

DEPARTMENT OF CITY AND REGIONAL PLANNING

University of North Carolina at Chapel Hill

PLAN 745: Development Impact Assessment

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Fall 2020

12:00 – 1:15 MW (Dey Hall 409 [Toy Lounge])

Course site: <http://sakai.unc.edu>

Course Zoom access: <http://go.unc.edu/plan745>

(or <https://unc.zoom.us/j/92414266761>;

password: 745zooms)

Course question site: <https://pollev.com/bendor>

Course approach and objectives

Development impact assessments are used in a variety of ways in public and private planning, including evaluation of land use planning alternatives, assessment of private and public development proposals, and marketing of development proposals.

In this class, you will learn the skills and techniques needed for predicting, evaluating, and mitigating potential adverse impacts of land development projects, particularly as they affect urban infrastructure. You will also develop skills in documenting and reporting impact assessment analyses, findings, and recommendations in a competent, professional manner. By analyzing and discussing various examples of those applications, the course will help you develop an appreciation of the strengths and limitations of various impact assessment approaches in specific applications. You will also learn to critically approach impact assessment and analyze others' assessments.

PLAN 745 employs a “flipped” classroom; you will be expected to view lectures and readings online, and develop questions that you would like to discuss during class time. The course will meet for two 75 minute sessions each week, during which time we will discuss the lectures, readings, and questions that you, other students, and the instructor have generated. Some of these course meetings will also involve live lectures and discussions with guest speakers. While PLAN 745 ordinarily includes field trips, due to the COVID-19 outbreak, these field trips will instead be recorded by the instructor for student viewing.

While the lectures and readings are important, an equally critical aspect of learning in this course comes from your preparation of a range of impact assessments for a variety of different types of development projects.

What is this syllabus?

This document is many things. 1) It is a planning document, so you can plan your time commitment for reading and assignments. 2) It is a roadmap through the class that aims to give you bearings for each class. 3) It is also a contract of sorts, telling you the level of effort that I intend to put into course as a teacher, as well as the level of effort that I expect from you as a student.

How can you do well in this class?

To do well in this course, I expect you to spend significant time and effort: 1) on the impact assessment assignments, and 2) working through the lectures and reading material in advance of class. I also expect you to 3) attend class and **participate** (defined below).

Time Commitment: In this course, you should expect to spend at least 3 hours outside of class for each hour you spend in class. This amounts to at least 7-8 hours per week outside of class. It is likely, however, that during some weeks, this course will require much more time, and in other weeks, it will require much less time.

What is participation? Participation means that you are actively listening and engaging in classroom discussions, as well as engaging the class with your own questions, whether you bring them in class or through the question website that I have created for PLAN 745: <http://planquestions.web.unc.edu/>. Please contact the instructor or TA if you have any questions, problems with the readings or the course, or any other issues that you wish to discuss. Students in this class are encouraged to speak up and participate during class meetings. Because the class will represent a diversity of individual beliefs, backgrounds, and experiences, every member of this class needs to show respect for every other member.

There is a lot of reading. How do I get through it all? The most important thing to do is planning your time. Some tips:

- If you do not have one, **get a calendar!** Put all due dates and special class activities (e.g. field trips) on your calendar. Probably the easiest and most flexible is Google Calendar, but you may prefer others.
- There are lots of resources for time management available, here is a good one: <https://students.dartmouth.edu/academic-skills/learning-resources/time-management>
- Everyone reads articles differently, **you need to figure out how you can effectively read a large volume of material and come away with the main ideas and key points.** “Some books should be tasted, some devoured, but only a few should be chewed and digested thoroughly.” – Sir Francis Bacon. Skimming is your friend and an important strategy to keep up with the readings. However, when you see important points, slow down and digest thoroughly.
- Write down questions as you read! Submit those questions to the course’s Poll Everywhere poll: <https://pollev.com/bendor>: If you want your questions to remain anonymous, you can submit your questions here: <http://planquestions.web.unc.edu/>. **Asking questions is an important part of participating in your own learning process.**
- Why are we **doing** impact assessments? Bloom’s Taxonomy considers educational learning based on different levels of complexity and specificity. Our goal is to climb this “mountain,” where the peak means creating new knowledge and synthesizing the plethora of ideas that you have learned in this class. **Creation of new knowledge is the goal.**



