Water Conservation Technologies
Course Syllabus

Course Methods

A series of assignments will help you apply the principles and concepts to the creation of irrigation designs. You will need to review the tutorials attempting the assignments. The class meetings will be devoted largely to the development of design exercises and one-on-one critiques of your work.

Assessment (learning outcomes)

The following are the learning outcomes that the faculty have specified for this course. Please, adopt these as your own learning objectives.

- An understanding of the economic, social and environmental issues associated with water use.
- The ability to calculate peak runoff rates and volumes for stormwater in natural and developed landscapes.
- The ability to predict the performance of proposed landscapes based on research findings and calculations.
- The ability to design and detail water conservation and management projects including water harvesting, constructed wetlands and biological treatment of sewage and stormwater.
- The ability to produce designs and techical drawings for drip irrigation and water management plans .
- Production of a portfolio quality sample of your work.

Evaluation

Your course grade is based on the following percentages:
Quizzes - 40%
Semester project- 50%
Participation - 10%

Texts

This web site replaces the need for a text book but there will be occassional supplimental readings assigned from journals.

Required Materials

You will need both traditional drafing tools and computer software since there is a studio component to this course. We will use an number of software programs in the development of our design proposals and for stormwater modeling. There is a technology assistant who can provide you with help using AutoCadd and any of the Adobe Suite products. Flyers in the college buildings list the hours that this service is available.

You are encouraged to contact the instructor for discussion or additional help. Please use this opportunity to clarify points that you don't understand, locate information on areas of particular interest, or discuss personal problems affecting your performance in this class. If you have learning or physical disabilities that might impact your performance in this course please see me so that I can accommodate you.

Late Work

Late work may be penalized 10% for each 48 hours after the due date and time. There are valid reasons that a project might be late. Consult me before the due date if there are circumstances that prevent timely completion of a project.

Course Participation

Each student is expected to actively participate in their education by requesting critiques in every studio period dedicated to them. The student is expected to ask questions or offer comments that increase understanding of the material during class discussions. Time has been set aside outside of the regular class hours for discussion or additional help from the professor. More that two absences from the class may result in as much as one letter grade drop in the student's final course grade.

Incomplete Grades

Medical as well as some family or personal circumstances are grounds for an incomplete grade in this course. To be awarded an incomplete you must have completed 60% of the course with a grade of 60% or better. You must resolve an incomplete within six weeks after the beginning of the subsequent semester. Failure to do so (or to apply for an extension) automatically results in an F on your transcript.

Retention of Student Work

The insturctor may retain student projects as documentation of the course or as examples for future students. You may photograph or otherwise copy retained material by making an appointment with your professor.

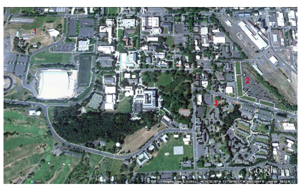
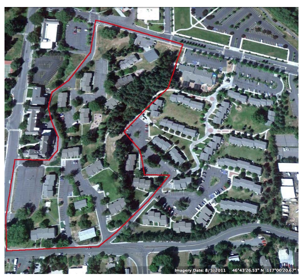
Water Conservation Technologies, Larc 380

Semester Assignment

Introduction

Over the length of the semester we will apply the concepts and techniques presented in this course to a redevelopment project. The project will focus on locating, sizing, detailing and documenting a number of site-scale, water management programs.

Site Location

Left: Aerial view of the University of Idaho campus, site 3 is the project site. Right: The project area is outlined in red.

The site is the married student housing project on the University of Idaho campus. Located at the intersection of Sweet Avenue and Deakin, the site is composed of a shallow valley. There are a few steeply sloping areas and upland benches. The existing buildings have nearly reached the end of their life. In fact, some of the buildings are currently unoccupied since they have been condemned due to the presence of mold that compromises air quality within the structures.

Site Planning

Three building footprints of proposed student housing structures have been provided for you. We will distribute these buildings in an in-class exercise in order to allow you to focus on the water issues this semester. However, you will develop parking, planting, irrigation, rough grading and water treatment plans. The water treatment plan will be supported by three dimensional models an sections to illustrate the concept and detail the construction requirements. Finally, and most important for this course, is the documentation of the performance of the landscape for water management and water quality. Download the AutoCad base here.

