Water Science & Management Graduate Course Descriptions

A EN 459. **Design of Water Wells/Pumping Systems:**	**3 cr.**
Design of water wells; selection and specification of pumps and power units. Prerequisite: C E 382	
A EN 475. **Soil and Water Conservation:**	**3 cr.**
Types and extent of erosion. Design and operation of structural and vegetative systems to control erosion. Elements of hydrology. C E 331. Corequisite: C E 382 or consent of instructor.	
A EN 478. **Irrigation and Drainage Engineering:**	**3 cr.**
Design and operation of surface and sprinkler irrigation systems; pumping and conveyances; introduction to principles and practices of drainage systems and wells. Prerequisite: C E 382 or consent of instructor.	
A ST 505. **Statistical Inference I:**	**4 cr.**
A qualitative introduction to the concepts and methods of statistical inference. Sampling, frequency distributions (z, t, x2, F), estimation, and testing. One-way analysis of variance. Simple linear regression. Prerequisite: Consent of instructor.	
AEEC 575. **Advanced Water Resource Management and Policy:**	**3 cr.**
Integrating natural and social sciences, analytical methods, and critical reasoning skills to evaluate water resource issues. Extensive use of data and numerical techniques applied to a variety of water resource topics. Crosslisted with: AG E 475, with additional work required at graduate level. Note: Familiarity with MS Excel or similar software desirable.	
AEEC 580. **Natural Resources and Environmental Policy:**	**3 cr.**
Surveys and analyzes natural resource and environmental policy, both domestic and global, in terms of content and context, policy, processes, policy models, levels of government, and values and ethical positions. Includes public lands policies, private property issues, air and water quality, waste disposal, energy and sustainable development with emphasis on natural resources and agriculture.	

AG E 475. **Water Resource Management and Policy:**	**3 cr.**
Emphasis on integrating natural and social sciences, analytic methods, and critical reasoning skills to evaluate water resource policy and management issues. Extensive use of data and numerical applications applied to a variety of water resource topics. Prerequisite: Junior or above standing. Note: Familiarity with MS Excel or similar software desirable.	
AGRO 620. **Instrumentation in Agronomy:**	**3 cr.**
Use of instruments used in research in all areas of agronomy including gas chromatography, high performance liquid chromatography, neutron soil moisture probe, and other instruments. Same as HORT/SOIL 620.	
AXED 485. **Agriscience Laboratory Applications:**	**3 cr.**
Students learn to set up and teach in a modular Agriscience laboratory, utilizing a variety of technologies. Modules covered may vary from semester to semester, but examples are: aquaculture systems, microscopy, tissue culture, soil and water testing, electrophoresis, hydroponics, global positioning systems, robotics, and presentation technologies. Students may develop their own modules and/or experiments. Prerequisite: Junior or above standing. Graduate students will assist in laboratory set up and delivery.	
BIOL 477. **Applied and Environmental Microbiology:**	**4 cr.**
A lecture-laboratory course on the microorganisms and the reactions they mediate which either impact the environment or have industrial applications. Reading of current literature will be emphasized. Topics include bioremediation, water quality, and aspects of industrial and food microbiology. Prerequisites:: BIOL 311, and 311L, or consent of instructor.	
BIOL 517. **Seminar in Physiological Ecology:**	**3 cr.**
Discussion of original research literature on the physiological responses of organisms and their adaptive value in ecological settings. Examples of plants, animals, and microbes as suited to student interest. Prerequisite: Consent of instructor.	
BIOL 533. **Environmental Physiology of Plants:**	**3 cr.**
Integral responses of plants and crop productivity to naturally occurring and modified environmental factors such as radiation, temperatures, water vapor, carbon dioxide, and air flow. Prerequisite: BIOL 314 or consent of instructor. Crosslisted with: AGRO 533 and HORT 533.	