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Semester big picture



Course project and grading

Students will conduct a comprehensive series of assessments for a number of development projects. Your reports will detail your recommendations to the local government for managing the impacts that you identify. To make the impact assessment feasible to conduct in a very short period, much of your assignment material is pre-packaged.

The requirements for this course include:

Active class participation and attendance	20 %
Linked-In Learning QGIS Module (submitted via Sakai)*	5 %
GIS assignment turned in to Phil McDaniel	5 %
<u>Comprehensive impact assessment (7 sections)</u>	<u>70 %</u>
Total	100%

Assignments are due on **Fridays by midnight** and can be submitted via [Sakai Assignments](#). Complete all assignments individually; discussions with classmates are encouraged, *but all final work must be entirely your own.*

Assessment reports			Field trips	
	Due date	Topic	Date	Location
1	Aug 28	Fiscal impacts	Oct 12	Water treatment plant field trip (virtual)
GIS	Sept 4	LinkedIn Learning GIS module	Oct 19	Wastewater treatment plant trip (virtual)
2	Sept 11	Transportation		
3	Oct 2	Public services		
4	Oct 9	Health		
5	Oct 30	Water supply/wastewater impacts		
6	Nov 13	Stormwater		
7	Nov 20	Climate change impacts		

Course textbook and readings

Required textbook: Elmer, Vicki and Adam Leigland. 2014. *Infrastructure Planning and Finance: A Smart and Sustainable Guide*. Routledge. [Now available for free electronically via UNC Library]

The course Sakai site (<http://sakai.unc.edu/>) contains course information, lectures, handouts, data, assignments, and links to relevant websites.

Other academic business

Policy on Late or Incomplete Work: In order to be fair to your fellow students, **late assignments will be docked 20% per day.**

Grading Notes: Generally, an **H** grade is given for exceptional work that demonstrates a real mastery of course material. **L** or **F** work substantially fails to meet minimum requirements either due to incomplete coverage of required information, incorrect results, or sloppy, unprofessional reporting of results.

IF YOU HAVE A MEDICAL EMERGENCY, PLEASE INFORM THE INSTRUCTOR AS SOON AS POSSIBLE. Grades of incomplete may be given in the event of a medical or another emergency. In these cases, a written application for an incomplete on any assignment must state the reasons for the request and propose a new deadline.

Resources: Our purpose as professors is to help you to excel in this learning environment. Should you need further assistance beyond the help of the professor, please consult the following on-campus resources:

- The Writing Center: <http://writingcenter.unc.edu>
- The Learning Center: <http://learningcenter.unc.edu>
- The Learning Center resources for students with learning disabilities (LD) and/or attention-deficit/hyperactivity disorder (ADHD): <https://learningcenter.unc.edu/services/ldadhd-services/>
- The Center for Student Success and Academic Counseling: <http://cssac.unc.edu>
- Counseling and Wellness Services: <http://campushealth.unc.edu>

The University's Honor Code is in effect. The University of North Carolina at Chapel Hill has had a student-administered honor systems and judicial system for over 100 years. The Honor Code represents UNC-Chapel Hill students' commitment to maintain an environment in which all students respect one another and are able to attain their educational goals. As a student at Carolina, you are entering a community in which integrity matters – integrity in the work you submit, and integrity in the manner in which you treat your fellow Carolina community members. Because academic honesty and trustworthiness are important to professional planning, this is a significant University and Departmental tradition. Your attention is called to the Instrument of Student Judicial Governance for policies and procedures pertaining to the honor system. We are committed to treating Honor Code violations seriously and urge all students to become familiar with its terms set out at <https://studentconduct.unc.edu/>. If you have questions, it is your responsibility to ask the professor about the Code's application. Please consult with the instructor if you are uncertain about your responsibilities under that code with respect to this course.

