

Civil Drafting Technology

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Pearson

EIGHTH EDITION



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Cover Photo: Shutterstock
Full-Service Management and Composition: R. Sreemeevakshi/SPi Global
Printer/Binder: LSC Communications, Inc.
Cover Printer: Phoenix Color/Hagerstown
Text Font: ITC Usherwood Std

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Library of Congress Cataloging-in-Publication Data on File

10 9 8 7 6 5 4 3 2 1



ISBN 10: 0-13-443604-0
ISBN 13: 978-0-13-443604-3

Preface

Civil Drafting Technology is a basic thorough advanced civil drafting textbook appropriate for use by students enrolled in any secondary or postsecondary drafting or related course, and for anyone who is interested in learning about civil drafting theory and applications. Students will explore the design and drafting principles and practices used in the civil drafting field. Students are acquainted with civil drafting disciplines, mapping, computer-aided design and drafting (CADD), surveying, locations, distances, angles, directions, contour lines, site plans, horizontal alignments, profiles, earthwork, detail drawings, and geographic information system (GIS).

American Design Drafting Association (ADDA) Approved Publication

The content of this text is considered a fundamental component to the design drafting profession by the American Design Drafting association. This publication covers topics and related material, as stated in the ADDA curriculum certification standards and the ADDA certified drafter examination review guide. Although this publication is not conclusive with respect to ADDA standards, it should be considered a key reference tool in pursuit of a professional design-drafting career.

Approach and Purpose

Civil Drafting Technology offers a workbook approach that provides comprehensive civil drafting instruction. This textbook has been tested in the classroom and was created with input from civil engineering industry professionals and educators. The primary objectives of *Civil Drafting Technology* are to provide students with a foundation of the work done by civil engineering companies and a broad education in the civil drafting field, which includes associated drawings, skills, and terminology. Most civil engineering drawings and maps are generated by CADD software, and a variety of data often collected using electronic surveying techniques. Regardless of the CADD software used, a drafter must have knowledge of how maps and drawings are created.

Civil Drafting Technology is arranged in 14 chapters, each dealing with a specific subject area. Each chapter provides realistic

examples, illustrations, review questions, and problems. The examples illustrate recommended drafting and design presentation based on civil drafting standards, with actual industry drawings used for reinforcement. The correlated text explains drafting techniques and provides professional applications for skill development. Layout methods offer a logical approach to setting up and completing drafting problems. The content, review questions, and problems can fit a variety of course formats and lengths. When used in the prescribed manner, ***Civil Drafting Technology*** provides a broad understanding of civil drafting and a working knowledge of the basic components of mapping.

The knowledge and skills students gain from this textbook opens a variety of job opportunities, and these opportunities can offer an inspiring career. Careers found in civil drafting can be filled with variety and excitement, and can include disciplines such as CADD, surveying, construction, courthouse research, artistic interpretation, mapping, and cartography. Civil drafting and mapping requires accuracy, neatness, and an eye for creative and uncluttered layout. ***Civil Drafting Technology*** provides a practical approach to drafting as related to standards typically found in the civil engineering industry. This textbook also serves as a valuable desk reference for civil drafting professionals.

Features

Civil Drafting Technology delivers easy-to-read, comprehensive, and highly illustrated coverage of civil drafting practices that conform to industry standards. Each chapter provides complete descriptions, real-world practices, realistic examples, illustrations, and related assignments associated with chapter content. The examples illustrate typical civil drafting practices used throughout the civil engineering field. Chapters are organized in a format that is consistent with the process used to take civil engineering projects from preliminary concept through all phases of design and documentation.

This textbook includes many features to guide readers through the world of civil drafting. Chapter learning objectives, for example, provide motivating learning goals that act as an effective road map of each chapter and help students track their learning. Another example is the Note box feature used where appropriate to provide reference to other chapters, additional explanation, helpful tips, professional information, or alternate practice.

This textbook provides a broad and highly useful range of content that is not found in another single textbook. From generic design and drafting theory, to maps and map making, to surveying, to specific civil design and drafting applications; this textbook provides enough information about a wide variety of topics to benefit many different courses and programs, and by anyone interested in a quality overview of civil drafting technology and related disciplines. The following information describes several other special features found in this textbook.

