements in new technology and ever more efficient and effective surveying methods can challenge Caltrans to deliver better, faster, cheaper, safer and smarter transportation products and services. National engagement, through the Federal Highway Administration (FHWA), Transportation Research Board (TRB), American Association of State Highway Transportation Officials (AASHTO) and others, provides opportunities to share best practices, lessons learned and conduct focused research with academia and industry to investigate and deploy solutions to solve problems and improve processes.

The Division of Research, Innovation and Systems Information manages Caltrans annual research program. Program Steering Committees (PSC) and Technical Advisory Panels (TAP) are established in each of the major functional areas, including Land Surveys, and are responsible for developing the annual portfolio of problem statements, preliminary investigations, proposals and priorities for research projects to further the implementation and deployment of new technologies and innovative workflows.