The University of North Carolina – Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in difficulties with accessing learning opportunities. All accommodations are coordinated through the Accessibility Resources and Service Office. Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately early in the semester to discuss your specific needs. Students with documented disabilities should contact the Department of Disability Services at 919-962-8300 (SASB North, Suite 2126; <https://accessibility.unc.edu>) to coordinate reasonable accommodations.

Course outline

For each course topic, required readings are provided. A special effort has been made to select relevant, timely and well-written readings. Additional resources are listed that can be examined in detail, depending upon your interest in the subject. The source and style of each reading varies considerably. I recommend downloading all of the materials as they may serve you as useful references during future classes or in your career.

*** Reading comprehension and time management are skills. PLEASE READ ASSIGNED MATERIAL AND VIEW LECTURES BEFORE EACH CLASS***

The professor reserves the right to make changes to the syllabus, including project due dates, when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.

Please arrive on time, activate your video on Zoom and remember to mute yourself if you are not speaking

Aug 10, 12: Course overview, impact assessment history, uses, and key choices

- Textbook:** Chapter 4 (Institutions of Infrastructure: The Providers) and Chapter 8 (Developing the Public Infrastructure Project)
- Mary M. Edwards. 2000. Chapter 1, Introduction and Chapter 6, Putting It All Together, in *Community Guide to Development Impact Analysis*, Madison, WI: Wisconsin Land Use Program, University of Wisconsin-Madison, March 2000, pgs. 3-7 and 73-76.
- Edward J. Kaiser, David R. Godschalk, and F. Stuart Chapin, Jr. 1995. Development Proposal Evaluation, in *Urban Land Use Planning*, Fourth Edition, Urbana, IL: University of Illinois Press, pgs. 438-453.
- Carissa S. Slotterback. 2011. Evaluating the Implementation of Environmental Review Mitigation in Local Planning and Development Processes. *Environmental Impact Assessment Review* 28(8): 546-561.
- David P. Lawrence. 2007. Impact Significance Determination – Back to basics. *Environmental Impact Assessment Review*, 27: 755–769.

Additional resources providing an overview of development impact assessment:

- For those new to planning and in need of an overview of planning and infrastructure relationships: **Textbook:** Chapter 3 (Growth, Demand, and the Need for Infrastructure) and Chapter 5 (Local Plans and Infrastructure)
- **Textbook:** Chapter 7 (Smart and Sustainable Development Rules) and Chapter 14 (Exactions and Impact fees)
- Richard K. Morgan. 2012. Environmental impact assessment: the state of the art. *Impact Assessment and Project Appraisal*, 30(1): 5-14.
- Leonard Ortolano. 1997. Chapter 16: Forecasting Environmental Effects of Proposed Projects and Regulatory Actions, *Environmental Regulation and Impact Assessment*, New York: John Wiley and Sons, Inc., pgs. 347-373.
- Developer perspectives: Robert W. Burchell. 1994. Chapter 2: Legal and Administrative Considerations, in *Development Impact Assessment Handbook*, Washington, DC: ULI-the Urban Land Institute, pgs. 16-25.
- Zhao Ma, Dennis R. Becker, and Michael A. Kilgore. 2009. Characterising the landscape of state environmental review policies and procedures in the United States: a national assessment. *Journal of Environmental Planning and Management* 52(8): 1035–1051.
- Robert W. Burchell. 1993. Environmental Setting, in *Development Impact Assessment Handbook*, Washington, DC: Urban Land Institute. Pgs. 38-41.
- Robert D. Sculley. 1998. *A Basic Strategy for EIR Preparation*, San Francisco, CA: Tetra Tech, Inc.
- Bruce Hendler. 1977. *Caring for the Land*, Planning Advisory Service Report No. 328. Chicago: American Planning Association, pgs. 5-65.
- R.K. Jain, et. al. Introduction. *Environmental Assessment*, 2nd Edition. New York: McGraw-Hill, 2002, pgs. 1-12
- William Fulton. 2013. 60% of EIR Challenges Involve Infill Projects. California Planning & Development Report [Also online]. Available: <http://www.cp-dr.com/articles/node-3310>