Industry Approach to Problem Solving

This textbook explains how to prepare drawings by providing basic guides for layout and arrangement in a systematic knowledge-building format. One concept is learned before the next is introduced. The concepts and skills learned in one chapter are used in the next chapters, so that by the end of the text, students have the ability to solve problems using a multitude of skills learned previously through discussions, examples, and activities. Each chapter provides realistic examples, illustrations, review questions, and problems. The examples illustrate recommended drafting and design presentation based on civil drafting standards, with actual industry drawings used for reinforcement. The correlated text explains drafting techniques and provides professional applications for skill development. Step-by-step layout methods provide a logical approach to setting up and completing drafting problems.

Numerous High-Quality Illustrations

Real-world drawings, images, and other illustrative examples are used generously throughout this textbook to support text content. The figures in this textbook are clear, easy to understand, provide appropriate detail, and are consistent throughout. Many illustrations show actual civil drafting examples used to illustrate chapter content.

Computer-Aided Design and Drafting (CADD)

CADD applications throughout this textbook illustrate how the use of CADD is streamlining the civil engineering design and drafting process. The authors describe current CADD procedures and techniques including: CADD software used in drafting and design, U.S. National CAD Standards, CADD templates, CADD layers, CADD material requirements, specific CADD applications, file management, plotting guidelines, CADD symbols for specific civil engineering drafting applications, increased productivity with CADD, reuse of drawing content with CADD, the CADD environment in industry, and ergonomics. The focus of this textbook is not instruction in one specific brand of software or one specific software product. Autodesk's AutoCAD is often mentioned due to its popularity. Although specific software products are mentioned, it is not imperative that the student use those products to learn the materials presented in this textbook.

Chapter Review

A content-related review, or test, is provided at the end of each chapter for examination or review. Reviews include a variety of questions, such as short-answer, multiple-choice, true-and-false, sketching, and print reading exercises to help students understand chapter content. Chapter review questions provide excellent review of chapter content, and allow readers to further examine and reconsider chapter subject matter. Review questions also act as an effective assessment tool. Students can provide answers to chapter review questions

manually by removing the perforated pages for convenient use, or can access the **Student Resources** at <http://www.pearsonhighered.com/careersresources/> to download the questions.

Chapter Problems

Each chapter ends with real-world industry review and drafting and design problems for students to practice what they have learned. Problems vary from basic through complex, and are presented in order of difficulty. Problems include engineering sketches, engineering layouts, written instructions, and actual industry projects. The problems are presented in a manner that is consistent with the civil engineering environment. The goals and objectives of each assignment are consistent with recommended evaluation criteria based on the progression of learning activities. Some chapter problems include a PowerPoint feature that allows students to create and present PowerPoint slides directly related to the textbook content and examples.

Civil Drafting Technology Digital Resources (<http://www.pearsonhighered.com/careersresources/>)

The Civil Drafting Technology Digital Resources contain Microsoft Word .doc files for all Chapter Reviews, .pdf files for Chapter Review print reading questions, AutoCAD .dwg files for certain Problems, AutoCAD .dwt template files, and related weblinks. Go to www.pearsonhighered.com/careersresources/ and navigate to this textbook to access the Digital Resources.

Suggested Course of Study

By studying ***Civil Drafting Technology*** and enrolling in a course in which students can apply the concepts presented, students are providing themselves with an excellent civil drafting foundation. If students are interested in expanding their knowledge and skills in civil drafting and design, they should enroll in advanced civil courses, surveying courses, or courses that provide training in specialized civil design and drafting software and geographic information systems (GIS). A wide variety of civil engineering design, modeling, drafting, and GIS software is used today.

To access supplementary materials online, instructors need to request an instructor access code. Instructors can go to www.pearsonhighered.com/irc, where they can register for an instructor access code. Within 48 hours after registering, the instructor will receive a confirmation email that provides an instructor access code. After the instructor receives their code, they can go to the site and log on for full instructions on downloading the desired materials.

Special Note on the Eighth Edition

Civil Drafting Technology is a very unique textbook. There is no other product available today that effectively addresses all of the topics found in this textbook. A great deal of effort has gone into making

the ***Eighth Edition*** of this textbook better than ever before. This edition offers accurate, up-to-date content that is clearer, better organized, and easier to understand than in previous editions. This edition has updated content to reflect current practices, while retaining some traditional information as background. New material has been added to support CADD in civil engineering. All chapters have been updated with information about current practices.