C E 452. **Geohydrology:**	**3 cr.**
Origin, occurrence, and movement of fluids in porous media and assessment of aquifer characteristics. Development and conservation of ground water resources, design of well fields. Prerequisites: C E 160 or GEOL 111G, and C E 231. Crosslisted with: E S 452	
C E 482. **Hydraulic Structures:**	**3 cr.**
Engineering design of water-regulating structures. Prerequisite: C E 301 and C E 382	
C E 483. **Surface Water Hydrology:**	**3 cr.**
Hydrologic cycle and relationships between rainfall and surface water runoff. Prerequisite: C E 331 or consent of instructor.	
C E 485. **Design of Earth Dams:**	**3 cr.**
Engineering design applied to site selection, foundation inspection and treatment, hydrology and hydraulics, stability, and seepage analysis. Economic and environmental factors. Prerequisite: C E 231	
C E 506. **Advanced Soil Mechanics:**	**3 cr.**
Stress and strain analyses in soil, stress paths; drained and undrained shear strengths of granular soils and clays, consolidation, liquefaction, soil improvement. Prerequisites: C E 457 or consent of instructor.	
C E 525. **Advanced Analysis of Engineering Systems:**	**3 cr.**
Development of engineering systems requiring advanced analytical solutions. Solutions to equations arising from engineering problems selected from the following topics: groundwater flow, beams and plates, electrical potential, heat transfer, structural dynamics, structural stability, solute transport problems, diffusion problems, and others.	
C E 531. **Open Channel Hydraulics:**	**3 cr.**
Theoretical and applied hydraulics of open channels, with emphasis on nonuniform flow, rapidly varied flow, and wave formation. Prerequisite: C E 382 or consent of instructor.	
C E 557. **Water Resources Development:**	**3 cr.**
Students function as members of a consulting panel and prepare reports on major water resources development	

problems. Political, financial, and social aspects of water resources development are considered as well as scientific and technical details. Background: C E 450. Corequisites: C E 483, or C E 482.	
C E 581. **Ground Water Hydrology:**	**3 cr.**
Mathematical treatment of water flow in porous media. Emphasis on hydraulics of water movement, including pumping and recharge wells, drainage, and water quality. Prerequisites: MATH 392, G EN 452, and C E 382, or consent of instructor.	
C E 582. **Statistical Hydrology:**	**3 cr.**
Application of statistical techniques to hydrologic data, including distributions, hypothesis testing, linear models, non-parametrics, and time-series and stochastic models. Background: C E 510, E ST 465, or consent of instructor.	
C E 681. **Topics in Hydrodynamics I:**	**3 cr.**
Selected topics from the following: ideal and real fluids flow; laminar/ turbulent flow; boundary layer; stream function and conformal mapping; hydraulic transients; characteristics of wave phenomena; method of characteristics. Prerequisite: Consent of instructor.	
C E 682. **Topics in Hydrodynamics II:**	**3 cr.**
Selected topics in flow-in open channels, flow-through porous media, and transport of sediments and contaminants. Prerequisite: Consent of instructor.	
CHEM 472. **Analytical Methods for Toxic Organics and Metal Ions in the Environment:**	**3 cr.**
Laboratory course with lectures on principles of analytical techniques related to environmental monitoring of pollutants and waste management. Prerequisite: CHEM 371 or C E 462 or consent of instructor.	
ECDV 651. **Economic Development Theory:**	**3 cr.**
Builds upon a general understanding of microeconomic and macroeconomic theory to focus specifically on theories of economic development at all levels. Prerequisite: AEEC 501 and 502.	

