

**University & Community College System of Nevada
New Program Proposal Summary**

Date: November 6, 2000

Campus: University of Nevada, Las Vegas

Proposed Program: Geomatics, M.S. degree

Brief Description of Program:

A two-year Master of Science degree in Geomatics is proposed simultaneously with a 4-year baccalaureate degree in Surveying Engineering. The B.S. degree in Surveying Engineering is covered in a separate parallel proposal. The M.S. degree in Geomatics is requested to provide a means for attracting graduate students to support faculty research and the proposed B.S. program. The master's degree will help to meet state, regional and national needs for licensed surveying engineers, professionals who combine land measurements with geographic information, systems, global positioning and information technologies to analyze and map both constructed facilities and natural resources. The M.S. degree in Geomatics is intended to attract persons with bachelor's degrees in engineering, natural science and surveying who are interested in acquiring advanced level surveying skills and applying them to research problems in the areas of land measurement and resource mapping. The B.S. degree is proposed to fulfill the requirements of Nevada's land surveying practice act, Nevada Revised Statute 625 (NRS 625), passed by the 1999 legislature, which requires a baccalaureate degree for licensing as a surveyor by the year 2010, provided that a suitable academic program is established and operating within the state of Nevada before the year 2006. Persons with baccalaureate education in surveying may seek the M.S. degree to enhance their skills in a particular specialty area, to prepare themselves for management positions, or to perform either research leading to a terminal M.S., or to prepare for doctoral level studies. It is proposed that persons without B.S. degrees in surveying who earn the M.S. degree in Geomatics receive sufficient additional training to be adequately prepared for licensure as land surveyors, and, if the State Board approves, to qualify for licensing by having a "related" degree.

Demonstrated Need for Program (academic, state, regional, national):

National need

It is now generally recognized that global positioning, geographic information systems and computer technologies have increased the complexity and required level of professional services of the surveying profession. Surveyors' accurate assessments of land boundaries and resources have significant legal, economic and political consequences. Land developers, natural resource managers and civil engineers need vast amounts of geographic information for land subdivision, natural resource assessment, and facilities design and construction, respectively, and are relying on surveyors to provide the necessary expertise. There is demand among persons with baccalaureate training in the above disciplines for formal training as land surveyors and resource mappers. Biological and geological resources, and, in urban areas, real estate assets, roads, power and communications lines, water and sewer lines, roadways and other aspects of physical infrastructure, are now extensively mapped by electronic means, and persons trained to map and use geographic information systems to analyze these resources are in high demand. In some cases, these persons may seek licensure as land surveyors. In other cases, they may seek training to use surveying and mapping tools in their own disciplines.

State need

Recognizing the need for improved training in surveying, the Nevada Association of Land Surveyors

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(NALS) and the Nevada State Board of Professional Engineers and Land Surveyors (NSBPELS) have, in recent years lobbied the Nevada Legislature for revisions to the Nevada Land Surveying Practice Act, Nevada Revised Statute 625 (NRS 625), that would require a baccalaureate degree for licensing as a Professional Land Surveyor (P.L.S.). In 1999, the Nevada Legislature passed revisions to NRS 625 that require a 4-year degree for licensing as a land surveyor in the year 2010 and after, provided that a suitable academic program is established and operating in the state by the year 2006. The University of Nevada, Las Vegas is developed a 4-year program in land surveying engineering to meet a portion of this demand. In addition to the 4-year degree, it is recognized that persons with baccalaureate degrees in other areas may seek to become licensed as land surveyors. Although a second baccalaureate may be a viable option for some individuals, in other cases, sufficient training may be acquired through study in a M.S. program. Additionally, tenure-track faculty in an institution with a growing research emphasis, such as UNLV, will need support from graduate students in order to carry out research projects. Current M.S. degree programs at UNLV do not provide the right background for advanced level training in surveying and geomatics. An M.S. program in Geomatics is therefore proposed for three reasons:

1. To meet demand for training in surveying leading to licensure from persons with baccalaureate degrees in science and engineering.
2. To provide advanced training in surveying and geomatics for persons with baccalaureate degrees in surveying.
3. To provide a venue for attracting students into surveying and geomatics research and thereby support the research interests of tenure-track surveying faculty.

Regional need

At present, there are no four-year surveying programs in the states of Arizona or Utah. Four-year surveying degrees are offered in California at CSU Fresno and in Oregon, at Oregon Institute of Technology. A four-year program is under development at the University of Idaho. Advanced-level training in surveying leading to a M.S. degree is available at California State University Fresno (CSUF) and at New Mexico State University (NMSU). If licensing boards in Arizona and Utah move towards requiring four-year surveying degrees, a surveying engineering B.S. or Geomatics M.S. degree from Nevada could supply some of the demand, and therefore serve both southwestern and intermountain region needs for training of surveying engineers. A graduate program in Geomatics and UNLV could also attract persons from Arizona, Utah and Idaho who seek graduate-level training in this area.

The U.S. Environmental Protection Agency maintains its national laboratory in remote sensing and geographic information systems on the UNLV campus, and it is anticipated that there will be interest on the part of EPA staff in the graduate program in Geomatics. Substantial opportunities for collaboration between EPA and UNLV could develop from this graduate program, including increased student enrollments, participation as part-time instructors, service on graduate research committees, and development of funded research projects. Collaboration with EPA could greatly enhance the regional and national reach and visibility of the proposed M.S. Bechtel Corporation, under contract with the U.S. government, manages a federal remote sensing laboratory at Nellis Air Force Base that may also be a source of potential students and research projects.

Relationship of Program to System, Division, College and Department:

System relationship

There is a statewide need for four-year and advanced-level training for land surveyors. A two-year, terminal Associate of Arts in Applied Science (A.A.S.) degree in surveying is now available through

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the Building Technology program at the Community College of Southern Nevada (CCSN). There are no other surveying programs offered in the UCCSN. A proposed curriculum for a two-year transfer degree (distinct from the terminal A.A.S. degree) is included as part of the B.S. Surveying Engineering proposal. It is envisioned that distance education would be an integral part of a UNLV four-year degree program, with some upper-division surveying courses available at other UCCSN campuses via Web and video means of distribution. Some of the upper-division surveying courses would also be offered as beginning graduate level courses in a M.S. Geomatics program. In the attached proposed two-year graduate curriculum, courses proposed to be available via distance means are identified with an asterisk (*). Students could therefore complete a portion of their graduate education via distance means, and reduce the time needed in residence at UNLV to two or three semesters.

Division and College relationships

The University of Nevada, Las Vegas (UNLV) was approached by NALS and NSBPELS with a request to develop four-year and graduate degrees in Surveying Engineering and Geomatics. UNLV's proximity to Nevada's largest and fastest growing metropolitan area is a major factor in the request to locate surveying/geomatics programs at this institution. Rapid population growth has created significant local demand for surveyors as land is developed for residential, commercial and industrial purposes. Pressure on natural and archaeological resources in southern Nevada has also generated needs for accurate mapping so that these resources may be preserved as development takes place.

The University of Nevada Las Vegas Howard R. Hughes College of Engineering is proposed as the institutional home for the statewide Surveying Engineering B.S. and Geomatics M.S. programs. The College currently offers accredited four-year degrees in civil engineering, computer science, electrical engineering, and mechanical engineering. UNLV's National Supercomputing Center for Energy and the Environment (NSCEE) and the College of Engineering's Transportation Research Center (TRC) and Department of Civil and Environmental Engineering have existing computing and personnel resources that would play a significant role in the development of a modern surveying engineering/geomatics program.

The College of Engineering's expertise in obtaining accreditation for engineering and computer science programs, and the pre-existing skills and knowledge currently available in the College's Department of Civil and Environmental Engineering, combine to make it the most feasible administrative home for a new program in Surveying Engineering and Geomatics. The College has a well-developed geographic information systems (GIS) research and instructional capability in its Transportation Research Center, with a 10-year track record of attracting GIS research at levels in excess of \$100,000 per year. It is anticipated that these resources would be an integral part of a graduate program in Geomatics.

Departmental relationship

The Department of Civil and Environmental Engineering has some pre-existing expertise in surveying and has developed a relationship with the two-year Surveying Technology program at CCSN. For more than 30 years, the department has taught Elementary Surveying, CEG 121, as a required course for students in the civil engineering baccalaureate program. The department also recently approved a for-credit course in Public Lands Surveying, EGG 323, to be offered through the University's College of Continuing Education. The department has also offered CEG 423, Advanced Surveying, as an upper-division elective in the civil engineering program. The department also offers CEG 468/668, GIS Applications in Civil Engineering, to civil engineering majors and to natural science majors from across the UNLV campus. The latter two courses are anticipated to be part of both a baccalaureate program in Surveying Engineering (as advanced electives) and a two-year masters program in

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Geomatics (as entry level courses).

The department's surveying equipment inventory is in the process of being combined with equipment donated by NALS to CCSN for their two-year degree program. The combined inventory will be housed on the UNLV campus, and used for field instruction in surveying courses offered by both UNLV and CCSN.

Civil and Environmental Engineering faculty and graduate students provide 100% of the staffing for the College's Transportation Research Center. Two faculty, two professional staff and a half-dozen graduate and undergraduate students are skilled in instruction and applications of Geographic Information Systems (GIS) technology, and two other faculty are skilled in instruction and applications of surveying. It is anticipated that these faculty and staff could serve as mentors and advisors to incoming graduate students in Geomatics.

Review of Directly Related Programs within the Institution:

Civil and Environmental Engineering

The M.S. degree in Engineering, major, Civil Engineering, with specialization in construction, environmental, geotechnical, structural, transportation and water resources, is the most closely related program in the College of Engineering. Surveying is essential to the civil engineering profession, where engineers use surveying tools and skills to check the alignments, elevations and locations of roadways, utilities, tunnels, bridges and buildings. Civil engineers also use surveying skills to estimate volumes of earth needed for addition or removal to sites, to estimate land slopes and also to estimate changes in elevation that occur over time (land subsidence). Currently, all civil engineering majors at UNLV are required to take one introductory course in land surveying, and they must use this surveying knowledge in advanced courses in hydrology, foundations and geographic information systems. Civil engineers must frequently interact with professional land surveyors, who generate and graphically organize the information that engineers use in their designs. Currently, two advanced undergraduate, beginning graduate courses offered in the Civil Engineering Department, CEG 423 and CEG 468/668, could be cross-listed and incorporated into a Surveying Engineering program.

Other UNLV Academic programs

Other academic units at UNLV have needs for surveying related skills and could provide opportunities for interdisciplinary collaboration and research. The Department of Mechanical and Aerospace Engineering uses accurate digital terrain maps in models that compute the trajectories of winds in the atmosphere. The Department of Geosciences has needs for surveying skills to accurately map the locations of geologic resources such as ore bodies and rock formations. Surveying and mapping skills are needed to accurately track dislocations across active faults and inflation and deflation of active and dormant volcanoes. Surveying and mapping of distributions of plants and animal habitats is carried out by the Department of Biological Sciences, and surveying and mapping of archaeological resources is performed in the department of Anthropology. Health Physics conducts research on the isotopic content of sediment cores, and needs accurate determinations of core positions. Additional resource mapping and analysis needs could emerge in the Environmental Studies Program.