Nearly all of the figures and other illustrations have been redrawn or recaptured so that all figures are now easier to read and understand, up-to-date, better represent and convey text content, and are consistent. Additional figures have been incorporated throughout to better illustrate content. New and updated chapter review sections offer more review questions and print-reading exercises to help reinforce chapter content. New and updated chapter problems offer more review, study, and drafting and design exercises to help reinforce chapter content and provide students the opportunity to practice what they have learned.

Students, instructors, and reviewers all provide valuable input to the content and revisions of a textbook such as this. The authors welcome your comments and suggestions. Please direct comments to one of the editors at Pearson listed in the front of the textbook.

Instructor Resources

The ***Instructor Resources*** for ***Civil Drafting Technology***, found at www.pearsonhighered.com/irc, include the following components to help minimize instructor preparation time and engage students, and to help educators develop civil drafting technology courses.

Syllabus

Lesson plans created by chapter are available with the Instructor's Manual. Instructors have the option of using these lesson plans with their own course information.

PowerPoint Presentation

Slides for each chapter of the text provide the basis for a lecture outline that helps instructors to present concepts and material. Key points and concepts can be graphically highlighted for student retention.

Solutions Manual

A Solutions Manual with answers to end-of-chapter review questions and solutions to end-of-chapter problems.

Final Exam

A sample final exam provided with the Instructor's Manual that can be used to test students at the end of the course of study.

Acknowledgments

Special thanks are extended to the professionals who provided comprehensive reviews of the text and assisted with new content. The quality of this textbook is improved by the support and contributions from designers, engineers, surveyors, and vendors. Acknowledgment is given at each illustration. The following individuals and companies or agencies, in alphabetical order, gave exceptional support with technical information and art for this edition.

Carlson Software

(www.carlsonsw.com)

Jim Reinbold, Regional Sales Director

Chief Architect Software

(www.chiefarchitect.com)

Derek Pedersen, Sales Manager

City of Portland, Oregon

Dan Perde, CAD Technician III, Environmental Services

Kevin Martin, Technical Services Manager, Bureau of Planning & Sustainability

ESRI

(www.esri.com)

Donny Sosa, Surveying Industry Specialist

Matt Davis, A/E/C Sales Exec

Just Trails LLC

(www.justtrails.com)

Al Walsh, Owner

KPFF Consulting Engineers

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Adam Roth, P.E., LEED AP, Associate

Otak, Inc.

(www.otak.com)

Jon Yamashita, P.L.S., Survey Manager

PACE Engineers, Inc.

(www.paceengrs.com)

James Shaver, P.E., Senior Principal Engineer

Sage Civil Engineering

(www.sagecivilengineering.com)

James Evans, P.E., Principle Engineer

Topcon Positioning Group

(www.topconpositioning.com)

Ralph Strabala, Senior Manager Creative Services

Scott Langbein, Director of Product Marketing

Town of Chapel Hill, North Carolina

(www.townofchapelhill.org)

Deborah Frederick-Squires, GISP, Planning and Sustainability

Special thanks to the following reviewers for their help with this new edition: Debra Boren, Grayson College; Zhiqin Jiang, Houston Community College; and Ron Pergl, Central Texas College.

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CHAPTER

1

Introduction to Civil Drafting Technology

Learning Objectives

After completing this chapter, you will be able to:

- Define civil engineering and civil drafting.
- Identify civil drafting employment opportunities.
- Describe the education and qualifications required to be a civil drafter.
- Identify professional civil engineering and civil drafting organizations.
- Define terms and elements related to maps and civil drafting.
- Identify a variety of map types.
- Describe the design and drafting process.
- Explain the purpose and provide examples of drafting standards.
- Discuss workplace ethics.

Key Terms

Civil engineering
Surveying
Civil drafting
Two-dimensional (2-D)
Three-dimensional (3-D)
Geomatics
Consulting engineering
Computer-aided design and drafting (CADD)
Geographic information systems (GIS)
Professional engineer (PE)
Manual drawing
Map
Charts
Elevation
Cartography
Cartographer
Border
Title block
Legend
Key
Scale
Physical map
Political map
Thematic map
Photogrammetric map
Photogrammetry
Aerial photographs
Topographic map
Contour line

(continued)

Key Terms (continued)