Additional resources on specific aspects of development impact assessment:

- *California Environmental Quality Act (CEQA) model*: Robert Olshansky. 1996. The California Environmental Quality Act and Local Planning. *Journal of the American Planning Association*. 62(3): 313-330.
- *North Carolina State Environmental Policy Act (SEPA)*: N.C. Department of Administration. 1999. Environmental Assessment Guidelines. pgs. 1-7.
- Tim Snell and Richard Cowell. 2006. Scoping in environmental impact assessment: Balancing precaution and efficiency? *Environmental Impact Assessment Review* 26(4): 359-376.

- Thomas D. Boston. 2005. The Effects of Revitalization on Public Housing Residents: A Case Study of the Atlanta Housing Authority. *Journal of the American Planning Association* 71(4) 393-407.

Examples of environmental assessments on Sakai:

- *World Trade Center: Lower Manhattan Development Corporation*. 2004. The World Trade Center Memorial and Redevelopment Plan Final Generic Environmental Impact Statement. [Online].
- *Domestic Example: City of Lakewood, CA*. 2007. Master Environmental Assessment (MEA) for the City of Lakewood Comprehensive General Plan.
- *International Example: Dublin Docklands Development Authority*. 2003. Dublin Docklands Area: Strategic Environmental Assessment of the Draft Master Plan.
- *International Example: Trump International Golf Links Scotland, Ltd*. 2008. Aberdeenshire Council Planning Authority under Town and Country Planning (Scotland) Act of 1997.

Aug 17, 19: Fiscal impact assessment

Zenia Kotval and John Mullin. 2006. *Fiscal Impact Analysis: Methods, Cases, and Intellectual Debate*. Cambridge, MA: Lincoln Institute of Land Policy.

Additional resources

- **Textbook:** Chapters 9-15 [comprehensive overview of infrastructure financing]
- Lamie, R. David, Wallace Campbell, and William Molnar. 2012. The Fiscal-Geographic Nexus: An Overview of Fiscal Impact Assessment in Local Policy Development. *Applied Geography* 32(1): 54–60.
- Leistritz, F. Larry. 1994. Economic and Fiscal Impact Assessment. *Impact Assessment* 12(3): 305–317.
- Example from Chatham Park development project: Vicus Development Group. 2017. North Village fiscal impact analysis (Chatham Park). Chatham Park Investors, LLC: Pittsboro, North Carolina.
- See zipped file listing several “foundational readings” on fiscal impact assessment on Sakai

Aug 24, 26, 31: Transportation impact assessment (Session 2+3 - Roger Henderson, Director of Planning, Ramey Kemp and Associates; Sessions 2 – Bergen Watterson, Transportation Planning Manager, Town of Chapel Hill; Classes will be LIVE over Zoom) Class Session 1:

Textbook: Chapter 20 (Streets and Streetscapes) and Chapter 21 (Automobiles and Mass Transit)
Michael McNally. 2007. The four-step model, in *Handbook of transport modelling*, pgs. 35-41.

Class Session 2:

Institute of Transportation Engineers. 2006. Transportation Impact Analyses for Site Development (Student Supplement).
Papacostas, P. and P. Prevedouros. 2001. Chapter 9: Traffic Impact and Parking Studies (Pgs 456-497). *Transportation Engineering and Planning, 3rd edition*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Class Session 3:

Morten Skou Nicolaisen, and Patrick Arthur Driscoll. 2014. Ex-post evaluations of demand forecast accuracy: A literature review. *Transport Reviews* 34(4): 540-557.
U.S. Department of Transportation, Federal Highway Administration. 2007. Chapter 4C. Traffic Control Needs Studies. *Manual on Uniform Traffic Control Devices, 2003 Edition with Revisions 1 and 2, December 2007*.