Why propose a graduate degree program (M.S.) in Geomatics?

Tenure-track faculty hired to instruct and perform research in Surveying Engineering and Geomatics will need graduate students who can provide instructional and research support. Surveying engineering faculty will be primarily tenured on the basis of research productivity (grants and publications). Additionally, employment opportunities exist for persons trained at advanced levels in surveying and

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resource mapping, especially if they desire to advance to leadership positions in the field. The population interested in this kind of training comprises persons with 4-year degrees in surveying, engineering, and natural sciences (predominantly geoscience, and biological sciences) who are interested in mapping of infrastructure and natural resources. The College's current M.S. degree in Engineering generally requires a 4-year degree in engineering for admission. While it is anticipated that a Geomatics specialty could be developed under the M.S. Engineering degree for engineers seeking advanced training, persons with natural science and applied science degrees could not qualify for admission to the M.S. Engineering program. The College's current M.S. degrees in Computer Science and Transportation are targeted at audiences that have interests and backgrounds different from the audience that would be interested in surveying, GIS and resource mapping. Hence, an M.S. degree in Geomatics, a subject name that is recognized in the profession as associated with land measurement and resource mapping, is proposed to simultaneously provide a means to attract non-engineering graduate students to support surveying faculty, and also serve as a means of entry into specialized areas of surveying for persons who seek to develop advanced skills in infrastructure and natural resource mapping.

Home Academic Department for Surveying Engineering / Geomatics

Given the Department of Civil and Environmental Engineering's pre-existing expertise in surveying instruction and applications, and GIS technology, it is proposed that Civil and Environmental Engineering be the initial home department for the proposed M.S. Geomatics and B.S. Surveying Engineering degrees.

Estimated Fall Enrollment Headcount:

Headcounts are computed assuming that one-quarter to one-half of the demand for licensed surveyors will come from persons who already have B.S. degrees in other areas. A portion of the 10 licenses a year coming from related bachelor's degrees represents the one part of the potential market for the M.S. degree in Geomatics. Another portion of the demand would come both from recent graduates of four-year surveying programs and from employed surveying professionals who seek to advance to leadership positions in the field. It is conservatively estimated that the M.S. program could produce 10 graduates a year by the year 2007.

If graduate program headcount was half the size of the undergraduate program, with an average of nine credits per head count the following revenue would be generated in each of the following planning years.

1 st year (Fall 2002)	<u>4</u>	x 2 semesters x 9 credits x 96 \$/credit = \$6,912
2 nd year (Fall 2003)	<u>11</u>	x 2 semesters x 9 credits x 96 \$/credit = \$19,008
3 rd year (Fall 2004)	<u>17</u>	x 2 semesters x 9 credits x 96 \$/credit = \$29,376
4 th year (Fall 2005)	<u>20</u>	x 2 semesters x 9 credits x 96 \$/credit = \$34,560
5 th year (Fall 2006)	<u>22</u>	x 2 semesters x 9 credits x 96 \$/credit = \$38,016

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Estimated Fall Enrollment Full-time Equivalency (FTE):

Computed assuming that, during the first five years of program operation, 1/3 of each year's fall head-count will be full-time (9 credits) and 2/3 will be part-time (3-6 credits)

1 st year (Fall 2002)	<u>2</u>
2 nd year (Fall 2003)	<u>6</u>
3 rd year (Fall 2004)	<u>9</u>
4 th year (Fall 2005)	<u>11</u>
5 th year (Fall 2006)	<u>12</u>

Estimate of Resources Needed (personnel, library holdings, facilities, equipment):

Personnel

Summary

For the Surveying Engineering B.S. degree program, the department requested three faculty, a half-time management assistant, one additional full-time instrument technician, and three graduate assistantships for support of the surveying/geomatics program. Given that existing department faculty can provide some teaching and research support, and that requested faculty and teaching assistants for the B.S. Surveying Engineering program will also be advising and occasionally instructing in the graduate program, additional resources requested for the M.S. Geomatics program are one additional faculty to handle the anticipated graduate-level teaching loads in Geomatics, two additional graduate teaching assistantships, and an increase in operating budget to handle additional costs associated with running a graduate degree program.

Faculty - According to ABET accreditation guidelines (Section I.C.1.C) a core of three full-time tenured or tenure-track faculty dedicated to the B.S. Surveying Engineering program is the absolute minimum that is needed for an accredited program. Since additional course instruction would be needed for a two-year graduate degree program, one additional faculty member is requested. One additional faculty teaching six different graduate courses in three semesters, in addition to instruction provided by other surveying and civil engineering faculty, would provide the minimum level of instruction needed for completion of a 2-year M.S. program. It is envisioned that several (two or three) part-time faculty drawn from the professional community would teach specialized courses each semester, especially during the early years of the program.

Faculty searches and hires for the B.S. program would take place in the 2001-2002, 2002-2003, and 2003-2004 academic years. These faculty would be primarily involved in development of the B.S. program; however, they would also be generating funded research and advising graduate students. The fourth faculty search for the faculty member primarily responsible for the M.S. Geomatics graduate program would take place in the 2004-2005 academic year. The 2001-2002 search would be for a senior faculty who could serve as Surveying/Geomatics program director. The 2002-2003, 2003-2004 and 2004-2005 searches would be for tenure-track junior-level faculty. The Geomatics graduate program would get off to an earlier start, and would generate its first graduates sooner if the department were to be allowed to conduct two searches in either 2002-2003 or 2003-2004.

Administrative - A half-time management assistant position is needed to accommodate the expected

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work load that includes admissions, management of student records, course scheduling, management of program assets, travel, and faculty support. In 1998, the department's construction management graduate program was approved with a half-time management assistant position that has yet to be filled. If both the B.S. and M.S. programs in surveying engineering and geomatics program proposal are approved, and the programs are staffed to four faculty, then the department would have 20 total faculty. The department currently has two management assistants for 16 faculty. The department requests that the two half-time management assistant positions for construction management and surveying/geomatics be combined into a full-time position, and that this position be authorized to be filled in the 2002-2003 academic year.

Technical - The Civil and Environmental Engineering department currently has one full-time technician to support the teaching and research needs of 16 faculty, 350 students and six degree programs. A second position was included in the department's Civil Engineering Ph.D. program proposal, approved in 1991, but has never been authorized for hire. The current single technician has been stretched thin over all the department's shops and laboratories, and support by only one technician is far less than the support available to other departments in the College of Sciences, where two or three technicians support teaching and research needs of each department. The additional needs for instrument and computer maintenance in a surveying/geomatics program would also require the services of a skilled instrument technician, and it is vital that a second technician position be authorized for hire by the department at the start of the surveying program. The department requests that this additional technician position be authorized for the 2000-2001 academic year.

Graduate assistants - The Civil and Environmental Engineering department currently has 12 authorized state-funded graduate assistant positions. These 12 positions currently cover the needs of 16 faculty, 350 students, six degree programs and six graduate specialty areas in engineering. Three additional graduate assistantship positions were contained in the M.S. in Construction Management proposal that was approved by the UCCSN in 1999. These positions have yet to be authorized and would bring the department's total to 15, slightly less than one per faculty member. If the surveying/geomatics programs are approved, and four additional faculty positions are authorized, the department requests that six more graduate assistantships be authorized (four for the B.S. degree, and two for the M.S. degree), bringing the total number of approved graduate assistant positions to 21. These positions are requested to provide instructional support for the tenured and tenure-track surveying engineering faculty. The assistants would support 4-6 laboratory classes each semester, hold discussion and recitation sessions, provide grading services in large classes, and support faculty research in surveying and geomatics.

Library holdings:

A minimum of four journal subscriptions would be required to adequately support the proposed surveying/geomatics program:

1. American Congress on Surveying and Mapping (ACSM) Surveying and Land Information Systems Journal
2. ACSM Cartography and Geographic Information Systems Journal
3. American Society for Photogrammetry and Remote Sensing (ASPRS) Photogrammetric Engineering and Remote Sensing Journal
4. Urban and Regional Information System Association (URISA) Journal

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Facilities:

Classrooms- The department anticipates the following course offering schedule for classes in surveying engineering:

Fall 2002, Spring 2003 - one full-time faculty teaching two classes each semester, each initially enrolling an average of 10 students - and one part-time faculty teaching one class each semester, each enrolling 10 students, *requires three scheduled 10-seat classroom slots each semester.*

Fall 2003, Spring 2004 - two full-time faculty teaching four classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling 20 students, *requires five scheduled 20-seat classroom slots each semester.*

Fall 2004, Spring 2005 - three full-time faculty teaching six classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling an average of 20 students, *requires eight scheduled 20-seat classroom slots each semester.*

Fall 2005, Spring 2006 and subsequent years - four full-time faculty teaching eight classes each semester, with six undergraduate classes enrolling 20 students per semester, and two graduate classes enrolling 10 students per semester.

By Fall 2005, one classroom would need to be reserved for an entire day and evening, for a minimum of three days per week, to meet the needs of the surveying program.

Laboratories - The department anticipates needing dedicated facilities for the graduate program in Geomatics to be identical to those needed to support the B.S. Surveying Engineering program. These facilities include:

1. A 1000 square-foot computation and mapping laboratory, consisting of seven IBM-compatible personal computers with surveying software, and seven photogrammetric workstations with GPS reduction and image analysis software. This facility does not exist, and would be dedicated to the surveying/geomatics program.
2. An 800 square-foot GIS laboratory consisting of 15 workstations for geographic data analysis and processing. This facility does not exist, and would be shared between the surveying/geomatics and civil engineering programs. It is estimated that six of these workstations would be needed by the surveying/geomatics program.

Office space - In addition to the needs stated for the B.S. Surveying Engineering program, the department anticipates the requesting one additional faculty office space and one additional graduate student office space for the M.S. Geomatics program. These additional spaces would be added on the following schedule:

1. One additional 180 square-foot faculty office - added in 2005.
2. One additional 180 square-foot graduate assistant office, used by 2 TA's, added in 2002.

Ideally, the surveying faculty and graduate assistant office cluster, and the surveying/construction management secretarial desk would be located near the surveying laboratories to provide ease of communications for students, staff and faculty.

Projected budget increases and additional costs to implement new program:

Additional state operating budget increases shown below are based on projected graduate program enrollments listed above, and assume per capita student funding in the state operating budget of about \$200 per student headcount per year for administrative costs. Software licensing costs, also part of the operating budget, are assumed to be supported by external funds, are identical to needs for the B.S. Surveying Engineering program. Additional software licensing fees for graduate research programs are

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listed in this program proposal.

