
Surveyors, Cartographers, Photogrammetrists, and Surveying and Mapping Technicians

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Significant Points

- About 7 out of 10 jobs were in architectural, engineering, and related services.
- Opportunities will be best for surveyors, cartographers, and photogrammetrists who have a bachelor's degree and strong technical skills.
- Overall employment of surveyors, cartographers, photogrammetrists, and surveying technicians is expected to grow much faster than the average for all occupations through the year 2016.

Nature of the Work

Surveyors, cartographers, and photogrammetrists are responsible for measuring and mapping the Earth's surface. *Surveyors* establish official land, airspace, and water boundaries. They write descriptions of land for deeds, leases, and other legal documents; define airspace for airports; and take measurements of construction and mineral sites. Other surveyors provide data about the shape, contour, location, elevation, or dimension of land or land features. *Cartographers and photogrammetrists* collect, analyze, interpret, and map geographic information from surveys and from data and photographs collected using airplanes and satellites. *Surveying and mapping technicians* assist these professionals by collecting data in the field, making calculations, and helping with computer-aided drafting. Collectively, these occupations play key roles in the field of geospatial information.

Surveyors measure distances, directions, and angles between points and elevations of points, lines, and contours on, above, and below the Earth's surface. In the field, they select known survey reference points and determine the precise location of important features in the survey area using specialized equipment. Surveyors also research legal records, look for evidence of previous boundaries, and analyze data to determine the location of boundary lines. They are sometimes called to provide expert testimony in court about their work. Surveyors also record their results, verify the accuracy of data, and prepare plots, maps, and reports.

Some surveyors perform specialized functions closer to those of cartographers and photogrammetrists than to those of traditional surveyors. For example, *geodetic surveyors* use high-accuracy techniques, including satellite observations, to measure large areas of the earth's surface. *Geophysical prospecting surveyors* mark sites for subsurface exploration, usually to look for petroleum. *Marine or hydrographic surveyors* survey harbors, rivers, and other bodies of water to determine shorelines, the topography of the bottom, water depth, and other features.

Surveyors use the Global Positioning System (GPS) to locate reference points with a high degree of precision. To use this system, a surveyor places a satellite signal receiver—a small instrument mounted on a tripod—on a desired point, and another

receiver on a point for which the geographic position is known. The receiver simultaneously collects information from several satellites to establish a precise position. The receiver also can be placed in a vehicle for tracing out road systems. Because receivers now come in different sizes and shapes, and because the cost of receivers has fallen, much more surveying work can be done with GPS. Surveyors then interpret and check the results produced by the new technology.

Field measurements are often taken by a survey party that gathers the information needed by the surveyor. A typical survey party consists of a party chief and one or more surveying technicians and helpers. The party chief, who may be either a surveyor or a senior surveying technician, leads day-to-day work activities. Surveying technicians assist the party chief by adjusting and operating surveying instruments, such as the total station, which measures and records angles and distances simultaneously. Surveying technicians or assistants position and hold the vertical rods, or targets, that the operator sights on to measure angles, distances, or elevations. They may hold measuring tapes if electronic distance-measuring equipment is not used. Surveying technicians compile notes, make sketches, and enter the data obtained from surveying instruments into computers either in the field or at the office. Survey parties also may include laborers or helpers who perform less-skilled duties, such as clearing brush from sight lines, driving stakes, or carrying equipment.

Photogrammetrists and cartographers measure, map, and chart the Earth's surface. Their work involves everything from performing geographical research and compiling data to producing maps. They collect, analyze, and interpret both spatial data—such as latitude, longitude, elevation, and distance—and nonspatial data—for example, population density, land-use patterns, annual precipitation levels, and demographic characteristics. Their maps may give both physical and social characteristics of the land. They prepare maps in either digital or graphic form, using information provided by geodetic surveys and remote sensing systems including aerial cameras, satellites, and LIDAR.

LIDAR—light-imaging detection and ranging—uses lasers attached to planes and other equipment to digitally map the topography of the Earth. It is often more accurate than traditional surveying methods and also can be used to collect other forms of data, such as the location and density of forests. Data developed by LIDAR can be used by surveyors, cartographers, and photogrammetrists to provide spatial information to specialists in geology, seismology, forestry, and construction, and other fields.

Geographic Information Systems (GIS) have become an integral tool for surveyors, cartographers and photogrammetrists, and surveying and mapping technicians. Workers use GIS to assemble, integrate, analyze, and display data about location in a digital format. They also use GIS to compile information from a variety of sources. GIS typically are used to make maps which combine information useful for environmental studies, geology, engineering, planning, business marketing, and other disciplines. As more of these systems are developed, many mapping specialists are being called *geographic information specialists*.

Work environment. Surveyors and surveying technicians usually work an 8-hour day, 5 days a week and may spend a lot of time outdoors. Sometimes, they work longer hours during the summer, when weather and light conditions are most suit-



Surveyors use sophisticated equipment to take measurements.

able for fieldwork. Construction-related work may be limited during times of inclement weather.