Quadrangle map	Planning map	Cutting-plane line
Geologic map	Zoning map	Typical cross section
Military map	Nautical chart	Detail drawing
Terrain	Aeronautical chart	Detail
Milliradian	Digital elevation model (DEM)	As-built survey
Mil	Digital surface model (DSM)	As-built drawing
Cadastral map	Remote sensing	As-built
Hydrographic map	Digital terrain model (DTM)	Standards
Engineering map	Surveyors	Code
Site plan	Plan view	Client
Plot plan	Plan	Specification
Plot	Vicinity map	Standards checking
Plat	Cross section view	Ethics
Subdivision	Cross section	Code of ethics
Infrastructure	Profile	Intellectual property

This textbook focuses on fundamental design and drafting theory and applications associated with common civil engineering projects. This chapter is an introduction to civil drafting technology and describes civil drafting employment opportunities, education, qualifications, and professional organizations. You will also learn about maps, the design and drafting process, drafting standards, and workplace ethics.

Civil Engineering

Civil engineering is the branch of engineering related to the planning, design, construction, and maintenance of structures. Civil engineers probably designed the construction site upon which your house or apartment, and school or office is built. The road on which you drive and the water supply system from which you drink also require civil engineering. Civil engineering is the second oldest form of engineering known, after military engineering. It is a broad discipline, and civil engineers are often involved in all phases of a construction project. Architecture, building construction and management, environmental health, material science, surveying, and transportation are a few of the many civil engineering subdisciplines. **Surveying** is the science of measuring distances, angles, and directions of characteristics of the Earth's surface.

Civil drafting is drafting performed for civil engineering. Civil drafters work with civil engineers and other industry professionals to prepare models and drawings for civil engineering projects. Examples of civil engineering projects are bridges, building sites, canals, dams, harbors, roadways, railroads, pipelines, public utility systems, and waterworks. Civil drafters create maps, plans, cross sections, profiles, and detail drawings. Projects are designed in two-dimensional (2-D) and/or three-dimensional (3-D) formats. **2-D** refers to a view displaying only width and height, width and length, or height and length. **3-D** refers to a view displaying width, height, and depth. Civil

drafters may also calculate excavation and fill volumes, and prepare graphs and diagrams used in earthmoving operations. Civil drafters can accompany survey crews in the field to collect data required to prepare or revise construction drawings.

Note: Surveying, mapping, civil engineering, and civil drafting are a few of the disciplines associated with the broad field of geomatics. **Geomatics** is the whole method of collecting, storing, managing, and presenting geographic or spatial data.

Employment Opportunities

Civil drafters are employed by consulting engineering companies; local, state, and federal government agencies; manufacturers of products and providers of services associated with civil engineering projects; and the military. **Consulting engineering** is an independent service that provides licensed and certified engineering for construction and related projects. Civil drafting job opportunities are available around the world; from rural communities to large cities.

Civil engineering is an extensive field. Therefore, civil drafters often create many different types of drawings for a variety of projects. Some civil engineering companies or agencies, especially consulting engineers, offer expertise in several areas. Other civil engineering firms specialize in certain aspects of civil engineering. The following is a list of some of the specialties in which civil engineering companies and agencies are involved:

- Agribusiness
- Construction observation
- Environmental studies
- Flood control
- Foundation work and soil analysis
- Hydrologic studies
- Irrigation and drainage
- Land and construction surveys
- Land planning and subdivision
- Map-making
- Municipal improvements
- Power plants
- Refuse disposal
- Sewage and water treatment
- Transportation

Drafting employment opportunities fluctuate with national and local economies. Employment for civil drafters is often linked with demands for construction and related industries. A national increase or decrease in construction affects the number of available drafting jobs. The economic effect on drafting job opportunities also occurs locally and within specific subdisciplines. For example, construction can be stronger in one part of the country than another, or one city or state may have more funding to apply toward municipal improvements

than another. The demand for civil drafters is accordingly higher in areas where the economy is stronger, and lower in areas where the economy is weaker. A growing number of drafters are finding employment on a temporary or contract basis as more companies and agencies turn to employment services to meet their changing needs.

Salaries for civil drafters are usually competitive with those in other professions with equal educational requirements. Working conditions vary but are usually excellent. Employment benefits differ according to each employer. However, most employers offer vacation and health insurance coverage, and some include dental, life, and disability insurance. Check your local and state employment offices and online employment resources for information about specific employment opportunities, salary ranges, and benefits.