With the exception of three additional computers to support additional graduate assistants, equipment budget requests are identical to those requested for the B.S. Surveying Engineering program. Most of the computer hardware would be acquired in the first two years of the program, with a three-year replacement cycle for computer hardware thereafter. The equipment budget assumes that state equipment funding will be matched by external funds from grants and gifts. External funding may have to be increased if state equipment funding is unavailable. Operating costs include expected additional annual renewal fees for CAD, GIS, GPS and surveying software licenses, starting at \$3,000 per year, and then increasing at 6% per year thereafter. Listed operating costs do not include faculty salaries:

	Additional operating (in addition to B.S. program)	Additional Equipment (in addition to B.S. program)
1 st year - 2001-2002	\$3,800	\$6,000
2 nd year - 2002-2003	\$5,400	\$0
3 rd year - 2003-2004	\$6,800	\$0
4 th year - 2004-2005	\$7,700	\$6,000
5 th year - 2005-2006	\$8,400	\$0

Source of funds:

	Operating -state	Equipment - state	Oper & Equip - external
1 st year - 2001-2002	\$800	\$3,000	\$6,000
2 nd year - 2002-2003	\$2,200	\$0	\$3,200
3 rd year - 2003-2004	\$3,400	\$0	\$3,400
4 th year - 2004-2005	\$4,000	\$3,000	\$6,700
5 th year - 2005-2006	\$4,400	\$0	\$4,000

Is the new program listed in the campus academic master plan?

The Department of Civil and Environmental Engineering commenced planning for the surveying engineering/geomatics program in the Fall of 1998, and included Surveying Engineering and Geomatics in its Fall 1998 Planning Document. The 1998 College of Engineering Planning Document also included surveying engineering/geomatics as part of its long-range master plan. The Provost's office has indicated strong support for the development of the surveying/geomatics program at UNLV.

Date Approved by Academic Affairs Council: _____

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University & Community College System of Nevada

Program Proposal - Geomatics, M.S.

I. Degree(s) to be awarded upon completion of requirements; or title of department, school, or college to be initiated.

M.S. degree in Geomatics, to be administered by the Department of Civil and Environmental Engineering in UNLV's Howard R. Hughes College of Engineering.

II. Proposed date of implementation.

Program initiation is proposed for Fall 2002, with hire of the first faculty member, serving as Program Director, during the 2001-2002 academic year. Additional faculty hires would take place in 2002-2003, 2003-2004, and 2004-2005. One of these four faculty hires would be dedicated to the M.S. program in Geomatics, with the others dedicated to the B.S. program in Surveying Engineering. The first graduate students would matriculate in Fall 2003, with the first M.S. program graduates expected in Fall of 2005.

III. Description of program or instructional unit.

Surveying Engineering / Geomatics

The program name is Surveying Engineering/Geomatics. The program will offer an ABET-accredited B.S. degree in Surveying Engineering and a M.S. degree in Geomatics. A four-year college degree will be required for Nevada licensure in the year 2010 and thereafter, provided that a program is available in the state in the year 2006. It is anticipated that a portion of the licensure demand could be satisfied by graduates of the M.S. program.

The M.S. degree in Geomatics is intended for persons with baccalaureate degrees in engineering, natural sciences and surveying who seek to develop advanced skills in surveying and mapping and to prepare for leadership positions in the field. Graduate students in the Geomatics M.S. program will also support the research and teaching efforts of tenured and tenure-track Surveying Engineering faculty. Surveying faculty will be expected to maintain active research programs, and a graduate program in Geomatics will help to attract high quality graduates with majors in mathematics, physics, forestry, biology, geography, geology, zoology and engineering.

The Surveying Engineering/Geomatics program will be initially administered by the Department of Civil and Environmental Engineering at UNLV. The M.S. program will require one additional faculty hire above the needs of the B.S. program, participation by part-time instructors, and will also take advantage of the department's pre-existing expertise in surveying, global positioning and geographic information systems. The department currently has one faculty with expertise in surveying and global positioning, and two faculty with expertise in geographic information systems. The department's current inventory of surveying and GIS equipment would be augmented to provide adequate instructional support for the proposed Surveying Engineering/Geomatics degrees.

The graduate programs nearest to Nevada are at California State University Fresno, and at New Mexico State University. The proposed UNLV Surveying Engineering/Geomatics program is intended to have a regional impact, attracting students from other southwestern and intermountain states, including Arizona and Utah, where no baccalaureate or masters programs currently exist.

The Surveying Engineering/Geomatics program will be intended to serve:

- a. full-time day students in residence, and

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b. a local and statewide population of part-time students.

Courses are intended to be primarily offered in afternoons and evenings, and the statewide population will be served by a combination of extension courses for credit, and distance education credit courses, taught via videotape or via the World-Wide Web.

Since the proposed program would be located in southern Nevada and would be the only 4-year program in the state, a significant population in other parts of the Nevada would also need to be served. Some beginning-level graduate courses in the proposed M.S. Geomatics program would be offered through distance education means, perhaps cutting one semester in residence from degree requirements.

IV. Statement of degree objectives.

The objectives for the M.S. Geomatics degree are:

1. To train graduates to perform advanced work in surveying and mapping,
2. To prepare students for leadership positions in the spatial information industry, including the areas of surveying, mapping and geographic information systems.
3. To provide sufficient surveying content to permit its graduates to successfully gain licensure as Professional Land Surveyors with an appropriate amount of supervised work experience. This objective may need to be satisfied by requiring up to 15-20 credit hours of undergraduate surveying courses, depending on the background of each student.
4. To develop an understanding of how surveying skills may be applied to solving research problems associated with the mapping of physical infrastructure, and natural and cultural resources.
5. To develop skills in research problem solving, including formulation of a research question, literature research, development of a scope of work, and analysis of research data.

V. Plan for assessment of degree objectives.

The Civil and Environmental Engineering department has previously conducted a survey of its civil engineering alumni and employers that led to significant enhancements of the civil engineering curriculum. Similar tools would be developed for assessment of the B.S. Surveying Engineering program.

1. Surveying employers will be periodically surveyed on the skills, knowledge and performance of UNLV Geomatics graduates relative to the performance of graduates from other programs.
2. Alumni will be periodically surveyed to determine how their education prepared them for survival in the workplace.
3. A Surveying Engineering Advisory Committee will be developed. The Committee will meet every semester, and will provide feedback on performance of student interns, recent graduates, and adequacy of curriculum and facilities
4. Student comprehension of surveying knowledge and adequacy of student skills will be assessed using traditional academic performance measures (homework problem sets, term papers, quizzes, and examinations).
5. Student performance on the nationally-administered Fundamentals of Land Surveying (F.L.S.) examination will be used to assess long-term understanding of surveying principles and performance of UNLV graduates relative to the performance of graduates from other institutions and regions.

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VI. Contribution and relationship of program objectives to:

1. Institutional mission.

In 1996, the University of Nevada, Las Vegas developed a Planning Document with seven major goals. Among the goals were:

Goal #4 - Grow Selectively and Serve the Region. The M.S. Geomatics degree is being developed in response to an identified need for higher education in a vital segment of the professional community. Persons with baccalaureate degrees seeking to either develop or improve their knowledge in Geomatics are the principal audience for this degree program. It is anticipated that some of the demand for licensed surveyors may be met by graduates from the M.S. program. This additional route to licensure (in addition to the B.S. Surveying Engineering baccalaureate program) was also suggested by David Gibson, the University's program consultant on surveying.

2. Campus Academic Master Plan.

The campus academic master plan, which incorporated the College master plan, included surveying engineering / geomatics in 1998 when the need for a 4-year surveying program in Nevada was first recognized. The campus plan also emphasizes the increasing importance of research in the University's academic efforts. The proposed M.S. program in Geomatics will provide a mechanism for attracting faculty to the program, as it will provide them with a graduate program that will attract high-quality graduate students who can assist surveying faculty in funded research in surveying, mapping and spatial positioning.

3. Department and College Plan.

At the department level, surveying/geomatics program objectives are very similar to those developed for both civil engineering and construction management. Proposed assessment tools are identical to tools developed for civil engineering and construction management.

Considerable interaction is expected between surveying students and faculty and the civil engineering and construction management disciplines. Geomatics faculty and graduate students will be able to provide expertise in solving practical and research surveying problems that arise in civil engineering. Collaboration is expected between geomatics and civil engineering faculty on problems associated with, for example, mapping and spatial positioning of soil and water quality data, soil and rock properties, subsidence and alignment of building foundations, mapping of traffic volumes and accident frequencies, and delineation of watershed boundaries and cones of depression.

At the College level, development of a surveying engineering/geomatics program is expected to enhance the ability of College faculty to attract funded research, a major College and University objective. Surveying engineering/geomatics faculty can collaborate with faculty in other departments to attract interdisciplinary research projects. For example, geomatics faculty could assist electrical engineering faculty with mapping and risk assessment of electric power transmission infrastructure. Surveying faculty could also develop improved terrain maps for use in complex atmospheric flow models developed by mechanical engineering and computer science faculty.

Master's-level program requirements in the College's engineering departments are fairly similar. All programs generally require 30-33 units of graduate credit with a minimum of 15 700-level credits in the discipline. Most master's degree programs either require 33 credits and three-credit professional paper, or 30 credits and a 6 credit M.S. thesis.

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4. Other Programs in the Institution.

Program objectives for surveying engineering/geomatics should generate opportunities for collaboration with other programs at UNLV. Surveying engineering/geomatics faculty could collaborate with geosciences faculty in the mapping of geologic features such as karst terrain, fault displacement, or inflation/deflation of volcanoes, and in mapping of geological resources such as ore bodies and groundwater. Surveying faculty could collaborate with biological sciences faculty in the mapping of endangered species, and in the determination of the extent of plant communities. Additionally, surveying faculty could assist anthropology faculty in the mapping of archaeological and cultural resources.

5. Other Related Programs in the System.

Currently, the Community College of Southern Nevada offers a two-year Associate of Applied Science degree in Surveying, administered by its Building Technology program. This is the only surveying-related program currently operating in the UCCSN. Other institutions, such as UNR or Truckee Meadows Community College offer one or two introductory surveying courses, but no other degree programs are currently offered or planned in the System.

6. Articulation issues.

Articulation of the B.S. Surveying Engineering program with community colleges was discussed in the B.S. program proposal. It is anticipated that students with baccalaureate backgrounds in surveying will generally be able to complete the M.S. Geomatics program in 30-36 credits. It is anticipated that persons with B.S. degrees in other areas having sufficient math and some prior surveying background may require up to 12 additional credits of undergraduate courses to successfully complete the M.S. program. For persons with baccalaureate degrees in natural sciences with math deficiencies and no prior background in surveying, up to 24 additional credits of courses may be required to successfully complete the M.S. program.

It is proposed that several beginning graduate courses in the M.S. Geomatics program be made available through distance education, so that place-bound students in northern, western and eastern Nevada and other parts of the country can earn a portion of the credits towards the M.S. degree and reduce their required time in residence on the UNLV campus.

VII. Evaluation of need for the program.

1. Intrinsic academic value of program within the discipline.

The intrinsic value of the B.S. Surveying Engineering program within the discipline is discussed in the B.S. Surveying Engineering program proposal. The M.S. Geomatics degree is intended to serve three student populations:

- 1) students desiring advanced-level training in surveying and geomatics, who may be seeking to move into advanced technical positions or management positions,
- 2) students interested in conducting applied research in areas served by surveying and geomatics
- 3) students with baccalaureate degrees in other areas who seek to acquire sufficient skills to attain licensure as a Land Surveyor.

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2. Evidence of existing or projected local, state, regional, national and/or international need for program.