Surveyors and technicians engage in active, sometimes strenuous, work. They often stand for long periods, walk considerable distances, and climb hills with heavy packs of instruments and other equipment. They also can be exposed to all types of weather. Traveling is sometimes part of the job, and land surveyors and technicians may commute long distances, stay away from home overnight, or temporarily relocate near a survey site. Surveyors also work indoors while planning surveys, searching court records for deed information, analyzing data, and preparing reports and maps.

Cartographers and photogrammetrists spend most of their time in offices using computers. However, certain jobs may require extensive field work to verify results and acquire data.

Training, Other Qualifications, and Advancement

Most surveyors, cartographers, and photogrammetrists have a bachelor's degree in surveying or a related field. Every State requires that surveyors be licensed.

Education and training. In the past, many people with little formal training started as members of survey crews and worked their way up to become licensed surveyors, but this has become increasingly difficult to do. Now, most surveyors need a bachelor's degree. A number of universities offer bachelor's degree programs in surveying, and many community colleges, techni-

cal institutes, and vocational schools offer 1-, 2-, and 3-year programs in surveying or surveying technology.

Cartographers and photogrammetrists usually have a bachelor's degree in cartography, geography, surveying, engineering, forestry, computer science, or a physical science, although a few enter these positions after working as technicians. With the development of GIS, cartographers and photogrammetrists need more education and stronger technical skills—including more experience with computers—than in the past.

Most cartographic and photogrammetric technicians also have specialized postsecondary education. High school students interested in surveying and cartography should take courses in algebra, geometry, trigonometry, drafting, mechanical drawing, and computer science.

Licensure. All 50 States and all U.S. territories license surveyors. For licensure, most State licensing boards require that individuals pass a written examination given by the National Council of Examiners for Engineering and Surveying (NCEES). Most States also require surveyors to pass a written examination prepared by the State licensing board.

Licensing happens in stages. After passing a first exam, the Fundamentals of Surveying, most candidates work under the supervision of an experienced surveyor for 4 years and then for licensure take a second exam, the Principles and Practice of Surveyors.

Specific requirements for training and education vary among the States. An increasing number of States require a bachelor's degree in surveying or in a closely related field, such as civil engineering or forestry, regardless of the number of years of experience. Some States require the degree to be from a school accredited by the Accreditation Board for Engineering and Technology. Many States also have a continuing education requirement.

Additionally a number of States require cartographers and photogrammetrists to be licensed as surveyors, and some States have specific licenses for photogrammetrists.

Other qualifications. Surveyors, cartographers, and photogrammetrists should be able to visualize objects, distances, sizes, and abstract forms. They must work with precision and accuracy because mistakes can be costly.

Members of a survey party must be in good physical condition because they work outdoors and often carry equipment over difficult terrain. They need good eyesight, coordination, and hearing to communicate verbally and using hand signals. Surveying is a cooperative operation, so good interpersonal skills and the ability to work as part of a team is important. Good office skills also are essential because surveyors must be able to research old deeds and other legal papers and prepare reports that document their work.

Certification and advancement. High school graduates with no formal training in surveying usually start as apprentices. Beginners with postsecondary school training in surveying usually can start as technicians or assistants. With on-the-job experience and formal training in surveying—either in an institutional program or from a correspondence school—workers may advance to senior survey technician, then to party chief. Depending on State licensing requirements, in some cases they may advance to licensed surveyor.

The National Society of Professional Surveyors, a member organization of the American Congress on Surveying and

Mapping, has a voluntary certification program for surveying technicians. Technicians are certified at four levels requiring progressive amounts of experience and the passing of written examinations. Although not required for State licensure, many employers require certification for promotion to positions with greater responsibilities.

The American Society for Photogrammetry and Remote Sensing has voluntary certification programs for technicians and professionals in photogrammetry, remote sensing, and GIS. To qualify for these professional distinctions, individuals must meet work experience and training standards and pass a written examination. The professional recognition these certifications can help workers gain promotions.

Employment

Surveyors, cartographers, photogrammetrists, and surveying technicians held about 148,000 jobs in 2006. Employment was distributed by occupational specialty as follows:

Surveying and mapping technicians	76,000
Surveyors	60,000
Cartographers and photogrammetrists	12,000

The architectural, engineering, and related services industry—including firms that provided surveying and mapping services to other industries on a contract basis—provided 7 out of 10 jobs for these workers. Federal, State, and local governmental agencies provided about 14 percent of these jobs. Major Federal Government employers are the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), the National Geodetic Survey, the National Geospatial Intelligence Agency, and the Army Corps of Engineers. Most surveyors in State and local government work for highway departments or urban planning and redevelopment agencies. Construction, mining and utility companies also employ surveyors, cartographers, photogrammetrists, and surveying technicians.