ECDV 661. **Regional Economic Modeling I:**	**3 cr.**
Provides an introduction to the basic tools and methods of regional economic development analysis. Prerequisite: AEEC 501, 502, and 540.	
ECDV 662. **Regional Economic Modeling II:**	**3 cr.**
Continuation of ECDV 661 with focus on more advanced tools and methods of regional economic development analysis.	
ECDV 664. **Population Economics:**	**3 cr.**
Examines the causes and consequences of demographic change. Examines theories of basic demographic processes, population projection and estimation. Prerequisite: Consent of instructor required.	
ECDV 668. **Economic Development Finance:**	**3 cr.**
Focuses on the tools and methods of economic development finance.	
ECDV 671. **Sustainable Economic Development:**	**3 cr.**
Focuses on the interconnections between economic development and the environment. Provides a broad set of tools and ideas related to the impacts of human activities on the environment. Prerequisites: AEEC 501, 502, and 540.	
ECON 455. **Public Utilities Regulation:**	**3 cr.**
Procedures of utility regulation; regulatory theory applied to specific industries; commission regulation compared to public ownership and deregulation. Prerequisites: ECON 252G, FIN 306, or consent of instructor. Crosslisted with: MGT 455	
ENVE 456. **Environmental Engineering Design:**	**3 cr.**
Design of chemical, physical and biological operations and processes involved in water and wastewater treatment. Prerequisite: C E 356	
ENVE 462. **Sampling and Analysis of Environmental Contaminants:**	**3 cr.**
Theory, application, methodology, and instrumentation used in the sampling and analysis of environmental contaminants. Prerequisites: C E 256 and E S 256 Crosslisted with: E S 462	

ENVE 551. **Unit Processes/Operation of Water Treatment:**	**3 cr.**
Theory and applications with unit processes in environmental engineering. Physical / chemical treatment methods emphasized. Prerequisite: Consent of instructor. Corequisite: ENVE 551L Note: Restricted to majors.	
ENVE 551L. **Unit Processes/Operation of Water Treatment Laboratory:**	**1 cr.**
Practical laboratory covering development of design information for common unit operations/process using bench scale and small pilot scale facilities. Prerequisite: Consent of instructor. Corequisite: ENVE 551 Note: Restricted to majors.	
ENVE 552. **Unit Processes/Operation of Wastewater Treatment:**	**3 cr.**
Theory and applications with unit processes in environmental engineering. Biological treatment methods emphasized. Prerequisite: Consent of instructor. Corequisite: ENVE 552L Note: Restricted to majors.	
ENVE 552L. **Unit Processes/Operation of Wastewater Treatment Laboratory:**	**1 cr.**
Dry laboratory emphasizing design of common unit operations/processes in biological treatment. Prerequisite: Consent of instructor. Corequisite: ENVE 552 Note: Restricted to majors.	
ENVE 553. **Chemical Theories of Environmental Engineering:**	**3 cr.**
Theoretical aspects of physical chemistry applied to the solution of environmental engineering problems. Emphasis on carbonate equilibria solubility, buffering and redox conditions. Prerequisite: Consent of instructor.	
ENVE 554. **Microbiological Theories of Environmental Engineering:**	**3 cr.**
The theory and application of microbiology as related to environmental engineering; understanding and controlling the performance of biological unit processes when used in treatment of wastes and wastewaters. Prerequisite: Consent of instructor.	
ENVE 557. **Surface Water Quality Modeling:**	**3 cr.**
Modeling the impacts of waste disposal practices on surface waters. Emphasis on fate and transport of bacteria, dissolved oxygen, nutrients, and toxicants in rivers, lakes, and tidal waters. Note: Restricted to majors.	

ENVE 558. **Advanced Waste Management:**	**3 cr.**
Advanced unit operations/processes of wastewater treatment; pretreatment requirements, flow equalization, neutralization, precipitation, adsorption, air floatation, air stripping, and nutrient removal. Examples drawn from trade waste. Note: Restricted to majors.	
ENVE 630. **Fate and Transport of Environmental Contaminants:**	**3 cr.**
Modeling of transport phenomena in natural and engineered systems for predicting the fate of contaminants in the air, soil, sediment, and water compartments of the ecosystem. Prerequisites: C E 555 and consent of instructor.	
ENVE 631. **Topics in Environmental Engineering I:**	**3 cr.**
Selected topics in treatment of contaminated soils and groundwater; advanced water treatment; environmental modeling. Course subtitled in the Schedule of Classes. Prerequisite: Consent of instructor.	
ENVE 632. **Topics in Environmental Engineering II:**	**3 cr.**
Selected topics in treatment of industrial and hazardous wastes, advanced wastewater treatment, environmental modeling. Course subtitled in the Schedule of Classes. Prerequisite: Consent of instructor.	
EPWS 520. **Environmental Fate of Pesticides:**	**3 cr.**
Mechanisms of pesticide movement, degradation, behaviors and persistence in soil, water, and plants. Experimental and analytical techniques. Prerequisites: CHEM 211, EPWS 311, and EPWS 314.	
FWCE 459. **Aquatic Ecology:**	**4 cr.**
Plant and animal communities in aquatic ecosystems with emphasis on chemical and physical properties, productivity, species interactions, population dynamics, and concepts for diagnosing problems and restoring aquatic ecosystems. Prerequisite(s): FWCE 301 or BIOL 301, CHEM 112G, MATH 142G.	
FWCE 482. **Ichthyology:**	**4 cr.**
Classification, morphology, identification, life history, and ecology of fishes. Prerequisite(s): FWCE 330 or consent of instructor.	