Tasks

The semester-long assignment is divided into several tasks associated with the topics of the course.

Download the project site base and contours. Combine them into a single file. Right click the links below to download the .dwg files.

Project AutoCad Base
Project AutoCad Contour Lines

Task 1 - Site Inventory and Analysis

Work in teams of six persons or less. Print the site base sheet (with contours) and annotate it during your site visits to document the existing conditions. Visit the site with a camera, two tape measures, twine, line level, a calculator an engineering scale, and your base sheet.

- Measure the slope percentage of the wooded slope on the eastern boundary. From contours and spot elevations find the greatest difference in elevation on the site.
- Gather data for our stormwater calculations - Determine the length and slope percentages for the longest path that water follows to reach the outlet at Sweet Avenue. Note the location of grade breaks and surface cover on the site base. Document the route with photographs.
- Locate opportunities for earth sheltered buildings. At these places measure the slope percentage and photograph the place.
- Verify the location of existing trees and shrub masses. Note off-site connections to green space (future ecological corridor connection).

Task 1 Deliverables

- A new project base sheet that includes the following elements:
- Existing contours, low points, high points
- Street curbs, names
- Existing manholes, catch basins, storm sewer lines
- Existing trees and shrub masses.
- Existing street lights
- Outside the boundary of the site show about 50' of existing buildings, roads, parking, open space, etc. for context.

Presentation template

- In InDesign prepare a 24" x 36" sheet with drawing scale, north arrow, project title, student names, professor's name, semester and year. Save the sheet as a template to receive Adobe Illustrator and other assets.

Site inventory and analysis

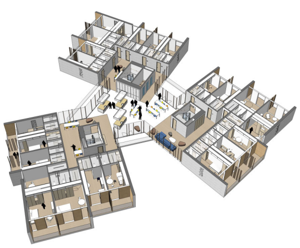
- Create an Adobe Illustrator file of the imported AutoCad Base. In the illustrator file generate professional graphics showing: slopes greater than 25% and slopes 0-5%, Time of Concentration line with distances, land cover and slope, square footage of the site, square footage of wooded areas, square footage of off-site stormwater contribution, manhole and catch basin locations, low and high points, grade breaks, soil type boundaries, soil infiltration rate, precipitation average by month, existing trees and shrub masses, existing driveway and street curbs, lights, and names, outline of existing parking areas, off-site connections to open space. Illustrate the site conditions with at least 20 photographs of the site elements and note the opportunities and constraints that they depict. Import the Ai file into the InDesign template and export as a PDF and submit with the file name SiteInvTeam*One* or *Two. See* the course calendar for the due date.

Task 2 - Building and Drainage Concept

Working in teams of six or less, distribute the proposed buildings on the site according to the in-class exercise. Calculate the proposed population of the site and the number of dwelling units per gross acre (our target is 30 - 40 units per acre). Locate and size parking to meet the standard of .75 spaces per unit. Assume 350 square feet per parking space (including aisles). Locate parking areas (minimize parking at the street edge on Taylor, Blake and Sweet Ave.). Do not draw the individual spaces or associated planting areas for this task. Locate and size all walkways and plaza spaces. The detailed design of the plazas will be done later.

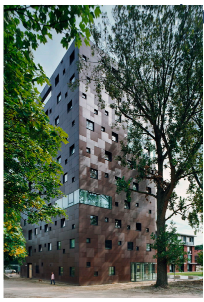
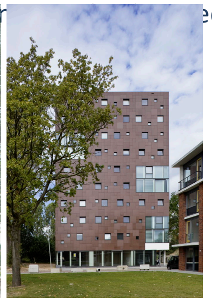
Below are a series of images and plans for student housing. Adopt these floor plans and distribute them where most appropriate on the site (note that the University of the Pacific option can be adapted as an earth sheltered building. Define the number of floors in the buildings shown to meet your purposes. Trace the images in AutoCad and rescale them to match the scale of your master plan (1" = 40'). Then copy the building footprint and place it to create arrangements that enclose exterior spaces. Then define the paved and landscaped space. Calculate the are of the plaza paving for each building group.