Job Outlook

Surveyors, cartographers, photogrammetrists, and surveying and mapping technicians should have favorable job prospects. These occupations should experience much faster than average employment growth.

Employment change. Overall employment of surveyors, cartographers, photogrammetrists, and surveying and mapping technicians is expected to increase by 21 percent from 2006 to 2016, which is much faster than the average for all occupations. Increasing demand for fast, accurate, and complete geographic

information will be the main source of growth for these occupations.

An increasing number of firms are interested in geographic information and its applications. For example, GIS can be used to create maps and information used in emergency planning, security, marketing, urban planning, natural resource exploration, construction, and other applications. Also, the increased popularity of online mapping systems has created a higher demand for and awareness of geographic information among consumers.

Job prospects. In addition to openings from growth, job openings will continue to arise from the need to replace workers who transfer to other occupations or who leave the labor force altogether. Many of the workers in these occupations are approaching retirement age.

Opportunities for surveyors, cartographers, and photogrammetrists should remain concentrated in engineering, surveying, mapping, building inspection, and drafting services firms. However, employment may fluctuate from year to year with construction activity or with mapping needs for land and resource management.

Opportunities should be stronger for professional surveyors than for surveying and mapping technicians. Advancements in technology, such as total stations and GPS, have made surveying parties smaller than they once were. Additionally, cartographers, photogrammetrists, and technicians who produce more basic GIS data may face competition for jobs from offshore firms and contractors.

As technologies become more complex, opportunities will be best for surveyors, cartographers, and photogrammetrists who have a bachelor's degree and strong technical skills. Increasing demand for geographic data, as opposed to traditional surveying services, will mean better opportunities for cartographers and photogrammetrists who are involved in the development and use of geographic and land information systems.

Earnings

Median annual earnings of cartographers and photogrammetrists were \$48,240 in May 2006. The middle 50 percent earned between \$37,480 and \$65,240. The lowest 10 percent earned less than \$30,910 and the highest 10 percent earned more than \$80,520.

Median annual earnings of surveyors were \$48,290 in May 2006. The middle 50 percent earned between \$35,720 and \$63,990. The lowest 10 percent earned less than \$26,690 and the highest 10 percent earned more than \$79,910. Median annual earnings of surveyors employed in architectural, engineering, and related services were \$47,570 in May 2006.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-2016	
				Number	Percent
Surveyors, cartographers, photogrammetrists, and surveying technicians.....	—	148,000	179,000	31,000	21
Cartographers and photogrammetrists	17-1021	12,000	15,000	2,500	20
Surveyors	17-1022	60,000	74,000	14,000	24
Surveying and mapping technicians	17-3031	76,000	90,000	15,000	19

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

Median annual earnings of surveying and mapping technicians were \$32,340 in May 2006. The middle 50 percent earned between \$25,070 and \$42,230. The lowest 10 percent earned less than \$20,020, and the highest 10 percent earned more than \$53,310. Median annual earnings of surveying and mapping technicians employed in architectural, engineering, and related services were \$30,670 in May 2006, while those employed by local governments had median annual earnings of \$37,550.

Related Occupations

Surveying is related to the work of civil engineers, architects, and landscape architects because an accurate survey is the first step in land development and construction projects. Cartographic and geodetic surveying are related to the work of environmental scientists and geoscientists, who study the earth's internal composition, surface, and atmosphere. Cartography also is related to the work of geographers and urban and regional planners, who study and decide how the earth's surface is being and may be used.

Sources of Additional Information

For career information on surveyors, cartographers, photogrammetrists, and surveying technicians, contact:

► American Congress on Surveying and Mapping, Suite 403, 6 Montgomery Village Ave., Gaithersburg, MD 20879.

Internet: <http://www.acsm.net>

Information about career opportunities, licensure requirements, and the surveying technician certification program is available from:

► National Society of Professional Surveyors, Suite 403, 6 Montgomery Village Ave., Gaithersburg, MD 20879.

For information on a career as a geodetic surveyor, contact:

► American Association of Geodetic Surveying (AAGS), Suite 403, 6 Montgomery Village Ave., Gaithersburg, MD 20879.

For career information on photogrammetrists, photogrammetric technicians, remote sensing scientists and image-based cartographers or geographic information system specialists, contact:

► ASPRS: Imaging and Geospatial Information Society, 5410 Grosvenor Lane., Suite 210, Bethesda, MD 20814-2160.

Internet: <http://www.asprs.org>

General information on careers in photogrammetry, mapping, and surveying is available from:

► MAPPS: Management Association for Private Photogrammetric Surveyors, 1760 Reston Parkway, Suite 515, Reston, VA 20190. Internet: <http://www.mapps.org>

Information on about careers in remote sensing, photogrammetry, surveying, GIS, and other geography-related disciplines also is available from the Spring 2005 Occupational Outlook Quarterly article, "Geography Jobs", available online at:

<http://www.bls.gov/opub/ooq/2005/spring/art01.pdf>