National need

It is now generally recognized that global positioning, geographic information systems and computer technologies have increased the complexity and required level of professional services of the surveying profession. Surveyors' accurate assessments of land boundaries and resources have significant legal, economic and political consequences. Land developers, natural resource managers and civil engineers need vast amounts of geographic information for land subdivision, natural resource assessment, and facilities design and construction, respectively, and are relying on surveyors to provide the necessary expertise. There is demand among persons with baccalaureate training in the above disciplines for formal training as land surveyors and resource mappers. Biological and geological resources, and, in urban areas, real estate assets, roads, power and communications lines, water and sewer lines, roadways and other aspects of physical infrastructure, are now extensively mapped by electronic means, and persons trained to map and use geographic information systems to analyze these resources are in high demand. In some cases, these persons may seek licensure as land surveyors. In other cases, they may seek training to use surveying and mapping tools in their own disciplines.

State Need for Program

Recognizing the need for improved training in surveying, the Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors (NSBPELS) have, in recent years lobbied the Nevada Legislature for revisions to the Nevada Land Surveying Practice Act, Nevada Revised Statute 625 (NRS 625), that would require a baccalaureate degree for licensing as a Professional Land Surveyor (P.L.S.). In 1999, the Nevada Legislature passed revisions to NRS 625 that require a 4-year degree for licensing as a land surveyor in the year 2010 and after, provided that a suitable academic program is established and operating in the state by the year 2006. Currently, there is no 4-year degree program available within Nevada. The closest institutions with accredited 4-year degree programs are California State University-Fresno, Oregon Institute of Technology and New Mexico State University. A Nevada program is needed to meet the requirements of NRS 625. The Nevada Association of Land Surveyors and the Nevada State Board of Professional Engineers and Land Surveyors have approached the University of Nevada, Las Vegas with a request to develop a suitable B.S. Surveying Engineering program.

Statewide licensing rates for professional land surveyors are projected to be about 40 per year in the year 2010. It is anticipated that the proposed surveying engineering/geomatics program could be generating 20 graduates per year by that time, with about 10 others coming from out-of-state programs, and another 10 coming from related bachelor's degrees in engineering, geography and the natural sciences. It is this latter population of persons with related bachelor's degrees that will be served by the M.S. Geomatics program. The Geomatics program will provide opportunities for them to develop the skills and knowledge necessary for licensure or for work that applies surveying and geomatics to their own disciplines.

Regional need

Currently, the closest graduate level programs in surveying and geomatics are at California State University Fresno and at New Mexico State University. Currently, there are no 4-year or graduate-level degree programs in Arizona, Utah or Idaho. Licensing boards in those states may soon require 4-year surveying degrees or other evidence of satisfactory completion of a minimum set of courses. A

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M.S. degree may be a viable substitute for persons who already possess a four-year degree in a related discipline. A program in Nevada could therefore serve both southwestern and intermountain region needs for training of surveyors. Memoranda of understanding (MO's) could be negotiated with the professional groups and licensing boards of neighboring states to facilitate acceptance of Nevada B.S. or M.S. degrees as suitable preparation for licensure. Additionally, in-state or reduced out-of-state tuition rates for students from neighboring states could be established. Most areas of the U.S. have regional university consortia that allow students to cross state lines at in-state rates.

Successful completion of MO's and implementation of reduced tuition rates would facilitate development of a regional program, and increase the pool of candidates for the UNLV program.

The U.S. Environmental Protection Agency maintains its national laboratory in remote sensing and geographic information systems on the UNLV campus, and it is anticipated that there will be interest on the part of EPA staff in the graduate program in Geomatics. Substantial opportunities for collaboration between EPA and UNLV could develop from this graduate program, including increased student enrollments, participation as part-time instructors, service on graduate research committees, and development of funded research projects. Collaboration with EPA could greatly enhance the regional and national reach and visibility of the proposed M.S. degree program.

Local need

The southern Nevada economy is currently exhibiting strong demand for surveyors, largely driven by construction of resorts, commercial centers, housing developments, and related infrastructure such as roads and utilities. Current growth forecasts indicate no slowing of construction activity until the year 2020, when geographic and topographic constraints may limit outward expansion. Local demand for qualified, licensed surveyors could be met by graduates from either a B.S. Surveying Engineering program, or by graduates of a M.S. Geomatics program.

3. Evidence of employment opportunities for graduates (state and national).

A recent poll of employers who are members of the Nevada Association of Land Surveyors (NALS), indicated that:

- a. More than three-quarters had difficulty filling positions for qualified land surveyors.
- b. A recent graduate of a 4-year surveying program who has passed the Fundamentals of Land Surveying examination can expect to be offered \$35,000-\$45,000 per year to start as a Land Surveying Intern.
- c. Demand for Professional Land Surveyors is so high that a typical starting salary for a recently licensed P.L.S. (a professional who has met the education and experience requirements, generally, 4 year degree plus 4 years experience as a Land Surveying Intern, and has just passed the Principles and Practice of Land Surveying Examination) is \$50,000-\$60,000 per year, and a P.L.S. with 10 years of experience can expect to earn \$70,000-\$75,000 per year.
- d. There are currently 90 firms with surveying departments in southern Nevada. The number of employers has steadily increased from 15 in 1980 to 90 in 2000. Of these 90 firms, 80 are in metropolitan Las Vegas (source: Byron Johnson, City of Las Vegas).
- e. Strong demand for qualified surveyors also exists at public agencies, with needs for surveying and mapping skills at the U.S. EPA, U.S. Geological Survey, U.S. Forest Service, U.S. Bureau of Land Management, U.S. National Park Service, U.S. Natural Resource Conservation Service and other resource management agencies at state and local levels.

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The following table gives 5-year averages for surveyor licensing rates in the state of Nevada from 1980 to 1999 (Data provided by Rita Lumos, Vice-Chair, Nevada State Board of Professional Engineers and Land Surveyors, February, 2000)

Interval	# licensed	#by reciprocity	# by examination
1980-1984	52	37	15
1985-1989	47	36	11
1990-1994	48	28	20
1995-1999	46	26	20

The average number of surveyors licensed in the state over the last 20 years is 49, with 17, or 35% licensed by examination within the state. Currently, persons seeking formal academic training in surveying must obtain it from outside the state. For planning purposes, statewide licensing rates for professional land surveyors are conservatively projected to be about 40 per year through the year 2020.

It is anticipated that the proposed surveying engineering/geomatics program could be generating 20 baccalaureate-level graduates per year by 2010, with about 10 other licensees coming from out-of-state programs, and another 10 coming from related bachelor's degrees in engineering, geography and the natural sciences.

4. Student clientele to be served.

The Surveying Engineering/Geomatics program will be intended to serve both full-time day students in residence, and a local and statewide population of part-time students.

The graduate program in Geomatics could capture:

- Some currently licensed land surveyors within Nevada who seek professional development hours (PDH's) to maintain their licenses, and who may also seek to earn an advanced degree for purposes of career enhancement.
- Some of the persons with related 4-year degrees who seek to acquire skills needed for licensure in a formal academic setting, and
- Persons seeking advanced training in surveying and geomatics so that they perform applied research in related subject areas, such as natural or urban resource mapping and analysis.

To best serve the local part-time student population, upper division and graduate-level courses are intended to be primarily offered in late afternoons and evenings. The late afternoon and evening time slots would serve both part-time students, and full-time graduate students who would perform research during the day and then attend class at night. The statewide part-time population would be served by several distance education credit courses, taught via videotape or via the World-Wide Web.

5. Procedures used to arrive at the decision to propose the program.

In the Fall of 1998, the Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors approached UNLV with a request to initiate a program in Surveying and Geomatics. Their request was based on:

- the requirements of NRS 625, which will require a four-year degree for licensure in the years 2010 and beyond, provided that a four-year program is operating in the state by the year 2006, and
- the need to provide training in emerging technologies in the field, including Computer Assisted Design (CAD), Global Positioning (GPS), Geographic Information Systems (GIS), and Remote Sensing.

The request from NALS and the State Board was referred to the College of Engineering for action, and the decision was made to develop the surveying engineering/geomatics program proposal in the

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Linear Algebra	3 credits
Statistics for Scientists and Engineers	3 credits
C language programming	3 credits
Lab science: Select two from list, depending on prior background: Chem I, Chem II, Phys I, Phys II, Biol I, Biol II	8 credits
Undergraduate surveying:	
SEG/CEG 121 Elementary Surveying	3 credits
SEG 202 Computation and Mapping	3 credits
SEG 301 Geodesy	3 credits
SEG 303 Image Mapping and Analysis	3 credits
SEG 304 Geographic Information Science & Lab	4 credits
SEG 305 Satellite Positioning	4 credits
SEG 306 Boundary and Cadastral Principles	3 credits
Total undergraduate articulation:	52 credits

Rationale for selected undergraduate courses:

To provide knowledge of physical and chemical principles behind the acquisition of surveying information, including emissions, propagation and reflection of light:

CHE 115	Chemistry I and Lab	4 credits
CHE 116	Chemistry II and Lab	4 credits
PHY 180	Engineering Physics I and Lab	4 credits
PHY 181	Engineering Physics II and Lab	4 credits

To provide basic knowledge of natural resources that mapped by surveyors:

BIO 190	Biological Science I and Lab	4 credits
BIO 191	Biological Science II and Lab	4 credits

To provide computational skills needed for manipulation of surveying, geodetic and satellite data:

MAT 181	Calculus I	4 credits
MAT 182	Calculus II	4 credits
MAT 283	Calculus III	3 credits
MAT 253	Linear Algebra	3 credits
STA 463/663	Statistics for Scientists	3 credits
CSC 119	Computer programming, C language	3 credits

To provide sufficient skills for graduate-level courses in surveying and geomatics:

SEG/CEG 121 Elementary Surveying	3 credits
SEG 202 Computation and Mapping	3 credits
SEG 301 Geodesy	3 credits
SEG 303 Image Mapping and Analysis	3 credits
SEG 304 Geographic Information Science & Lab	4 credits
SEG 305 Satellite Positioning	4 credits
SEG 306 Boundary and Cadastral Principles	3 credits

It is anticipated that students from related disciplines will take undergraduate courses to rectify background deficiencies. For example, a student with biological science background may have already completed courses equivalent to BIO 190-191, CHE 115-116 and an equivalent to STA 463, and would concentrate on MAT, PHY and SEG courses. A student with physical science or

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engineering background would likely have already completed CHE 115, MAT 181-182-283, and PHY 180-181, and would concentrate on BIO and SEG courses.

Survey program course descriptions:

All course descriptions are similar to those presented in the B.S. Surveying Engineering program proposal. Undergraduate courses listed here represent a sub-set of courses listed in the B.S. Surveying Engineering proposal. Courses marked with an asterisk (*) have the potential to be offered via distance education.

Recommended freshman-level course for graduate students needing undergraduate preparation in surveying:

SEG/CEG 121 Elementary Surveying (3 credits): basic surveying methods, angle and distances, leveling, traverse closure, topographic mapping, construction layout, applications to engineering projects. Prerequisite: Satisfactory grade (C, 2.0 or better) in high school or college-level plane trigonometry.