Additional resources

- *Examples of Traffic Impact Assessment Requirements: Chapel Hill, NC, Montgomery County, MD, County of Barnstable, MA, and the Maryland-National Capital Park and Planning Commission.*
- *Numerous Examples of Traffic Impact Assessment Reports are located on Sakai.*
- Reid Ewing and Robert Cervero. 2001. Travel and the Built Environment: A Synthesis. *Transportation Research Record*, 1780: 87-114.
- Randall Crane. 1996. Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning. *Journal of the American Planning Association* 62(1): 51-65.

Sept 7: Labor Day – NO CLASS

Sept 2, 9, 14, 16: GIS (Sessions 1-3 – Philip McDaniel, UNC GIS Librarian. Classes will be LIVE over Zoom; Session 4 – see VoiceThread materials on Sakai)

Jonathan Campbell and Michael Shin. 2011. Essentials of Geographic Information Systems. Minneapolis, MN: Center for Open Education. [Online] Available: <https://open.umn.edu/opentextbooks/textbooks/essentials-of-geographic-information-systems>. Please complete Chapters 1, 3-7.

PRIOR TO CLASS: On your own, please complete the Linked-In Learning course, “Learning QGIS” (Gordon Lockett; dated October 2019) at <http://linkedin.unc.edu/>. This course augments the GIS overview sessions of PLAN 745 and consists of 12 modules scheduled to take approximately 3 hours. At the end of the course, you will receive a PDF certificate, which you can submit via Sakai Assignments feature (due: September 4th). Please come with any questions you have about GIS or QGIS.

*** If you have not had previous GIS training (e.g. PLAN 491/591), you are required to enroll in the Linked-In Learning course “ArcGIS Essential Training,” which consists of 13 modules scheduled to take approximately 5.5 hours. If you need more basic training (i.e., you have never been exposed to GIS at all), you should also complete the course, “Learning ArcGIS” (3.25 hours) prior to the “ArcGIS Essential Training” course. ***

Additional resources

- QuantumGIS (QGIS) Tutorials: [Online]: <http://www.qgistutorials.com/en/docs/introduction.html>
 - This is a tutorial created for QGIS, a free and open-source alternative to ESRI's ArcGIS hegemony. Great worksheets and information on GIS concepts
- Harvard Map Collection. 2020. GIS Tutorials and Exercises: Introduction to Geographic Information Systems (GIS) Tutorial. Harvard University: Cambridge, MA. [Online]: <https://gis.harvard.edu/tutorials>
- Many books exist on GIS – including ArcGIS – I recommend a review (in the library): Michael Law and Amy Collins. 2018. Getting to Know ArcGIS Desktop [Fifth Edition]: ESRI Press: Redlands, CA.

Additional resources

- Juliana Maantay and John Ziegler. 2006. Map projections and coordinate systems, Chapter 2 – Spatial Data and Basic Mapping Concepts, pgs. 39-53 and Chapter 6 – Sources of Urban Data, pgs. 157-177 in *GIS for the Urban Environment*. Redlands, CA: ESRI Press.
- Agustin Rodriguez-Bachiller with John Glasson. 2004. GIS and Impact Assessment (Chapter 3), pgs. 52-80 in *Expert Systems and Geographic Information Systems for Impact Assessment*. London: Taylor and Francis.
- Robert B. Kent and Richard E. Klosterman. 2000. GIS and Mapping: Pitfalls for Planners. *Journal of the American Planning Association* 66(20): 189-198
- Another good overview of basic GIS material: Kang-tsung Chang. 2002. Chapter 1 – Introduction, pgs. 1-10, Chapter 3 – Vector Data Model, pgs. 31-49, and Chapter 6 – Attribute Data Input and Management, pgs. 100-113, in *Introduction to Geographic Information Systems*, Boston: McGraw-Hill.