Education and Qualifications

High schools, technical institutes, community colleges, and some four-year colleges and universities throughout North America offer drafting courses or programs. A school often focuses curriculum on the needs of industry in the immediate area. Many schools with a drafting program provide a general education with courses in a variety of drafting disciplines so that graduates have versatile employment opportunities. Some schools offer a specific civil drafting education, especially if necessary to fill the employment needs of local civil engineering companies and agencies. Identify the school and program that will best serve your specific goals. Research the curriculum and placement potential for graduates. Talk to representatives of local industries to help evaluate a school's drafting curriculum.

Students who desire to work as civil drafters should complete a one-year certificate or a two-year associate of science degree with studies in computer-aided design and drafting (CADD), civil drafting theory, and geographic information systems (GISs). **CADD** is the process of using a computer with CADD software to design and produce drawings and models according to specific industry and company standards. A **GIS** is a computerized database system used to manage, analyze, and display spatial data. Employers in the drafting industry typically prefer applicants who have at least two years of postsecondary training in a drafting program that provides strong technical skills and considerable CADD training. If you are interested in civil drafting as a career, your schooling should include math at least through basic trigonometry; application of CADD software programs; sketching techniques and skills; and the civil drafting theory, standards, and practices explained throughout this textbook.

After completing a two-year associate degree program, graduates can obtain jobs as drafters or continue education in a related field at a four-year college. A student wanting to become a civil engineer must complete four or five years of college and graduate with a bachelor of engineering or bachelor of science degree. Students can specialize in one of the wide variety of engineering subdisciplines in the final years of study. A **professional engineer (PE)** is an engineer who has a four-year degree in engineering from an accredited engineering program,

has passed the Fundamentals of Engineering (FE) exam, has completed four years of progressive engineering experience under a PE, and has passed the Principles and Practice of Engineering (PE) exam.

Note: **Manual drawing** is drafting done using traditional tools to create drawings by hand with pencil or ink on paper or other media. The need for precise hand line work, inking skills, and lettering has almost disappeared from the workplace, though occasionally the need to modify old, archived drawings does arise. However, technical sketching and CADD are the focus rather than the use of manual drafting equipment.

Professional Organizations

There are many professional organizations that offer a great deal of information and resources for engineers and drafters. Joining a professional design and drafting or related organization is a good way to further your career and expand your knowledge. Associations promote many different events and activities that can help you reach your professional goals by connecting with peers, volunteering, and sharing ideas. Most associations provide access to books, journals, magazines, articles, and other materials that are useful for learning about new concepts and practices. Some associations offer career resources such as job listings, and techniques for searching for and obtaining a job. The following information briefly explains a few of the professional associations related to civil drafting technology.

American Design Drafting Association/American Digital Design Association (ADDA)

The American Design Drafting Association/American Digital Design Association (ADDA) is a professional organization dedicated to the advancement of design and drafting and the graphics professions. The ADDA offers leadership opportunities, local professional councils, and student chapters. The ADDA also approves products based on quality, durability, usability, and value; and publications based on content relative to the design and drafting industry.

The ADDA holds the Annual Technical and Educational Conference and sponsors the Annual Design Drafting Week, Annual Poster Contest, and Annual Design Drafting Contest. Examples of other ADDA benefits are publication and product discounts, networking, members only forum, and access to publications and documents such as the *Drafting Examination Review Guides*. The following information highlights a few prominent ADDA programs for you to consider. For more information about the ADDA, go to www.adda.org.

Professional Certification Programs The ADDA professional certification exams are international certification programs that allow apprentice drafters, drafters, designers, design drafters, design technicians, engineering and architectural technicians, digital imaging

technicians, and other graphic professionals to indicate their knowledge in professional concepts and internationally recognized standards and practices. The ADDA developed these exams to elevate an individual's comprehension of the professional standards related to the design drafting and graphics professions.

Certification allows drafters to demonstrate professional capabilities and helps employers to identify quality employees. The tests do not cover specific CADD software or graphic production. The ADDA Drafter Certification Examination is open to all individuals, regardless of experience and formal education. An ADDA membership is not required to take the test or to become certified. Becoming a Certified Drafter reflects your proven knowledge of drafting. Certification enhances your credibility as a professional, improves your opportunities for promotion and pay increases, and gives you a competitive edge in a highly technical job market.

When employers hire an ADDA Certified Drafter, they know that the new employee meets certification criteria and has demonstrated initiative and pride in the profession by becoming certified. Therefore, certification can serve as one criterion for differentiating among candidates in the selection process. Certification also serves educators as a supplementary measurement of a student's performance on a recognized national level.