Recommended sophomore-level course for graduate students needing undergraduate preparation in surveying:

SEG 202 Computation and Mapping (plane) (3 credits): plane coordinate computation, plane coordinate geometry, computer mapping, state plane coordinate systems, universal transverse mercator, map projections, coordinate datum conversions. Prerequisite: High school geometry and CEG 121 or SEG 121

Recommended junior-level courses for graduate students needing undergraduate preparation in surveying:

*SEG 301 Geodesy (3 credits): reference frames, gravity distributions, ellipsoids, geoid determination, computation of geodetic position, earth-centered rectangular, geodetic coordinate conversion. Prerequisite: SEG 202

SEG 303 Image Mapping and Analysis and Lab (4 credits): aerial photography, flight operations, vertical aerial photos, stereo mapping, aerotriangulation, image mapping, remote sensing, image analysis, image detection and classification, orthophotos, digital terrain models. Prerequisite: PHY 181, SEG 202

SEG 304 Geographic Information Science and Lab (4 credits): digital mapping, topology, spatial objects, database design, relational database theory, GIS hardware and software, applications. Prerequisite: SEG 202

SEG 305 Satellite Positioning (3 credits): survey-grade GPS hardware, software and procedures, static, real time kinematic, network design, observation, reduction, differential methods. Prerequisite: SEG 201

*SEG 306 Boundary and Cadastral Principles (3 credits): cadastral systems, boundary law, resolution of deed and ownership issues according to case and statute law, senior rights, adverse possession, evidence, title, legal descriptions, instruments of title. Prerequisite: SEG 202

Beginning graduate courses: Courses marked 4xx/6xx are offered at the 400-level to advanced undergraduates and at the 600-level to beginning graduate students.

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*SEG 401/601 Professional Surveying Ethics (web-based) (1 credit): principles of professional ethics, systematic application of ethical rules, test cases.

*SEG 402/602 Public Land Surveying (3 credits): history of the public land survey system, original surveys, retracement, restoration of corners. Prerequisite: CEG 121 or SEG 121.

SEG 403/603 Surveying Practice and Lab (4 credits): professionalism, regulation of the surveying profession, licensure, project cost estimation, procedures for survey design and execution, standards for survey documentation, liability, negotiations, court room procedures, field evidence methods and evaluation. Prerequisites: SEG 301, 303, and 306.

SEG 404/604 Land Development Design and Lab (4 credits): subdivision land planning, tract analysis, plan review, lot and street design, platting, paving and drainage plans, development review. Prerequisite: CEG 202.

Graduate-level courses: Courses at the 700-level are intended for advanced study in surveying and geomatics.

SEG 701 Advanced Geodesy (3 credits): Advanced topics in the measurement of the earth, including radar altimetry, and recent map corrections. Prerequisites: Graduate standing and CEG 301.

SEG 703 Remote Sensing (3 credits): Use of satellite and aircraft-borne sensors to acquire information about earth resources. Spectral analysis in IR and visible wavebands, image processing. Prerequisites: Graduate standing and CEG 303.

SEG 704 GIS Applications in Resource Mapping (3 credits): Use of geographic information systems to map and analyze urban and natural resources, including mapping of roadways, land ownership, utilities, sensitive habitat, vegetation, accident statistics, air quality data and populations. Use of GIS in risk analysis. Prerequisites: Graduate standing and CEG 304.

SEG 705 Advanced Global Positioning (3 credits): Advanced topics in determining location on the surface of the earth, and fundamentals of data processing to remove positional errors. Prerequisites: Graduate standing and CEG 305.

3. Representative course of study by year (options, courses to be used with/without modification; new courses to be initiated).

Program of Study by year: M.S. Geomatics

Year 1

Fall Semester

Course	Type	Credits
SEG 601 Surveying Professional Ethics	new	1
SEG 603 Surveying Practice and Laboratory	new	4
SEG 704 GIS Applications Resource Mapping	new	3
Total		8

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Spring Semester

Course	Type	Credits
Select one from:		
SEG 602 Public Lands Surveying	new	3
SEG 604 Land Development Design and Lab	new	4
SEG 701 Advanced Geodesy	new	3
SEG 703 Remote Sensing	new	3
Total		9-10

Year 2

Fall Semester

Course	Type	Credits
SEG 705 Advanced Global Positioning	new	3
XXX 7yy Application area course #1	existing	3
SEG 797 Master's Thesis	new	3
Total		9

Spring Semester

Course	Type	Credits
XXX 7zz Application area course #2	existing	3
SEG 797 Master's Thesis	new	3
Total		6

XXX represents course in BIO, CHE, CEG, GEO, MEG, WRM etc.

Total graduate credits for degree: $8 + 9-10 + 9 + 6 = 32-33$ credits

4. Program entrance requirements.

Graduate program entrance requirements would be similar to those for other graduate programs at UNLV, including:

1. Minimum undergraduate overall grade-point average of 2.75 on a 0-4 scale, or 3.0 in the last two years in the major.
2. Satisfactory performance on the general aptitude (analytical, quantitative, verbal) portion of the Graduate Record Examinations.
3. Three letters of recommendation.
4. For students with a native language other than English, satisfactory performance on the Test of English as a Foreign Language (TOEFL).

5. Program completion requirements (credit hours, grade point average; subject matter distribution, prerequisites).

A. Credit hours

The M.S. degree requires a satisfactory completion of a minimum of 32-33 credits for graduation. This credit requirement is similar to the requirements for other engineering graduate programs at UNLV. Students entering the program with deficiencies in mathematics,

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sciences or surveying will be required to satisfactorily complete the necessary undergraduate classes, and may need as many as 52 additional credits to graduate.

B. Grade point average

1. A minimum 3.00 overall GPA is required for graduation, including undergraduate courses taken to rectify background deficiencies.
2. Graduate students must complete any required undergraduate courses in mathematics (MAT), civil engineering (CEG), chemistry (CHE), physics (PHY) or biology (BIO) with grades of C (2.00) or better.
3. The minimum passing grade in the graduate program is C (2.00), and no more than one passing grade less than B (3.00) will be allowed in graduate-level courses.

C. Other graduation requirements

Fundamentals of Land Surveying Examination

Graduate students interested in licensure as land surveyors should take the National Council of Examiners in Engineering and Surveying (NCEES) Fundamentals of Land Surveying (F.L.S.) Examination, administered by the Nevada State Board of Professional Engineers and Land Surveyors, in the semester prior to anticipated date of graduation.

D. Subject matter distribution

The proposed curriculum for the Master of Science degree in Geomatics has four components.

1. Basic graduate courses in Surveying and Geomatics, 8-9 credits. Courses intended to develop skills similar to those expected in a graduate from a 4-year degree program in surveying. Entering graduate students with satisfactory prior background in these areas may replace listed 600-level courses with other graduate-level courses in surveying, natural sciences and engineering.
2. Advanced graduate courses in Surveying and Geomatics, 12 credits. Courses intended to expose the student to the state of the art in geodesy and global positioning, and to develop advanced skills in resource mapping and remote sensing.
3. Outside-of-department application area courses in natural sciences and engineering, 6 credits. Courses intended to provide the student with background knowledge in areas appropriate to the mapping and analysis of urban or natural resources.
4. Thesis credits, 6 credits. Credits for carrying out a research project and writing a master's thesis.

6. Accreditation considerations

A. Accrediting Organization. Although the University will seek accreditation of the B.S. Surveying Engineering degree from Accreditation Board for Engineering and Technology (ABET), it is proposed that the University not seek accreditation for the M.Sc. in Geomatics. Instead, accreditation will be under the general university accreditation from the Northwest Association of Colleges and Universities. Additionally, the M.Sc. Geomatics program will be subject to periodic internal and external program reviews, in a manner consistent with program reviews carried out for other graduate degrees in the College of Engineering.

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B. Accreditation requirements. Although accreditation will not be sought for the M.Sc.in Geomatics, it is important to note that the most recent ABET statement on accreditation of undergraduate programs in surveying indicates a need for:

1. A minimum of three full-time equivalent faculty be devoted to the baccalaureate program.

Since a minimum of three full-time equivalent faculty must be devoted to the undergraduate program, additional FTE faculty should be committed to the graduate program. The current program proposal requests a minimum of one additional full-time equivalent faculty over and above the staffing needed by the undergraduate program.

2. Adequacy of institutional resources (space, equipment, operating funds) to support the program. The space, equipment, and operating funds to be committed to the undergraduate program will provide most of the support needed for the graduate program. Modest additional increases in space and equipment will be needed for the graduate program, including two additional TA's, one additional faculty office, one additional graduate student office, and slight increases in equipment and operating budget to support the graduate degree program.

C. Plan for attaining accreditation. Although the University will not seek accreditation for the M.Sc. Geomatics degree, it is recommended that an external graduate program review be initiated in the fifth year of the graduate degree program. This timetable would be sufficient to develop the graduate curriculum, hire graduate faculty, obtain and perform funded research, and generate the first graduates from the program. A detailed timetable for development of an accredited undergraduate program has been developed by David Gibson, the University's consultant on development of the Surveying Program. The timetable is attached to this proposal. Development of the undergraduate program under this timetable would also lead to development of most of the resources needed for the graduate degree program, and the graduate program timetable would be nearly identical to that developed for the undergraduate degree program. It is also proposed in the B.S. Surveying Engineering program proposal that an external consultant be retained to make an annual visit to the University to evaluate progress towards accreditation. This evaluation visit could also be used to assess progress in the graduate degree program. Because resources intended for the undergraduate program will also be used for the graduate program, the timetable proposed for the graduate program is linked to the undergraduate program. The combined timetable is shown below:

1. Fall 2001 - Spring 2002. Conduct search and hire surveying engineering Program Director, with start date of Fall 2001. Receive first consultant visit to evaluate progress.

2. Fall 2002 - Spring 2003. With assistance of Civil Engineering Chair, Surveying Program Director begins development of courses and laboratory/equipment resources. Teach two undergraduate courses per term. Conduct search and hire second faculty member at tenure-track assistant professor level. If resources are available, search for and hire a second faculty member who can begin development of the graduate curriculum. Admit first undergraduate students to program. Receive second consultant visit to evaluate progress.

3. Fall 2003 - Spring 2004. Continue development of courses and resources. Admit first graduate students to program. Teach four to six undergraduate courses per term. Conduct search and hire third (or fourth, if two were hired the year before) faculty member at tenure-track assistant professor level. Receive third consultant visit.

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4. Fall 2004 - Spring 2005. Complete development of laboratory and equipment resources. Develop accreditation document for submission to ABET in Spring 2005. Teach minimum of eight courses per term. Possibly hire fourth tenure-track faculty member, if not hired the year before. Receive fourth consultant visit.

5. Fall 2005 - Spring 2006. Receive ABET accreditation visit in Fall 2005. First M.Sc. Geomatics students graduate in Fall 2005. Continue to teach minimum of eight courses per term. Receive and respond to ABET evaluation in Spring 2006. Continue to graduate baccalaureate students from the program.