Sept 21, 23: Public service impact assessment

Textbook: Chapter 25 (Public Schools as Public Infrastructure) and 21 (Parks, Recreation, and Open Space)

Additional resources

- Shaham, Yonatan and Itzhak Benenson. 2016. Modeling Urban Fires in Mediterranean and Middle- Eastern Cities. IEE Conference Paper.
- Larry W. Canter. 1995. Chapter 14 – Prediction and Assessment of Impacts on the Socioeconomic Environment (*Education Services Impacts* section, pgs. 519-525) in *Environmental Impact Assessment, 2nd Edition*. New York: McGraw-Hill.
- Mary M. Edwards. 2000. Worksheet 4.5: Education and Libraries, in *Community Guide to Development Impact Analysis*, Madison, WI: Wisconsin Land Use Program, University of Wisconsin-Madison, March 2000, pgs. 104 (A20).
- *Example School Analysis: Wittman, Art.* 2002. Student Generation Multiplier Study. School Board of Palm Beach County, FL.
- Sue Enger. 1994. Parks/Open Space/Recreation Facilities Standards, pgs. 21-37 in *Level of Service Standards - Measures for Maintaining the Quality of Community Life*. Report No. 31, Municipal Research and Services Center of Washington.
- James D Mertes and James R. Hall. 1995. Section 3: Level of Service Guideline for System Planning, Pgs 57-92 in *Park, Recreation, Open Space, and Greenway Guidelines*, National Recreation and Park Association: Lubbock, TX.
- Peter Hartik. 2008. Creating and Maintaining Parks: Funding and Other Means, pgs 75-88 in *From Recreation to Re-creation (PAS 551): New Directions in Parks and Open Space System Planning*. Planners Press: Chicago, IL.

- Larry W. Canter, Samuel F. Atkinson, and F. Larry Leistritz. 1985. Police and Fire Protection (Pgs. 104-117) in *Impact of Growth: A Guide for Socio-Economic Impact Assessment and Planning*, Chelsea, MI: Lewis Publishers, Inc.
- Mary M. Edwards. 2000. Worksheet 4.4: Public Safety, in *Community Guide to Development Impact Analysis*, Madison, WI: Wisconsin Land Use Program, University of Wisconsin-Madison, pg. 103 (A19).

Sept 28: **Health impact assessment**

Anna Ricklin, Michelle Madeley, Elizabeth Whitton, and Angelica Carey. 2016. *The State of Health Impact Assessment in Planning*. Chicago, IL: American Planning Association.

Lhachimi, S. K., Nusselder, W. J., Boshuizen, H. C., & Mackenbach, J. P. 2010. Standard tool for quantification in health impact assessment: a review. *American Journal of Preventive Medicine* 38(1), 78-84.

Additional resources

- Human Impact Partners. 2011. *A Health Impact Assessment Toolkit: A Handbook to Conducting HIA, 3rd Edition*. Oakland, CA: Human Impact Partners.
- American Planning Association. 2017. *Healthy Communities Policy Guide*. American planning Association: Chicago, IL.
- Hebert, Katherine A., Arthur M. Wendel, Sarah K. Kennedy, and Andrew L. Dannenberg. 2012. Health impact assessment: a comparison of 45 local, national, and international guidelines." *Environmental Impact Assessment Review* 34: 74-82.
- Ross, C.L., de Nie, K.L., Dannenberg, A.L., Beck, L.F., Marcus, M.J. and Barringer, J., 2012. Health impact assessment of the Atlanta BeltLine. *American Journal of Preventive Medicine* 42(3), 203-213.
- The Health Impact Project: <http://www.pewtrusts.org/en/multimedia/data-visualizations/2015/hia-map>
- UCLA HIA Clearinghouse: <http://www.hiaguide.org/>

Sept 30, Oct 7: **Water supply impact assessment**

Oct 5: Planning and Infrastructure at OWASA (Guest Speaker: Mary Tiger, Sustainability Manager)

Class Session 1

Textbook: Chapter 16 (Water Supply)

Class Session 2

Jerry A. Nathanson. 2002. Chapter 2: Hydraulics, pgs. 27-41; and Chapter 7: Water Distribution Systems, pp 181-184, 200-211 in *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. 4th ed., Englewood Cliffs, NJ: Prentice Hall.