University of Southern Denmark Student Housing



University of the Pacific McGeorge Student Housing in Sacramento

eden

Task 2 Deliverables

- Create an Adobe Illustrator file of an imported AutoCad Base. In the illustrator file generate professional graphics showing: proposed buildings (define building by number and stories - R1/3), proposed cut and fill slopes, flow arrows indicating drainage around each building and across each parking area.
- Create a table in InDesign that documents the project size (acres), population, number of dwelling units per gross acre, number of parking spaces and the area of each lot (number the lots L1, L2 etc.) and the square footage of each roof (number each roof, R1, R2, etc.), square footage of each plaza (number each plaza, P1, P2, etc.), total walkway area (see sample below).

	Project Data								
Site size									
Population									
DU/gross ac									
Walkway SF									
	1	2	3	4	5	6	7	8	9
Parking lot spaces/SF	15/5,250	21/7,350							
Roof SF	10,000	20,000	10,000						
Plaza SF	15,000	30,000	10,000						

- Import the Ai file and table into the InDesign presentation template. Title the sheet as "Building and Drainage Concept". Save as a PDF file and submit as BldgConceptTeam*One* or *Two*. See the course calendar for the due date.

Task 3 Pre-Development and Conventional Post-Development Runoff Rate and Volume

In teams of two use the TR-55 Program to generate the pre-development peak cubic feet per second runoff for a 1" event, the 2-year, 10-year and 25-year 24-hour storms. From the TR-20 report find the runoff depth for each of these storms. Calculate the pre-development runoff volume for each storm.

Next generate the same information for the post-development condition. Assume all roof, streets, plazas and walkways are impervious. Calculate the post development runoff volume for each storm. Calculate the difference between the pre- and post-development runoff volumes for each design storm.

Note: for the off-site contribution of stormwater on Taylor Street assume meadow grass in good condition for the pre-development condition. For the site assume the same cover for the valley area and woodland for slopes over 25%. Model the woodland and grassland area as separate sub-drainage areas since the runoff Curve Numbers differ by more than 5.

Task 3 Deliverables

- Create a table using InDesign displaying pre- and post-development results. Display peak runoff CFS, runoff depth in inches, time of peak runoff, runoff depth in feet, runoff volume in cubic feet, the difference in pre- and post-development runoff volumes in cubic feet.
- Plot an outlet hydrograph showing the pre- and post-development condition for the 1" (water quality storm) event. Import the plot into Illustrator and redraw the image for presentation. This sheet will probably not be full. We will add information to it when we complete the next task.
- Import the table and Ai file into the InDesign presentation template. Title the sheet as "Pre- and Post-Development Runoff and Volume". Save as a PDF file and submit as TR55 *LastNames of Members*. See the course calendar for the due date.

Task 4 - Water Harvesting

Locate the runoff volume difference between pre- and post-development for the water quality storm from the previous task. This is the on-site storage target for a modified site design that incorporates green infrastructure elements that manage and treat stormwater. This task will focus on water harvesting to achieve two purposes. One is to reduce the consumption of potable water by substituting roof runoff for non-potable uses, such as toilet flushing. Second, the collection of roof runoff and using it in the building removes it from the stormwater volume. There is a potential conflict of goals here. Green roofs are valuable for reducing roof runoff and improving building energy performance. However, specifying green roofs reduces the amount of water available for harvesting for reuse and may reduce its quality. Green roofs are less effective, from an energy standpoint, on tall buildings. Therefore, you might specify white roofs on the tallest buildings and green roofs on others.

Decide on a green roof strategy and then working as individuals calculate the potential volume of water that you can collect from each of the roofs each month. Next estimate the amount of water needed to flush the toilets in the buildings each month. This will require an occupancy estimate for the summer months. We will attempt to get this from the UI facilities management department. Determine the storage volume required to serve the buildings during the months of low rainfall.