6. Summer 2006 - receive results of undergraduate program accreditation.

7. Fall 2006 - Spring 2007. Continue to teach eight courses per term, and improve program per ABET recommendations. Continue to graduate students from B.S. Surveying Engineering and M.Sc. Geomatics graduate programs.

5. Evidence of approval by appropriate committees of the institution.

At the date of writing of this draft (November 6, 2000), proposed BS Surveying Engineering and MS Geomatics program approval had been obtained by the Department of Civil and Environmental Engineering, and the College of Engineering program and curriculum review committee. University-level committee approvals have not yet been obtained. Prior to submission to the System, the draft program proposal will be submitted for review and approval by:

- a. the new Dean of the College of Engineering, Ron Sack;
- b. University Curriculum Committee;
- c. University Priority and Program Review Committee;
- d. Review by the Provost and President of UNLV;

The Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors (NSBPELS) will also be contacted for review and comment on the draft MS program proposal. NALS (December 8, 1999) and NSBPELS (January 15, 2000) have written letters of support for the proposed BS Surveying engineering proposal.

The program proposal will be modified to reflect the inputs of the above reviewers, and this section of the proposal will be modified to report the results those reviews.

IX. Readiness to begin program.

A. Faculty strengths (specializations, teaching, research, and creative accomplishments.

The following Civil and Environmental Engineering department faculty have specializations in teaching and research that are applicable to the proposed M.Sc. Geomatics program.

1. Dr. Barbara Luke, Assistant Professor, has taught CEG 121, Elementary Surveying, and uses Global Positioning System technologies in her research programs. Along with Dr. Shashi Nambisan, P.E., she has received grant funding to use and develop GPS technologies in civil engineering instruction and research.

2. Dr. Shashi Nambisan, PE, Professor, has expertise in use of Geographic Information Systems technology and has received grants totalling over \$1,000,000 in the last five years to conduct applied GIS research on traffic safety, hazardous materials routing, and inventory of publicly owned infrastructure, including utilities and roadways. Dr. Sathisan has also received a

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grant with Dr. Barbara Luke to acquire state-of-the-art Global Positioning System technology, and apply it to instructional and research problems in civil engineering.

3. Dr. Walter Vodrazka, PE, Professor, and Associate Dean of the College of Engineering, regularly instructs civil engineering courses that would be used in the Surveying Engineering program, including:

- a. EGG 307 - Engineering Economics
- b. CEG 409/609 - Engineering Project Management
- c. CEG 466/666 - Geometric Design of Highways, similar to
SEG 405 - Highway Geometric Design

CEG 609 and CEG 666 could serve as graduate electives in the M.Sc. Geomatics program.

4. The department has several adjunct faculty who serve as instructors in the following subjects:

a. Elementary Surveying. Mr. Tom Barnes, PLS, and Mr. Byron Johnson, PLS. It is anticipated that Messrs. Barnes and Johnson would provide instruction in SEG/CEG 121 if the B.S. Surveying Engineering program proposal is approved.

b. GIS Applications in Civil Engineering, CEG 468/668. Mr. Jeff Jensen and Mr. Bob Puterski have regularly taught this class, which could be an application area elective in the M.Sc.G. program.

5. Dr. Mohamed Kaseko, Associate Professor, has taught CEG 467/667, Computer Applications in Transportation, which could be an application area elective in the M. Sc.G. program.

B. Contribution of new program to department's existing programs (both graduate and undergraduate) and contribution to existing programs throughout the university.

1. Department's existing programs

It is anticipated that the proposed graduate program in Geomatics would have a substantial positive benefit on the department's undergraduate and graduate programs in Civil Engineering. Surveying and geomatics are essential to the civil engineering profession, where engineers use surveying tools and skills to check the alignments, elevations and locations of roadways, utilities, tunnels, bridges and buildings. Civil engineers also use surveying skills to estimate volumes of earth needed for addition or removal to sites, to estimate land slopes and also to estimate changes in elevation that occur over time (land subsidence). Currently, all civil engineering majors at UNLV are required to take one introductory course in land surveying, and they must use this surveying knowledge in advanced courses in hydrology, foundations and geographic information systems. Civil engineers must frequently interact with professional land surveyors, who generate and graphically organize the information that engineers use in their designs. Currently, three courses offered in the Civil Engineering Department, CEG 121, CEG 423 and CEG 468/668, could be cross-listed and incorporated into a B.S. Surveying Engineering program.

The addition of surveying faculty and equipment to the department would significantly enhance its ability to compete for external research funding in fundamental and applied areas of positioning technology, geographic information systems and remote sensing. Addition of surveying skills would enhance the department's ability to perform quality research in such areas as:

- a. Accurate location of sites for environmental sampling,
- b. Accurate determination of extent of contamination of soil and ground water
- c. Accurate measurement of expansion and subsidence of soils and foundations,

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- d. Accurate location of physical infrastructure
- e. Accurate estimation of terrain elevations and ground slopes

The Civil and Environmental Engineering department's inventory of surveying, positioning, and GIS technology would be enhanced by development of instrumentation for the Surveying/Geomatics program as additional total stations, sub-meter resolution GPS systems are acquired for the Surveying Engineering program.

2. Academic programs throughout the University

Several academic programs at UNLV have needs for surveying related skills and could provide opportunities for interdisciplinary collaboration and research. The Department of Mechanical Engineering uses accurate digital terrain maps in models that compute the trajectories of winds in the atmosphere. Geosciences has needs for surveying skills to accurately map the locations of geologic resources such as ore bodies and rock formations. Surveying and mapping skills are needed to accurately track dislocations across active faults and inflation and deflation of active and dormant volcanoes. Surveying and mapping of distributions of plants and animal habitats is carried out by the Biological Sciences department, and surveying and mapping of archaeological resources is performed in the department of Anthropology. Health Physics conducts research on the isotopic content of sediment cores, and needs accurate determinations of core positions. Additional resource mapping and analysis needs could emerge in the Environmental Studies Program.

3. Completed prior planning for the development of the program (recent hires, plans for future hires, securing of space, curricular changes, and reallocation of faculty lines.

a. Recent hires - The proposed program has not affected the nature of recent hires. Recent hires, including two in construction engineering and management and one in environmental engineering, were made in response to significant programmatic needs that were developed before the need for surveying/geomatics became apparent.

b. Plans for future hires - The department seeks faculty lines for Surveying Engineering / Geomatics that are in addition to needs developed for civil engineering. Since the mid 1990's, the department has made it a goal to develop a nucleus of three faculty in each of the following areas of specialization, environmental (2 currently), geotechnical (2 currently), structural (2 currently, with a third position now open and search underway), construction (3 currently), transportation (2^{1/2} currently), water resources (2 currently). Given the significant growth needs in southern Nevada and the southwest, and projected growth in student enrollments, the department requests that its priorities for faculty lines within its current specialty areas be retained, and that four surveying engineering positions (three undergraduate and one graduate) be developed in addition to the four slots needed to bring civil engineering up to a strength of 3 faculty in each existing specialty area.

c. Reallocation of faculty lines - Currently, there are no anticipated faculty departures from the department. With an average of two faculty in each specialty area, and a need for at least two undergraduate and two graduate courses per semester in each specialty area, the department is at minimal strength in each specialty area for adequate delivery of course instruction for its B.S., M.S. and Ph.D. degrees in Civil Engineering. If such departures were to take place, it would be in the best interest of the department to replace departing faculty members with someone in the same specialty area. The department would oppose any reallocation of existing faculty lines from civil engineering to surveying / geomatics.

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d. Securing space - Space in the Tiberti Engineering Complex is not currently adequate to house the surveying / geomatics program. For the short-term, until a major addition to the Tiberti Complex can be funded and constructed, space elsewhere on campus is needed for the program. It is anticipated that space could be made available in the Facilities Management Buildings A and B, when they are vacated sometime in the year 2001. If the proposed surveying / geomatics program is given priority, office and laboratory space in FMA and FMB would be sufficient for its initial needs. Plans for program space needs are detailed in Section XI of this proposal.

e. Curricular and equipment changes

Curriculum

The Department of Civil and Environmental Engineering recently approved EGG 323 - Public Lands Surveying, to be taught via a distance education. EGG 323 would later become a SEG course, SEG 405, in the Surveying Engineering program. The department is also seeking a part-time instructor to offer CEG 423, Advanced Surveying, as a civil engineering elective in Fall 2000. CEG 423 could be developed into a 600-level course, CEG 623, for beginning graduate students in surveying/geomatics.

Equipment

The department's surveying equipment inventory is now in the process of being combined with equipment donated by NALS to CCSN for their two-year degree program. The combined inventory will be housed on the UNLV campus, and used for field instruction in surveying courses offered by both UNLV and CCSN. This combined inventory would also be made available to the Surveying Engineering program.

4. Recommendations from prior program review and/or accreditation review teams.

As of the date of this writing, November 6, 2000, there have not been any prior program review or accreditation reviews of Surveying Engineering/Geomatics program proposals at UNLV. This document is the first graduate program proposal for the M.S. Geomatics degree. It is planned that this program proposal will be reviewed by several external organizations and agencies that have strong interests in the success of the program, including:

- a. The Nevada Association of Land Surveyors
- b. The Nevada State Board of Professional Engineers and Land Surveyors

Comments from these bodies will be incorporated into a revised version of the proposal.

5. Organizational arrangements that must be made within the institution to accommodate the program.

a. Additional faculty lines.

Faculty lines in addition to those planned for civil engineering should be developed for Surveying Engineering/Geomatics. The minimum number of faculty allowed by ABET for a separate undergraduate engineering discipline is three. At least one additional position would be necessary to maintain a viable graduate program. Four lines, with one at the senior level, and three at the assistant professor level, represent approximately \$260,000 - \$310,000 per year in faculty salary and benefits.

b. Initial faculty hire.

The first faculty hire in Surveying Engineering should be at a senior level (Associate or Full Professor) with tenure, and this first hire should be designated the Program Director for Surveying, with reduced teaching responsibilities that allow for a major effort in the development of curriculum, contacts, funded research and facilities.

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c. Support staff.

The level of institutional support for administrative and technical positions needs to be improved if the department's programs are to remain viable. It is vital that one additional management assistant and one additional laboratory technician position be authorized for the department if the Surveying Engineering/Geomatics program is approved. If the B.S. Surveying program attracts 60-100 undergraduate majors, 30 graduate students, and four faculty in the first five years, the department would be faced with trying to manage the needs of 20 faculty and 480 majors in eight degree programs with its current staffing of only two management assistants and one shop technician.

d. Graduate assistantships.

The Department of Civil and Environmental Engineering currently has 12 graduate assistant positions to meet the needs of 16 faculty and 300 undergraduate majors in civil engineering and construction management. The departmental allocation should be increased to at least 19 positions if the Surveying Engineering/Geomatics program is approved. Here are the reasons:

1. The department did not receive any additional assistantships when Construction Management was added to the department's responsibilities. The department has had to allocate assistantships from civil engineering to construction management to cover laboratory and grading responsibilities in that program. Three additional computer laboratory courses are being offered each semester in Construction Management. The department should receive three additional GA's to support the Construction Management B.S. and M.S. degree programs, but has currently received none. If three TA's are eventually awarded to support the Construction Management program, the department would be at 15 TA's.