Tony Nye and Karen Mancl. 2001. *Fact Sheet: Water Sources for Fire Protection in Small Communities*. Columbus, OH: The Ohio State University Extension.

Additional graywater/water re-use resources

- National Academies of Science. 2016. *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*. National Academies Press, Washington, D.C.
- J. Price, Fielding, K.S., Gardner, J., Leviston, Z. and Green, M., 2015. Developing effective messages about potable recycled water: The importance of message structure and content. *Water Resources Research*, 51(4): 2174-2187.

Additional infrastructure financing resources

- Ronald F. Cilensek. 2005. Water Treatment Plant Construction Cost Estimating, Ch. 26 in: American Water Works Association. *Water Treatment Plant Design, 4th edition*. New York: McGraw-Hill Professional.
- Tanellari, E., Bosch, D., Boyle, K. and Mykerezi, E., 2015. On consumers' attitudes and willingness to pay for improved drinking water quality and infrastructure. *Water Resources Research*, 51(1):47-57.

Additional infrastructure planning resources

- Ward, F.A. and Pulido-Velazquez, M., 2008. Water conservation in irrigation can increase water use. *Proceedings of the National Academy of Sciences*, 105(47): 18215-18220.
- Ross & Associates Environmental Consulting, Ltd. 2012. *Planning for Sustainability: A Handbook for Water and Wastewater Utilities (EPA-832-R-12-001)*. US Environmental Protection Agency: Washington, D.C.

Oct 12: **Virtual field trip to OWASA water treatment plant** (see Sakai for more information)

Textbook: Chapter 16 (Water Supply)

Oct 14: Wastewater impact assessment

Overview: **Textbook:** Chapter 17 (Wastewater and New Paradigms)

Jerry A. Nathanson. Chapter 2: Hydraulics, pgs. 41-44; and Chapter 8: Sanitary Sewerage Systems, pp 217-231 in *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. 4th ed., Englewood Cliffs, NJ: Prentice Hall, 2002.

Additional resources

- Ronald F. Cilensek. 2005. Water Treatment Plant Construction Cost Estimating, Ch. 26 in: American Water Works Association. *Water Treatment Plant Design*, 4th edition. New York: McGraw-Hill Professional.

Oct 19: Virtual field trip to OWASA wastewater treatment plant (see Sakai for more information)

Oct 21, 26, 28, Nov 2, 4: Stormwater impact assessment

Class Sessions 1 + 2 (stormwater quantity/hydrology):

Overview: **Textbook:** Chapter 18 (Stormwater and Flooding)

Jerry A. Nathanson. Chapter 9: Stormwater Management, pgs. 251-269 in *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. 4th ed., Englewood Cliffs, NJ: Prentice Hall, 2002.

Natural Resource Conservation Service (NRCS). 1986. *Urban Hydrology for Small Watersheds (Second Edition)*. Washington, D.C.: U.S. Department of Agriculture.

Class Sessions 3+4 (stormwater quality):

Jerry A. Nathanson. Chapter 9: Stormwater Management, pgs. 269-273 in *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. 4th ed., Englewood Cliffs, NJ: Prentice Hall, 2002.

John Randolph, Chapter 13, Land Use, Stream Flow, and Runoff Pollution, pgs. 392-406; 434-466 in *Environmental Land Use Planning and Management*, Washington, DC: Island Press, 2004.

Additional resources

- North Carolina Department of Natural Resources. Selecting the Right BMP, pgs. 4-1 -7 in *Stormwater Best Management Practices Manual*, July 2007.