Employment Center The ADDA Employment Center is available to help connect ADDA members with employment opportunities. Post your résumé online if you are seeking work. Access the newest jobs available by employers to professionals seeking employment.

Instructor and Curriculum Certification Programs The ADDA Instructor Certification Program is designed to provide professional recognition to instructors, teachers, and educational professionals. Instructors must be engaged in a design drafting and graphics training program within an approved educational setting on an annual schedule with an end result of a trade or craft certificate or diploma. The ADDA Certified Curriculum Program approves curriculum that meets or exceeds industry standards.

American Council of Engineering Companies (ACEC)

The American Council of Engineering Companies (ACEC) is a national organization devoted to the business and support of engineering companies. The ACEC mission is to contribute to America's prosperity and welfare by advancing the business interests of member firms. Members range from PEs and professional land surveyors (PLSs) to consulting engineering companies and large corporations.

The ACEC advocates for, and takes political action to support, the business interests of engineering companies. The ACEC offers educational webinars, seminars, workshops, and meetings. ACEC publications include the *Engineering Inc.* magazine, *Last Word* newsletter, and *ACEC Engineering Business Index* survey. The ACEC holds two conferences per year and presents a variety of awards and scholarships. For more information about the ACEC, go to www.acec.org.

American Society for Engineering Education (ASEE)

The American Society for Engineering Education (ASEE) is a non-profit association dedicated to promoting and improving engineering and technology education. The ASEE mission focuses on developing policies and programs that enhance professional opportunities for engineering faculty members and promote activities that support increased student enrollments in engineering and engineering technology colleges and universities. Members include engineering firms, government agencies, and educational institutions.

ASEE publications include the *Prism* and *eGFI* magazines, *Journal of Engineering Education* and *Advances in Engineering Education* journals, and *Profiles of Engineering and Technology Colleges* directory. The ACEC offers educational workshops, meetings, and conferences, including the ASEE Annual Conference and Exposition. The ASEE offers fellowship programs and presents a variety of awards. For more information about the ASEE, go to www.asee.org.

American Society of Civil Engineers (ASCE)

The American Society of Civil Engineers (ASCE) is a professional organization that provides value to members, member careers, partners, and the public by developing leadership, advancing technology, advocating lifelong learning, and promoting the civil engineering profession. The ASCE publishes numerous civil engineering products including books, manuals, journals, and standards. Examples of ASCE journals are *Journal of Bridge Engineering*, *Journal of Environmental Engineering*, *Journal of Transportation Engineering*, and *Journal of Water Resources Planning and Management*. *Civil Engineering* is the monthly ASCE magazine.

The ASCE offers educational webinars, seminars, workshops, and meetings. Education and continuing education courses and programs are available to help PEs meet competency requirements. The ASCE holds several conferences per year, including an annual conference. The ASCE also offers professional certification and presents a variety of awards. For more information about the ASCE, go to www.asce.org.

Map Fundamentals

A **map** is a graphic representation of part or all of the Earth's surface, drawn to scale on a plane surface. Some maps, such as aeronautical and nautical maps, are more commonly referred to as **charts**. Maps use lines, symbols, colors, and labels to display natural features such as mountains and rivers, and areas with constructed features such as buildings and roads. Maps have many different purposes, depending on their intended use. A map can accurately provide distances, locations, elevations, best routes, land features, and much more. **Elevation** is the height of a geographic location above or below a theoretically exact reference point, axis, or plane.

Cartography

Cartography is the art of making maps and charts. A **cartographer** is a highly skilled professional who designs and draws maps. Cartographers use a variety of graphic media, computer software, and artistic illustration to create maps. Civil drafting and cartography are similar in that both professions deal with making maps. However, civil drafting is generally concerned with drawings for civil engineering projects. Cartographers often use more graphic skills in the preparation of documents and maps. A cartographer typically has completed four years of education with emphasis on cartography, civil engineering, digital imaging, geodesy, geography, navigation, and optics.