2. If the Surveying Engineering/Geomatics program is approved, and three faculty, 60 students and eight classes per semester are added, including four laboratory sessions per semester in Fall (CEG 201, SEG 121, SEG 201, SEG 303), and six laboratory sessions per semester in Spring (CEG 201, SEG 121, SEG 202, SEG 304, SEG 403, SEG 404), the department will not be able to meet programmatic needs with 12 or 15 teaching assistants. A minimum of four additional state-supported graduate assistantships is needed to support Surveying laboratories and grading in Surveying classes.

X. Resource Analysis.

1. Proposed source of funds (enrollment-generated state funds, reallocation of existing funds, grants, other state funds).

a. Enrollment-generated state funds

Assuming an average of 9 graduate credits per head-count in the program, and fees of \$96 per graduate credit hour, development of the Surveying Program would provide the following additional student-generated revenue in each of the following planning years:

1 st year (Fall 2002)	<u>4</u>	x 2 semesters x 9 credits x 96 \$/credit = \$6,912
2 nd year (Fall 2003)	<u>11</u>	x 2 semesters x 9 credits x 96 \$/credit = \$19,008
3 rd year (Fall 2004)	<u>17</u>	x 2 semesters x 9 credits x 96 \$/credit = \$29,376
4 th year (Fall 2005)	<u>20</u>	x 2 semesters x 9 credits x 96 \$/credit = \$34,560
5 th year (Fall 2006)	<u>22</u>	x 2 semesters x 9 credits x 96 \$/credit = \$38,016

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These figures represent revenue to the state from student in-state tuition, and do not represent funds received by the department to operate the program.

b. Reallocation of existing state funds - The department's 1999-2000 and 2000-2001 operating budgets have been \$52,000. The department received a small amount (\$6,000) for state equipment dollars at the end of FY 1999-2000, the first allocation in three years (however, some student technology fee money was made available to the department in February 2000), and has no state funds for faculty or student travel. The operating budget is adequate for office supplies, part-time office help and general office suite software licensing of the Civil Engineering, Transportation, and Construction Management degree programs. It is conceivable that office support expenses for the first year of the Surveying Engineering/Geomatics program could be accommodated by this budget, but beyond year 1, funds in this account would not be sufficient to cover Surveying Engineering/Geomatics expenses.

Annual fees for licensing of the GIS, CAD, GPS and remote sensing software to be used by the Surveying Engineering/Geomatics program are expected to be very high, on the order of \$35,000 - \$40,000 per year, and these expenses would wipe out the department's current operating budget.

c. Gifts - Given historical levels of state funding support for other programs at the University, it is apparent that a significant portion of program funding may have to come from outside support. The UNLV Foundation's Director of Development for Engineering and Science, Jack Jenks, has already initiated a fund-raising campaign with the Nevada Association of Land Surveyors, and NALS has indicated a willingness to develop an initial level of external support in the range of \$20,000 to \$30,000 per year for the program, along with donations of equipment. An endowment for a complete scholarship for one student is under discussion.

d. Grants - It is anticipated that significant research funding opportunities exist in surveying and geomatics. The rapid development and incorporation of remote sensing technologies from satellites and aircraft, global positioning technologies, Geographic Information Systems technology, and laser-based measurement systems has created significant funding opportunities for incorporating these technologies into traditional surveying and mapping activities. Although the primary efforts of surveying/geomatics in the initial years will be focused on curriculum and program development, David Gibson, the surveying program consultant estimated that a minimum level of \$100,000 per year in surveying/geomatics research funding should be easily attainable in the first few years of program operation.

2. Each new program approved must be reviewed for adequate full-time equivalent (FTE) to support the program in the fifth year. Estimate the following:

a. full-time equivalent fall enrollment for the first, third, and fifth year.

Computed assuming that, during the first five years of program operation, 1/3 of each year's fall head-count will be full-time (15 credits) and 2/3 will be half-time (9 credits)

1st year (Fall 2002) 2

3rd year (Fall 2004) 9

5th year (Fall 2006) 12

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b. total headcount fall enrollment for the first, third, and fifth year.

Computed assuming matriculation of 5 students in year 1, and 10 students in year 2 and thereafter, with graduation rates slowly building from 3 in year 3 to 8-10 in year 5 of the program. These estimates are based on anticipated needs for surveying licensing in the state of Nevada of 40 per year, with 10 per year of this rate being met by persons with other degrees first completing the M.Sc. Geomatics degree to assist their qualifications for licensing as Land Surveyors.

1 st year (Fall 2002)	4
3 rd year (Fall 2004)	17
5 th year (Fall 2006)	22

3. Budget projections (revenue and expenditures) for each of the first three years, including:

a. revenue and expenditures associated with the program itself, (except for identical figures for grants, these values for the M.Sc.G graduate program, represent revenues and costs over and above those expected for the B.S. Surveying Engineering program.)

	Revenue students ¹	gifts	grants	Expenditures operating	salaries ²	equipmnt ³
1 st year (Fall 2002)	6,912	0	0	3,800	0	6,000
3 rd year (Fall 2004)	29,376	5,000	50,000	6,800	70,000	0
5 th year (Fall 2006)	38,016	10,000	100,000	8,400	80,000	0

¹Tuition revenue does not come back to the program directly

²Salaries include estimated fringe benefits, and assume one additional faculty in years 3 and 5 of the program, over and above those needed for the B.S. Surveying Engineering program.

³Equipment costs shown here skip over year 4, where computer replacement will require another \$6,000 in funds.

b. institutional financial support to be reallocated to accommodate the program,

At the time of writing of this draft (November 6, 2000), no plans for reallocation of institutional support have been made. As previously discussed, the current Civil and Environmental Engineering department operating budget could probably accommodate Surveying Engineering start-up operating costs in year 1, but after that, existing funds are inadequate to support the program.

c. full-time equivalent (FTE) faculty,

One full-time equivalent faculty in addition to the three requested for the B.S. Surveying Engineering program, and two additional part-time (one course per semester) graduate faculty (again in addition to those requested for the B.S. program) are needed to provide the minimum

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level of instructional support needed for a viable graduate program.

d. classified staff, professional staff, and graduate assistants,

1. Classified staff. Requests are identical to those needed for the B.S. Surveying engineering program. No additional classified staff resources are requested for the graduate program.

a. An additional half-time management assistant (which when combined with the half-time position authorized for the construction management program) adds to a full-time position.

b. An additional full-time laboratory/shop technician - approved with the department's Ph.D. program in 1991 but never authorized, is needed.

2. Professional staff - none

3. Graduate assistants - four additional graduate assistants to support anticipated demand for laboratory and classroom support

e. operating funds,

Expected operating funds needed in the first five years of the program are shown below. The bulk of the costs in years 2 through 5 are from annual licensing fees for the remote sensing, global positioning, and GIS software:

Year 1	\$3,800
Year 2	\$5,400
Year 3	\$6,800
Year 4	\$7,700
Year 5	\$8,400

f. library and information resources, and

Library funds will be needed to support subscription costs (print or on-line) for four major journals, shown below:

1. American Congress on Surveying and Mapping (ACSM) Surveying and Land Information Systems Journal
2. ACSM Cartography and Geographic Information Systems Journal
3. American Society for Photogrammetry and Remote Sensing (ASPRS) Photogrammetric Engineering and Remote Sensing Journal
4. Urban and Regional Information System Association (URISA) Journal

Interlibrary loan services should be available for specialized needs, and World-Wide Web / Internet access should be available to surveying faculty and students in their offices and laboratories.

g. other,

Significant start-up equipment costs can be anticipated for first two years of the B.S. surveying program. Modest equipment costs can be anticipated in years 4 and 5 as computer systems acquired during years 1 and 2 are replaced on a 3-year cycle. Additional graduate program costs are modest, comprising additional computers and software for the additional faculty and graduate students to be associated with the M.Sc.G. program. Estimated costs for years 1 through 5 of the program are shown below:

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	Undergraduate	Graduate
Year 1	\$49,000	\$6,000
Year 2	\$93,500	\$0
Year 3	\$0	\$6,000
Year 4	\$10,500	\$0
Year 5	\$16,500	\$0

4. **Estimated budgetary and financial ramifications for the institution.**

Anticipated expenditures in year 1 of the program, \$9,800, represent less than .01% of UNLV's current level of state support. Anticipated expenditures in year 5 of the program, \$88,400, represent approximately .09% of UNLV's current level of state support. The graduate program is fairly inexpensive to operate because most of the costs are incurred in the development of a viable accredited undergraduate program. The undergraduate program is expensive in comparison to programs of similar size in other departments because of anticipated high costs to maintain state-of-the-art computers and up-to-date software licenses in the program's instructional laboratories.

Given past levels of state funding, and anticipated slow or no growth in state funding for UNLV, a major effort in external fund raising will be necessary to develop a viable surveying/geomatics program.

5. **Impact of new program on department's existing resources.**

The department

- a. Has adequate surveying equipment to support the lower division and several upper division classes in surveying engineering/geomatics.
- b. Has adequate operating funds to support year 1 of the surveying engineering/geomatics program.
- c. Does not have adequate operating funds to support year 2 or beyond.
- d. Does not currently have the equipment budget to acquire equipment or computers needed for photographic analysis, CAD, GIS, Geodesy, or remote sensing analyses.
- e. Does not have open faculty lines that can be reallocated to surveying engineering.
- f. Does not have adequate classified staff to support the surveying engineering/geomatics program.
- g. Does not have adequate space to support the surveying engineering/geomatics program.
- h. Does not have adequate numbers of state-funded graduate assistantships to support the proposed surveying engineering/geomatics program.

XI. **Facilities and equipment required.**

1. **Existing facilities: type of space required, number of assignable square feet, space utilization assumptions, special requirements, modifications, effect on present programs.** Facilities needed for the combined surveying/geomatics program are listed below. Graduate program facilities are listed in *italics*.

a. **Existing facility:**

Equipment storage locker - The department's current storage locker space is anticipated to be adequate for storage of both civil engineering and surveying engineering field equipment. It

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has about 220 assignable square feet and can be secured with a Marlock key. No modifications are required.

b. Other department space:

Current departmental laboratory and office space is inadequate for the department's existing programs. Four faculty groups, geotechnical, structural, water resources, and transportation, are housed in trailers and buildings external to the Tiberti Engineering Complex, some 300 yards and 500 yards away from the building. Departmental faculty are housed in two separate buildings, and existing structural, fluid mechanics, geotechnical and environmental laboratories must combine teaching and research functions, requiring constant shifting and displacement of instructional apparatus and occasional displacement of research setups to accommodate instructional needs. The Transportation Research Center lacks space for its records and personnel. The College's CAD laboratory must be shared by civil engineering, construction management and mechanical engineering, and it will be booked for over 50 instructional hours per week in Spring 2000. This level of activity will increase in Fall 2000 and Spring 2001.

c. Space utilization assumptions:

It is assumed that:

1. Each surveying engineering/geomatics faculty will be assigned their own office, and that, at minimum, three 180 square foot offices will be needed for the three FTE undergraduate faculty to be hired, *and one 180-square foot office for one graduate FTE faculty.*
2. One 1000 square-foot laboratory dedicated to photogrammetry, and one 800 square foot laboratory dedicated to GIS instruction will be needed,
3. Two hundred square feet will be needed for a management assistant, files and supply storage,
4. Three hundred square feet will be needed for a shop technician, work benches and lockers,
5. Two 180 square foot shared offices will be needed for graduate assistants, *and one additional 180 square-foot shared office will be needed for graduate assistants supporting the graduate program.*

d. Effect on current programs:

There is no room for Surveying Engineering laboratories to be incorporated into existing departmental or College space.