In addition to the water harvested and reused there is contaminated grey and black water that we will collect and treat on-site. In this task you are to determine the monthly volume of greywater and blackwater that will require treatment. We will use hybrid wetlands to treat this water and make it available for reuse in irrigation.

Task 4 Deliverables

- Produce a table using InDesign displaying the required monthly volume and the harvesting potential for each building. Display the storage volume required for each building and the volume of runoff (water not used in the building).
- Produce a section or sketchUp model of a typical storage tank solution that incorporates the tank into the landscape design (aesthetic treatment). Provide the cost of the tank and the cost per gallon stored per year.
- Add this information to the TR55 sheet and resubmit.

Task 5 - Pollution Treatment

This task requires you to work independently again to redesign the parking lots to achieve two goals. First, the lot design must provide for shade over 50% of the surface area at noon on June 21, ten years after construction. Assume tree diameters at 60% of full maturity.

Second all of the runoff from the parking area must receive treatment to reduce non-point source pollution. There are several design options that will meet this goal to varying degrees. Often different techniques are combined to achieve reductions in runoff rate, runoff volume and pollution. For example the parking bays might be constructed of permeable paving (permeable concrete, permeable asphalt or unit pavers) to slow runoff and begin water quality improvement. The outflow might be directed to a bioretention basin or stormwater wetland for additional detention, infiltration and water quality improvement. You are to devise a treatment sequence and calculate the reduction in the runoff peak, infiltration volume, and expected water quality improvement.

This is a complicated problem since it requires that you acquire research data documenting the performance of various stormwater treatment landscapes compared to the pollution levels of conventional (untreated) runoff.

Task 5 Deliverables

- Create a table identifying the pollution concentrations and load that you expect in the parking lot runoff and the concentration (or percent reduction) of the contaminants due to the landscape treatment. Also, indicate the water quality standard for each contaminant if it has been set.
- Create a table displaying the runoff volume for the water quality storm and the size of the landscape elements required to contain and treat it. Note the anticipated outflow.
- Produce a plan that places and correctly sizes stormwater treatment landscapes associated with the parking areas. Produce a plan view enlargement and a section or sketchUp model of the treatment landscape. Include construction details and specifications critical to the effective performance of these landscape elements.
- Assemble the products on the InDesign presentation template. Title the sheet as "Pollution Treatment". Save as a PDF file and submit as Treatment *LastNames of Members*. See the course calendar for the due date.

Task 6 - Stormwater Retention and Detention

This task requires you to work independently and requires that you return to tasks 4 and 5 to recover the volumes that leave the harvesting and treatment elements. These will continue through the landscape to either infiltrate, evaporate, become used in irrigation or flow through the project outlet (storm sewer). However, the water quality storm volume must be retained entirely on-site.

Retrieve the water quality volume from a task 3. While the parking lot water has been treated once, runoff from the landscape also contains contaminants. There will also be runoff from walkways and plazas that contribute runoff. Find research data that indicates the contaminants expected from the landscape. Repeat the exercise from task five to locate, size and determine the reduction in contaminants from the landscape elements that you select. These could be stormwater wetlands or bioinfiltration basins or retention basins. As in the last task, provide plan, section and sketchUp models to illustrate the design and critical construction elements. Again note the outflow from the landscapes that you specify.

Task 6 Deliverables

See task 5 for the required products. Assemble the products on the InDesign presentation template. Title the sheet as "Pollution Treatment". Save as a PDF file and submit as Retention *LastNames of Members*. See the course calendar for the due date.

Task 7 - Blackwater and Greywater Treatment

This task requires you to work independently. You have already calculated the amount of wastewater produced by the building residents. Retrieve these amounts from task 4. Locate the required septic tanks and wetland treatment stages. The treated greywater can be reused for toilet flushing in the buildings if the volume of water from roof harvesting is insufficient. Otherwise it can be used for irrigation or to sustain wetland for aesthetic and habitat purposes. Treated blackwater can be used for habitat or irrigation. Once you have decided on a treatment and reuse strategy locate and size the treatment landscapes based on the environmental engineering literature. Be sure that stormwater runoff does not flow into these treatment wetlands. Use Task 4 as your guide to the processes and products required for this task.