Nov 9, 11: Climate change impacts and lifecycle assessment (Session 2 – Prof Noah Kittner, UNC DCRP and Environmental Science and Engineering)

Overview: **Textbook:** Chapter 27 (Energy and Power)

Padgett, J. P., Steinemann, A. C., Clarke, J. H., & Vandenbergh, M. P. 2008. A comparison of carbon calculators. *Environmental impact assessment review* 28(2): 106-115.

Carissa S. Slotterback. 2011. Addressing climate change in state and local environmental impact analysis. *Journal of Environmental Planning and Management* 54(6): 749-767.

Additional resources on general climate impact analysis issues:

- Reid Ewing, et. al. 2007. Overview, pgs. 1-16 in *Growing Cooler: The Evidence on Urban Development and Climate Change*. Washington, DC: Urban Land Institute, 2007.
- Elizabeth Wilson and Jake Piper. 2010 Chapter 2: Climate Change Mitigation and Adaptation: Impacts and Opportunities, pgs. 18-43 in *Spatial Planning and Climate Change*. Routledge.
- Harriet Bulkeley. 2013. Chapter 3: Accounting for urban GHG emissions, pgs. 45-70 in *Cities and Climate Change*. Routledge.
- University of Hamburg. 2012. *Why Weather isn't the same as Climate: Ten Climate Researchers Report*. University of Hamburg: Hamburg, Germany.
- Nejadkoorki, F., Nicholson, K., Lake, I. and Davies, T., 2008. An approach for modelling CO₂ emissions from road traffic in urban areas. *Science of the Total Environment*, 406(1): 269-278.
- Henry D. Jacoby. 2013. *Implications of Climate Science for Policy (Climate Policy Note # 2)*. MIT Joint Program on the Science and Policy of Global Change: Cambridge, MA.
- Patrick Condon. 2008. Planning for Climate Change. *Land Lines (Lincoln institute of Land Policy)*, January Pgs. 2-7.

Additional resources on lifecycle assessment:

- Charlene Bayer, Michael Gamble, Russell Gentry, and Surabhi Joshi. 2010. *AIA Guide to Building Life Cycle Assessment in Practice*. American Institute of Architects: New York, NY.

- Bilec, M.M., Ries, R.J. and Matthews, H.S., 2009. Life-cycle assessment modeling of construction processes for buildings. *Journal of infrastructure systems*, 16(3): 199-205.

Nov 16, 18: Wetland and stream impact assessment, mitigation, and policy

Fennessy, M. Siobhan, Amy D. Jacobs, and Mary E. Kentula. 2004. Review of rapid methods for assessing wetland condition (EPA/620/R-04/009). US Environmental Protection Agency: Washington, DC.

Textbook: Chapter 29 (A New Paradigm for Infrastructure)

Additional resources

- M. Acreman & J. Holden. 2013. How wetlands affect floods. *Wetlands* 33:773–786.
- NC Wetland Assessment Method (NCWAM). User Manual and Appendices: <https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-quality-program-development/ncwam-manual> (skim)
- USEPA. 2013. Wetlands Supplement: Incorporating Wetlands into Watershed Planning. US Environmental Protection Agency (Region 5): Chicago, IL. Focus on Pgs. 1-40
- Sutula, Martha A., Eric D. Stein, Joshua N. Collins, A. Elizabeth Fetscher, and Ross Clark. 2006. A practical guide for the development of a wetland assessment method: the California experience. *JAWRA Journal of the American Water Resources Association* 42(1): 157-175.
- Wright, Tiffany, Jennifer Tomlinson, Tom Schueler, Karen Cappiella, Anne Kitchell, and Dave Hirschman. 2006. Direct and Indirect Impacts of Urbanization on Wetland Quality, U.S. Environmental Protection Agency: Washington, D.C. See Pgs. 1-12

Additional resources (policy-focused):

- Palmer Hough and Morgan Robertson 2009. Mitigation under Section 404 of the Clean Water Act: where it comes from, what it means. *Wetlands Ecology and Management* 17(1):15-33.
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