FWCE 532. **Environmental Biology of Fishes:**	**4 cr.**
What makes a fish a fish. Mechanisms of circulation, gas exchange, osmotic and ionic regulation, swimming, migration, reproduction, and chemoreception. Students are responsible for all requirements for FWCE 432 plus additional work.	
FWCE 534. **Aquatic Contaminants and Toxicology:**	**4 cr.**
Basic principles and methodologies of aquatic toxicity testing. Routes of exposure and modes of action. Environmental legislation and ecological risk assessment. Students are responsible for all requirements for FWCE 434 plus additional work.	
FWCE 578. **Advanced Limnology:**	**3 cr.**
Concepts in aquatic production ecology and analytical methods for lake and flowing waters. Prerequisite: Consent of instructor.	
GEOG 467. **Transportation Geography:**	**3 cr.**
Nature and distribution of land, air and water transport facilities and their importance in regional development. Prerequisite: GEOG 120G or consent of instructor.	
GEOG 521. **GIS Applications and Modeling:**	**3 cr.**
Group oriented class in which students conduct an applied research project in a GI Science application or modeling area of choice and conduct focused library research. Prerequisite(s): GEOG 481, or consent of instructor.	
GEOG 552. **Landscape Ecology:**	**3 cr.**
Analysis of the structure, function and change of natural and anthropogenic landscapes. Patches, corridors, matrix and network, spatial organization, landscape dynamics, and role of disturbance in overall functioning of landscapes. Role of landscape heterogeneity in landscape management. Prerequisite(s): Either GEOG 351, BIOL 301, or other basic ecology course or consent of instructor. Same as BIOL 552.	

GEOG 553. **Applied Geomorphology:**	**3 cr. (3+3P)**
Geomorphic concepts applied to human activities that affect landforms. Prerequisite(s): GEOG/GEOL 353 or GEOG/GEOL 453 or consent of instructor. Same as GEOL 553.	
GEOG 571. **Cartography and Geographic Information Systems:**	**3 cr.**
Graduate level design and construction of thematic maps. Introduction to cartographic principles in lecture. Emphasis on map-making using GIS software in the labs. Prerequisite(s): GEOG 281	
GEOG 572. **Graduate Geodatabase Design:**	**3 cr.**
Graduate level introduction to designing geodatabases. The course takes you through the eleven steps of geodatabase design divided into four stages: thematic characterization; developing the database elements, relationships and properties; capture and collection; and finally implementation and documentation. Taught with GEOG 482. Prerequisite(s): GEOG 382.	
GEOG 573. **Introduction to Remote Sensing:**	**3 cr.**
Introduction to the theory, techniques, and applications of remote sensing. Topics include electromagnetic radiation; remote sensing systems; remote sensing of the biosphere, hydrosphere, atmosphere, lithosphere, and cultural landscapes. Course includes lectures and also labs focused on the basic analysis and interpretation of remote sensing products.	
GEOG 577. **GIS CAPSTONE:**	**3 cr.**
Graduate level capstone course in geospatial analysis. Demonstration of competence in the use of Geospatial tools, techniques, and concepts for the solution of applied geographic problems. Software may change from semester to semester. Prerequisite(s): GEOG 373 and 481	
GEOG 578. **Fundamentals of Geographic Information Systems:**	**4 cr. (3+3P)**
Fundamentals of computer-based systems that organize, analyze, and present spatially referenced data. Prerequisite(s): GEOG 571 or consent of instructor.	
GEOG 581. **GIS Design:**	**3 cr.**
A critical aspect of GIS is its ability to provide the necessary products within the organization within which it is implemented. This is an in-depth analysis of currently accepted planning methodologies designed to create	