Task 7 Deliverables

Plan and section drawings of each treatment wetland.
Treatment volumes and sizing criteria
A table of anticipated influent and effluent levels, similar to example below

Contaminant	Septic Tank Effluent mg/L	% removal by VSSF	VSSF Effluent mg/L	% removal by HSSF	HSSF Effluent mg/L
BOD	150	90	15	90	1.5
TSS					
Nitrate					
Etc					

Assemble the products on the InDesign presentation template. Title the sheet as "Wastewater Treatment". Save as a PDF file and submit as Wastewater *LastNames of Members*. See the course calendar for the due date.

Task 8 - Secondary Benefits

The stormwater landscapes that you have proposed in the previous tasks include benefits, such as aesthetic scenery, wildlife habitat and irrigation supply. This section asks that you reconsider your design for the project in order to maximize these secondary benefits. For example, you should develop a planting plan dominated by native plants, especially in areas adjacent to the habitat corridor through the site. Similarly, native and drought tolerant plants can minimize that amount of water needed for irrigation. After selecting the planting pallet and completing the planting plan, determine the irrigation volume required to achieve a thriving and attractive landscape. Use the research from the Water Use Classifications of Landscape Species research from California. Right click the link to download the PDF file to your computer. We will use the Region 1 data since it matches Moscow's summer conditions. Determine the water needs of each plant in your palette and for the total landscape. How much of this need can be provided by water that you store on-site in cisterns or ponds?

Task 8 Deliverables

- Planting design
- Plant Water Need spreadsheet.
- Volume of potable water conserved through substitution of non-potable water for toilet flushing and irrigation.

Task 9 - Irrigation Design for Water Conservation

We can engage a number of irrigation design practices and equipment specifications that will conserve the precious water we collect on-site or pump from the aquifer. A potential resource that mat be available since the University of Idaho is adjacent to the wastewater treatment plant is the reuse of sewage effluent for irrigation.

Task 9 Deliverables

Water a water conservation plan associated with irrigation.

Note: This is a text version of the assignment available at the web site http://www.webpages.uidaho.edu/larc380/new380/pages/Assignments/Assignment1.html

SouthHill Redevelopment

Inventory & Analysis

Site Inventory:

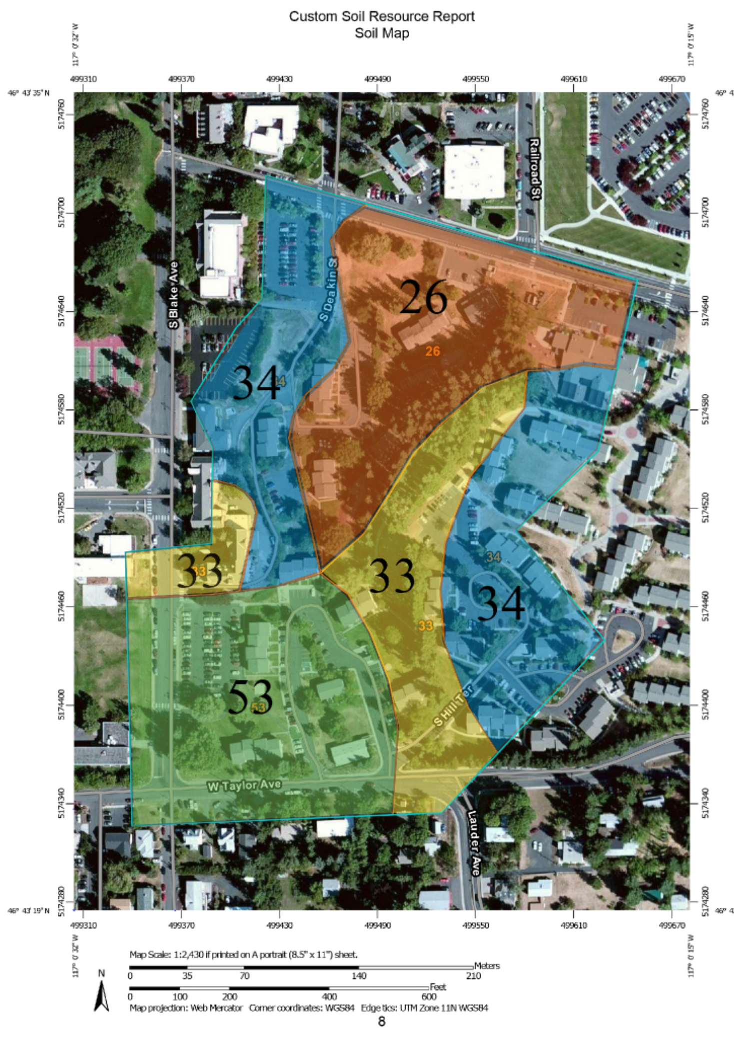
Area of Site:	505,017 sq. ft.
Area of Wooded Areas:	96,534 sq. ft.
Area of Off-site Stormwater Contribution:	8,561 sq. ft.