1. To avoid displacing existing Civil, Mechanical or Construction Management classes, surveying laboratory classes could only be taught on weekends in the existing space.
2. Creating a dedicated surveying engineering photogrammetry lab in existing space would require displacement of some other departmental or college function.
3. Adding surveying engineering faculty to existing office space would require faculty to share offices, with a detrimental effect on the quiet time needed for writing of proposals and publications.

- 2. Additional facilities required: number of assignable square feet, description of space required, special requirements, time sequence assumed for securing required space.** Facilities listed herein are for the undergraduate program, with additional graduate program facilities noted.

a. Description of space required and number of assignable square feet

Classroom - The department anticipates the following course offering schedule for classes in surveying engineering:

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Fall 2002, Spring 2003 - one full-time faculty teaching two classes each semester, each initially enrolling an average of 10 students - and one part-time faculty teaching one class each semester, each enrolling 10 students, *requires three scheduled 10-seat classroom slots each semester*,

Fall 2003, Spring 2004 - two full-time faculty teaching four classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling 20 students, *requires five scheduled 20-seat classroom slots each semester*

Fall 2004, Spring 2005 and subsequent years - three full-time faculty teaching six classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling an average of 20 students, *requires eight scheduled 20-seat classroom slots each semester*

By Fall 2004, one classroom would need to be reserved for the entire day, for a minimum of three days per week, to meet the needs of the surveying program.

Laboratories - The department anticipates needing the following dedicated facilities to support the surveying program

1. A 1000 square-foot computation and mapping laboratory, consisting of seven IBM-compatible personal computers with surveying software, and seven photogrammetric workstations with GPS reduction and image analysis software. This facility does not exist, and would be dedicated to the surveying/geomatics program.

2. An 800 square-foot GIS laboratory consisting of 15 workstations for geographic data analysis and processing. This facility does not exist, and would be shared between the surveying/geomatics and civil engineering programs. It is estimated that six of these workstations would be needed by the surveying/geomatics program.

Office space - The department anticipates the following additional office space needs for the surveying/geomatics program.

1. Three 180 square-foot faculty offices - added at a rate of one office per year for 2001, 2002, 2003, *with one additional office added when graduate FTE faculty is hired.*

2. Two 180 square-foot graduate assistant offices, with each office used for 2 TA's, *with one additional office needed for TA's supporting the graduate program.*

3. One 100 square-foot management assistant space - for desk and filing cabinets,

4. 50 square-feet as a storage area for office supplies,

5. 50 square-feet of secure space to house program administrative records,

Ideally, the surveying faculty and graduate assistant office cluster, and the surveying/construction management secretarial desk would be located near the surveying laboratories to provide ease of communications for students, staff and faculty.

b. Time sequence for securing required space

Classroom - By Year 3 of the program, when all required courses will be taught a classroom will need to be scheduled to surveying engineering/geomatics at least three full days per week.

Laboratory - By Year 2 of the program,

1. a laboratory space dedicated to photogrammetric analysis and surveying instruction must be located and set up, and

2. a civil engineering/surveying engineering shared GIS laboratory must be located and set up

Office space

1. Faculty offices, one new faculty office will be needed for the program in each of Years 1, 2, 3 and 4.

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2. Management assistant office, one new management assistant space needs to be identified for the program by Year 2.
3. Shop technician desk space - one new work area and desk for a second shop technician needs to be identified by Year 1 of the program.
4. One new graduate assistant office needs to be located for the program in each of Years 2, 3 and 4.
5. Office supply and file storage space needs to be identified for the program by Year 2.

c. Special requirements

1. Classroom. Needs minimum number of 20 seats and multimedia capability.
2. Laboratory. Photogrammetry laboratory should be large enough to accommodate Kelsh or similar analog stereoplotter, which is a very large (12 feet long) piece of equipment. All laboratories should have Ethernet/Internet networking
3. Office space. Ethernet/Internet access and faculty/GA/management assistant offices located in close proximity to each other (in a "cluster") would enhance communications and collaboration within the program.
4. File and supply space. Files should in a secure location and in close proximity to the management assistant's desk.

3. **Existing and additional equipment required.** Needs shown here are for the undergraduate program. No additional equipment will be needed for the graduate program.

a. Field equipment: UNLV's existing surveying field equipment should be adequate for the initial instructional activities. The local profession has loaned CCSN two total station surveying instruments, and these will soon merged with UNLV's more traditional surveying equipment. The program should have the following within the first two years of operation:

- Six or seven "lockers" of full sets of field equipment: optical theodolites, tapes, levels, level rods. This equipment is currently available.
- Three total station electronic surveying instruments with retro-reflectors with digital data recording capabilities. When combined with NALS equipment loaned to CCSN, two stations are currently available
- Data collection software (TDS or SMI) with each student having a HP48 for field data recording. This capability is not available.

It appears that only data collection hardware and software may be needed at the current time, supplemented by an additional total station instrument package. (estimated additional cost \$10,000)

b. Computational equipment: Once field measurements are taken, a considerable amount of computation and mapping is performed that requires specialized software. The program should have:

- A minimum of three AutoCAD PC computer stations that are fully accessible by surveying students within the first year of program operation. By the end of the five year period, there should be from five to seven stations where surveying students have full access. (estimated cost \$2,500 per seat with AutoCAD)
- Each of these PC's should also have a dominant coordinate geometry (COGO) software set such as Softdesk, or Eagle Point. This software should work seamlessly with AutoCAD for survey computation and plotting (estimated cost \$1,500 per seat).

A networked 15-seat laboratory (TBE B367) with CAD software is available, but is heavily scheduled for civil, mechanical and construction management. Surveying software must be acquired. Development of a second CAD/GIS instructional laboratory is strongly recommended.

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Photogrammetry instruction will require several specialized sets of hardware or software:

- Seven mirror stereoscopes and precise viewing and measurement of 9x9 air photos. (estimated cost \$2,000 each, total \$14,000).
- One “soft copy” stereo photogrammetric work station hardware and software (estimated cost \$30,000).
- One older analog stereoplotter, Kelsh or similar for demonstration. (no additional cost).
- Image mapping software for image and remote sensing mapping such as ERDAS or similar. (estimated cost \$3,000).

None of this equipment is currently available, however, the vice-president of NALS has secured a verbal agreement with several aerial photo companies to loan their equipment and office space for lab work in the late afternoon and early evening.

Instruction in geodetic surveying and mapping will require global positioning system hardware and reduction software:

- Two geodetic-grade (centimeter resolution) GPS system for static differential and kinematic surveying. (estimated cost \$20,000 each, total \$40,000).
- Two mapping grade (meter resolution) GPS systems. (estimated at \$5,000 each)

One single frequency geodetic grade GPS system with six units is available. A dual frequency geodetic grade GPS two mapping grade GPS systems need to be acquired.

Instruction in geographic information systems will require GIS software. UNLV already has ARC/INFO in its Transportation Research Center. ARC/INFO is the industry leader with a large percent of the GIS market, and this software is recommended. It is not clear whether surveying students would have access to the GIS capabilities of the TRC, but in any case the surveying students should have full access to:

- A networked lab of five PC's running ARC/VIEW. (estimated software costs \$1,500 each)
- At least one seat of “full” ARC/INFO software. (estimated software costs \$12,000)

A networked lab (B367) with GIS ArcView software exists, but is heavily scheduled. Development of a second computer laboratory with instructional capabilities in GIS and CAD is strongly recommended.

XII. Student services required.

1. Plans to provide student services to accommodate the program, including its implications for services to the rest of the student body.

A. Advising. M. Sc. Geomatics students will be advised in a manner similar to advising for Engineering and Construction management graduate students:

1. Incoming students will be assigned an initial faculty advisor to help students with academic planning. Students are required to meet with their advisor every semester to plan their degree program.
2. Graduate students will receive advising on initial course work, expected duties if working as TA's, development of plans of study, and areas of available research support.
3. Student academic records will be maintained in locked file cabinets, with access to each student's file limited to department faculty and staff, and to the student.
5. A comprehensive review of the student's record will take place when the student files paperwork for their Graduate Program of Study, Assignment of Examination Committee, and

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Abstract of Thesis or Professional Paper. This review will be carried out by the student's Research Advisor, the Graduate Program Coordinator, and the Department Chair.

B. Student activities.

1. Graduate students will be encouraged to join the planned student chapter of the Nevada Association of Land Surveyors and participate with surveying practitioners as advisors mentors to undergraduate students.

XIII. Consultants (required for university programs only).

1. Names, qualifications and affiliations of consultant(s) used.

David W. Gibson, Geomatics Program Director at the University of Florida, Gainesville, was retained by the College of Engineering to evaluate the feasibility of establishing a four-year surveying program in Nevada.

2. Summary of consultant's comments and recommendations.

Mr. Gibson completed a report in late October, 1999, titled "A Five-Year Plan for Development of a Surveying Degree Program at the University of Nevada, Las Vegas". Although the report was primarily targeted at developing a plan for an undergraduate program, Mr. Gibson also made recommendations about a graduate program. It was recommended that a M.S. degree in Geomatics be developed simultaneously with the B.S. degree in Surveying Engineering, so that graduate students could be attracted to support faculty research while receiving advanced training in surveying that would prepare them for leadership positions in the field.

The report laid out a detailed curriculum plan, hiring plan, space plan, and implementation schedule for a program in Surveying Engineering/Geomatics. Curricula were proposed for:

- a. A four-year B.S. degree in Surveying Engineering
- b. A two-year M.S. degree in Geomatics
- c. A two-year A.A. transfer degree from Community College

Existing equipment and laboratories were assessed during a site visit, and a plan presented for acquisition of equipment sufficient to initiate the program, along with a listing of the laboratory facilities needed to house and operate the equipment.

A plan for hiring one faculty a year for three years was presented, and an annual visit from an external consultant was recommended in the years leading up to an accreditation visit from ABET.

3. Summary of proposer's response to consultant.

Since acceptance of the final draft by the College of Engineering, the consultant's suggested graduate curriculum was modified to meet UNLV requirements for a minimum number of unique 700-level graduate courses. However, the curriculum in this proposal still adheres to the consultant's recommendation that the areas of geodesy, global positioning, geographic information systems, and remote sensing be emphasized in the graduate curriculum. The report is viewed as a thorough, comprehensive guide to the development of a Surveying Engineering/Geomatics program at UNLV.

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4. Attachment of consultant's complete report.

Please see attachment of complete report from Mr. Gibson dated 10/26/99. Substantial portions of his report have been incorporated into this program proposal with little modification.

Proposal format revised: 10/22/98