Map Elements

A map typically includes several basic elements such as a border, title, legend, information about scale and direction, and additional written labels and notes (see Figure 1-1). A **border** consists of lines that create the format margins of the sheet. Maps may or may not display a border, while civil engineering drawings usually include a border. The map title names the map. A title block often contains the title of a civil engineering drawing. A **title block** is a sheet block that

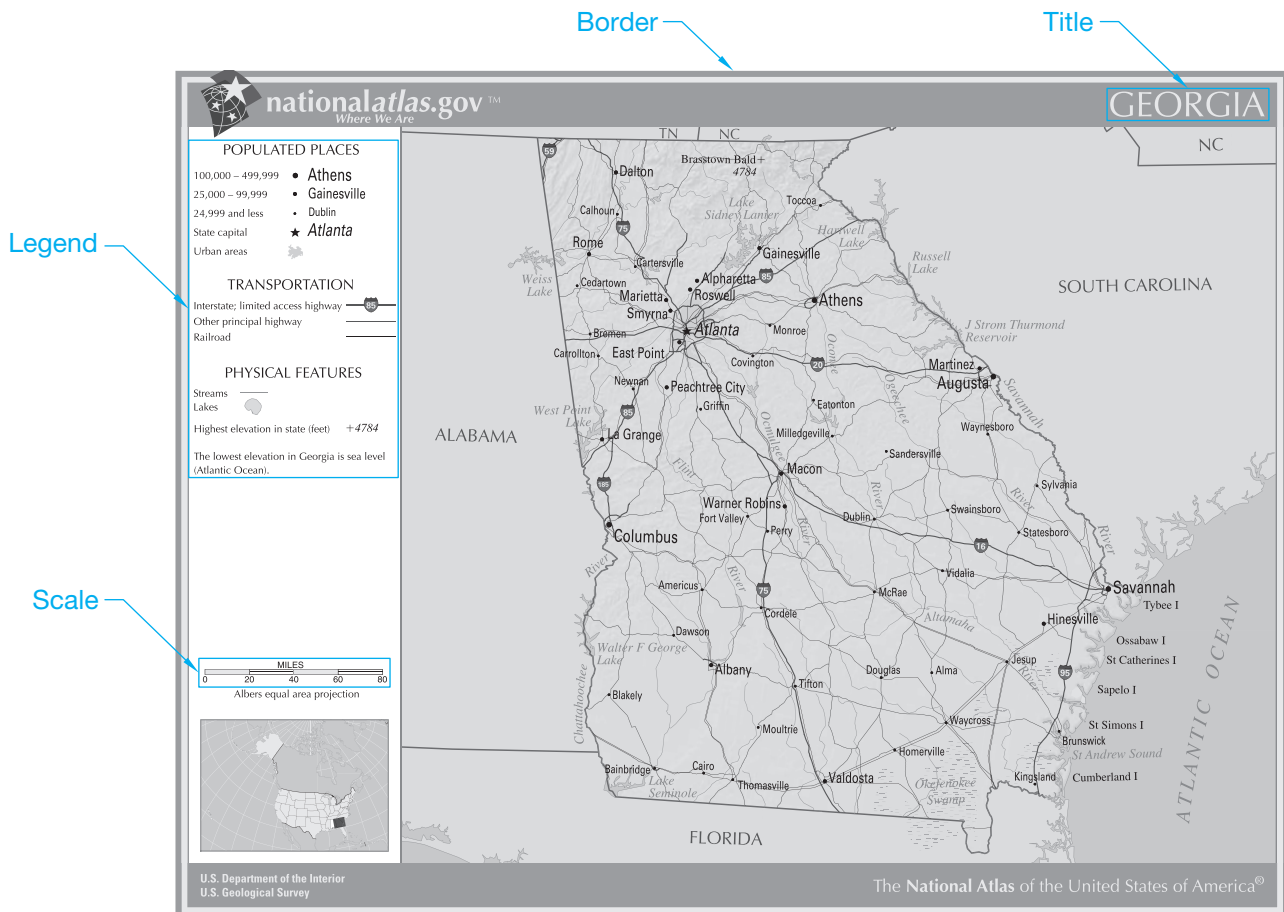


Figure 1-1. A general reference map of the State of Georgia. This map includes common map elements such as a border, title, legend, and scale.
(Courtesy of the U.S. Geological Survey)

provides a variety of information about a drawing, such as the title, sheet size, and predominant scale. Figure 1–2 shows an example of a title block. The title and information in a title block tell you immediately if you have the correct map or drawing.

Figure 1–2. A title block found on drawing for a residential construction project.

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<p>MANAGEMENT</p>
PROJECT NUMBER: RLC-01601
FILE NAME: G-01.dwg
DRAWN BY: DPM
CHECKED BY: MMM
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<p>TITLE COVER, SITE PLAN</p>
<p>SHEET G-01</p>
SHEET 1 OF 15