ToC Line= Time of Concentration line at 1350' has a time of concentraion of .267(hr) for a 2yr storm in Moscow of 1.8"
* A 1" event did not register and run-off

LARC 380 Managing Water in the Landscape
Spring 2014
Instructor: Gary Austin
Student Team One:
Robbie Quinn, Tyler Chambers, Jeff Gose, Kevin O'Hair, Kyle Moen, Jase Brooks

SouthHill Redevelopment

Soil Data:



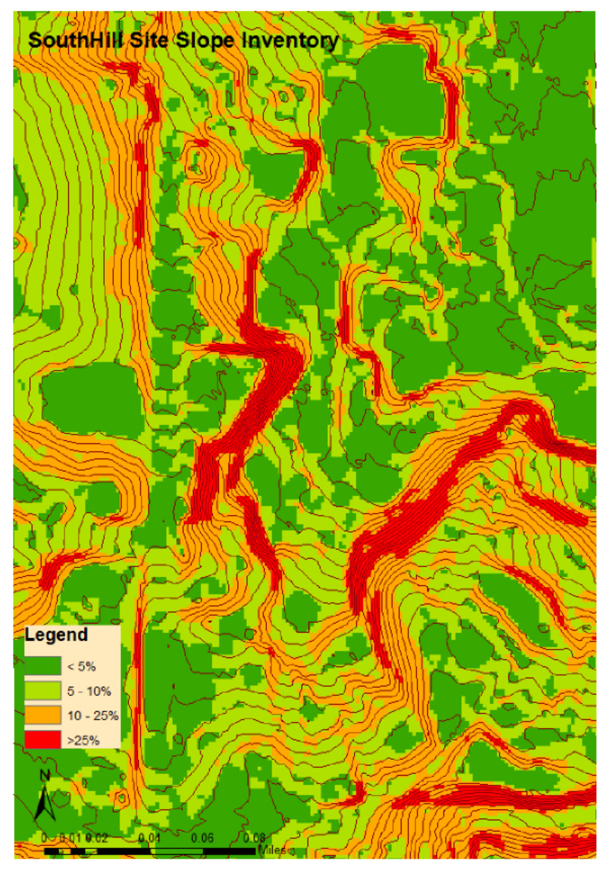
Soil Key

Map Unit Symbol	Map Unit Name	Rate of Percolation
Latah County, Idaho (ID057)		
26	Latahco silt loam, 0 to 3 percent slopes	.2 - .6 in/hr
33	Naff-Palouse complex, 7 to 25 percent slopes	.2 - .6 in/hr
34	Naff-Thatuna complex, 7 to 25 percent slopes	.2 - .6 in/hr
53	Thatuna silt loam, 3 to 7 percent slopes	.2 - .6 in/hr

Source: Natural Resources Conservation Service, 2013, Primary Data Characteristics Tables

There are four main soil types on the site. The largest being Naff-Thatuna complex, taking up about 30% of the site with a rate of percolation between .2 and .6 inches per hour. This soil type is found on slopes between 7% and 25%. The steepest locations on the site are generally the Naff- Palouse complex, which will require vegetation to minimize erosion.