a successful implementation of GIS inside organizations. Prerequisite(s): GEOG 481 or consent of instructor.	
GEOG 582. **Advanced Remote Sensing:**	**3 cr.**
Introduction to advanced topics in digital image processing, analysis, interpretation, and visualization. Topics include geometric and radiometric correction, image enhancement, image classification, change detection, and accuracy assessment. Lectures focus on the discussion of advanced remote sensing concepts, techniques, and applications; labs are applications-oriented. Prerequisite(s): GEOG 373/573 or consent of instructor.	
GEOG 585. **Advanced Spatial Analysis:**	**3 cr.**
Statistical analyses of point and areal patterns. Emphasis on quantitative research in geography. Prerequisite(s): STAT 251G or A ST 311; or consent of instructor.	
GEOG 586. **Geospatial Techniques for Natural Resource Assessments:**	**3 cr.**
Use of integrated geographic information science and technology (GIS&T, includes remote sensing and geographic information systems) approaches for the monitoring and assessment of environmental issues. Lectures focus on the analysis and evaluation of current uses, potentials, and challenges of GIS&T. Labs emphasize the design and implementation of an original research project that uses GIS&T to model a local or regional environmental issue. Prerequisite(s): GEOG 481/521 and GEOG 373/573 or equivalents.	
GEOL 452 **Geohydrology:**	**3 cr.**
Origin, occurrence, and movement of fluids in porous media assessment of aquifer characteristics. Development and conservation of ground water resources, design of well fields. Prerequisite(s): GEOL 111G and CE 231. Crosslisted with: C E 452 and E S 452.	
GEOL 474. **Ground Water Geology:**	**3 cr.**
Steady-state and transient ground-water flow in porous media: effects of lithology on hydrologic characteristics of aquifers and confining units; Darcy's Law applied to steady-state flow; distribution of hydraulic head in confined and unconfined aquifers; recharge and discharge in regional and local ground-water flow systems; ground-water surface-water interaction; steady-state and transient flow to wells; aquifer testing and evaluation of safe yields. Introduction to numerical flow modeling. Prerequisite(s): GEOL 111G.	
GEOL 515. **Advanced Principles of Geochemical Equilibria:**	**3 cr.**
Theory of thermodynamics and the applications of thermodynamics to geological problems.	

Phase equilibria in water-dominated and magmatic systems.	
GEOL 560. **Geochemistry of Diagenetic and Hydrochemical Systems:**	**3 cr.**
Solution-mineral equilibria and chemical kinetics applied to water-rock interactions, including diagenetic processes in sediments and sedimentary basins.	
HL S 452. **Environmental Health:**	**3 cr.**
Introduction to environmental health designed to address public health issues. Prerequisite(s): Junior or above standing. Crosslisted with: E S 454. Note: Restricted to C HL, HNFS and E S majors.	
M E 530. **Intermediate Fluid Mechanics:**	**3 cr.**
Application of exact and empirical solutions to fundamental flow problems, including viscous and inviscid behavior. These applications establish a theoretical basis for the origin and physical role of common terms in the governing equations. Prerequisite(s): M E 338 or consent of instructor.	
M E 533. **Comp/Theory Fluids:**	**3 cr.**
Application of fluid mechanics theory and computational approaches to advanced flow problems, including viscous/inviscid and laminar/turbulent behavior. Complex flow problems addressed through development of a theoretical formulation, followed by application of fluid dynamic (CFD) tools, and finally presentation and validation of solution data. Prerequisite(s): M E 530 or consent of instructor.	
M E 535. **Turbulence and Chaos:**	**3 cr.**
Classical and Computational Fluid Dynamics (CFD) techniques are used to investigate turbulent flows. Chaos and fractals introduced. Prerequisite(s): M E 530.	
MPH 550. **Environmental Public Health Issues:**	**3 cr.**
Environmental health issues from a public health perspective. Note: Restricted to MPH majors.	
MPH 554. **Environmental Epidemiology:**	**3 cr.**
Covers thematic and research aspects, as well as methodological issues related to environmental health and epidemiology, along with international and national priorities. Prerequisite(s): MPH 530 and MPH 550. Crosslisted with: HL S 454 with differentiated assignments for graduate students.	

MPH 565. **International Health Issues:**	**3 cr.**
Comparison of domestic health programs and problems with those in other parts of the world; emphasis on political parameters and delivery processes. Additional attention is focused on the health issues of the U.S.-Mexico border. Crosslisted with: HL S 465 with differentiated assignments for graduate students.	
MPH 567. **Rural Health Issues:**	**3 cr.**
Comprehensive overview of rural health services with southwestern United States and New Mexico focus. Prerequisite(s): HL S 395 or MPH 500. Taught with HL S 467.	
MPH 569. **U.S.-Mexico Border Health Issues:**	**3 cr.**
Interdisciplinary analysis of the impact of living conditions and health issues of communities along the U.S.-Mexico border and of the strategies and initiatives to address these issues. Problem-based learning, case analysis, lecture, guest speakers, CANVAS based instruction, and field trips. Same as HL S 469.	
RGSC 518. **Watershed Methods and Management:**	**3 cr.**
Management of rangeland and forest watersheds with emphasis on the hydrologic cycle and land use effects on runoff and water quality. Hydrologic monitoring methods problem sets required for graduate credit.	
SOIL 456. **Irrigation and Drainage:**	**3 cr.**
Principles and practices required for irrigation to exist as a permanent economy. Equipment and methods for measurement and control of water.	
SOIL 477. **Environmental Soil Physics:**	**3 cr.**
A description of the physical characteristics of porous media including soil. Examination of processes describing the transport of water, chemicals, heat and gases through porous media with application to environmental quality, waste management, and crop production.	
SOIL 477L. **Environmental Soil Physics Laboratory:**	**1 cr.**
Concurrent enrollment with SOIL 477 recommended. Hands on experience with techniques for characterizing soil physical properties such as particle size distribution, bulk density, water retention, hydraulic conductivity and solute transport. Demonstrations of field and laboratory techniques for measuring moisture content, soil water potential, gas/air flow and thermal conductivity. Prerequisite(s): SOIL 252	

SOIL 479. **Environmental Soil Chemistry:**	**3 cr.**
Basic elements of soil chemistry including discussion of clay mineralogy, cation and anion exchange and the chemistry of problem (acid, saline and flooded) soils. Prerequisites: SOIL 252L or GEOL 360, or three semesters of chemistry. Same as GEOL 479. Credit not given for both SOIL 424 and SOIL 479.	
SOIL 651. **Advanced Soil Chemistry:**	**3 cr.**
Advanced treatment of soil chemistry phenomena with emphasis on arid zone soils. Particular attention is given to reactions involved in environmental pollution and management of wastes. Prerequisite: SOIL 424 or SOIL 479	
SOIL 652. **Advanced Soil Physics:**	**3 cr.**
Advanced treatment of soil physics, modeling, includes working on an existing/new research project, modeling existing or new data, step by step guide on the use of some 1-D and 2-D models. Specific areas of specialization will be field scale variability of soil properties, water flow, solute transport, and plant water relations. Prerequisite(s): SOIL 477 and computer literacy; or consent of instructor.	
TOX 523. **Environmental Toxicology:**	**3 cr.**
Introduction to the science of environmental toxicology. This course examines common pollutants and their impact on human and environmental health. It also evaluates the role of environmental protection agencies in monitoring and regulating these substances. Prerequisite(s): CHEM 211 or CHEM 313-314.	