Slope Inventory:



As with the climate, there is a wide variety of slopes the site. Ranging from nearly flat, to greater than 25%. Some of the steepest slopes on site are heavily vegetated with trees and grass. The majority of slopes on the site are less than 10%.

Climate Data:

Month	Average Daily Temp.	Average Daily Max.	Average Daily Min.	Avg. # Growing Degree Days	Average Precipitation (in.)	Average # Days 0.10" or more	Average Snowfall (in.)
January	29.2	35.3	23.0	39	3.23	9	15.9
February	34.5	41.4	27.5	49	2.01	6	6.9
March	38.3	46.9	29.7	71	1.96	7	4.8
April	45.5	56.6	34.3	191	1.79	6	0.9
May	53.7	66.6	40.8	425	1.77	5	0.0
June	59.9	73.7	46.0	597	1.72	5	0.0
July	66.6	84.3	48.8	825	0.58	2	0.0
August	66.1	83.3	48.8	809	0.85	2	0.0
September	58.9	73.9	43.7	567	1.19	4	0.0
October	48.9	60.3	37.3	287	1.90	5	0.3
November	37.7	44.8	30.6	63	3.02	8	4.4
December	31.4	37.0	25.7	26	3.35	10	14.9
				Average Total	23.37	Average Total	48.1

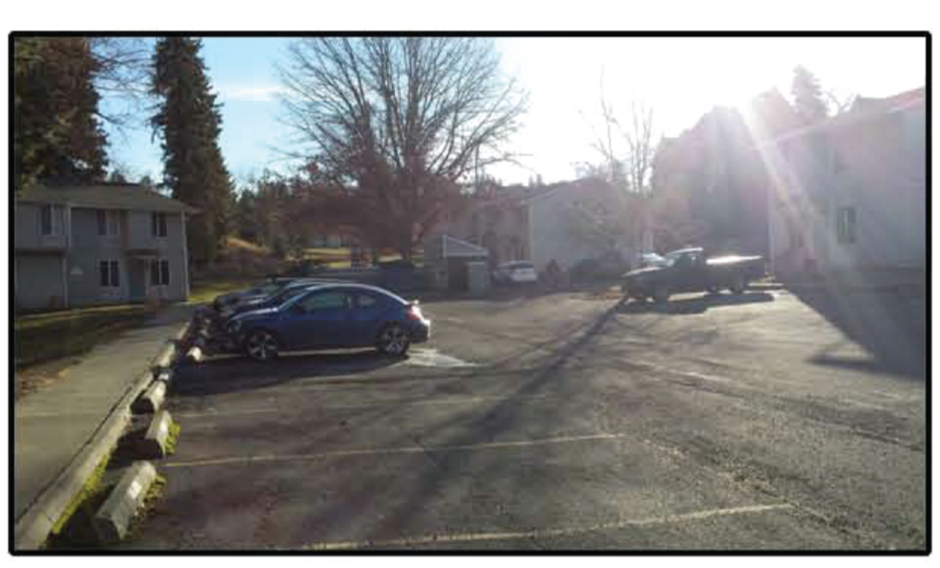
The climate in Moscow, ID is very wide spread, with temps range from 83.3 degrees in August to 35.3 degrees in January. There is also a wide range in precipitation, with the summer months receiving very little precipitation and the winter months receive much more, usually in the form of snow. This indicates that much of the plants will need to be somewhat drought tolerant for the summer, or require artificial water.

Photo Analysis

1. Taylor Ave Entry - All water from street flows right onto site
—

2. Large stand of Pines on the site is in excellent condition, some treatment for the brush is needed. Paths of desire have been clearly laid to the current design and could use professional attention for safety and asthetics.
+

3. Playground has no sense of place and lacks nearly any appeal to encourage play. The area is close to the apartments, however there is difficulty seeing children playing form the apartments. There is good sun light and mild slope.
—

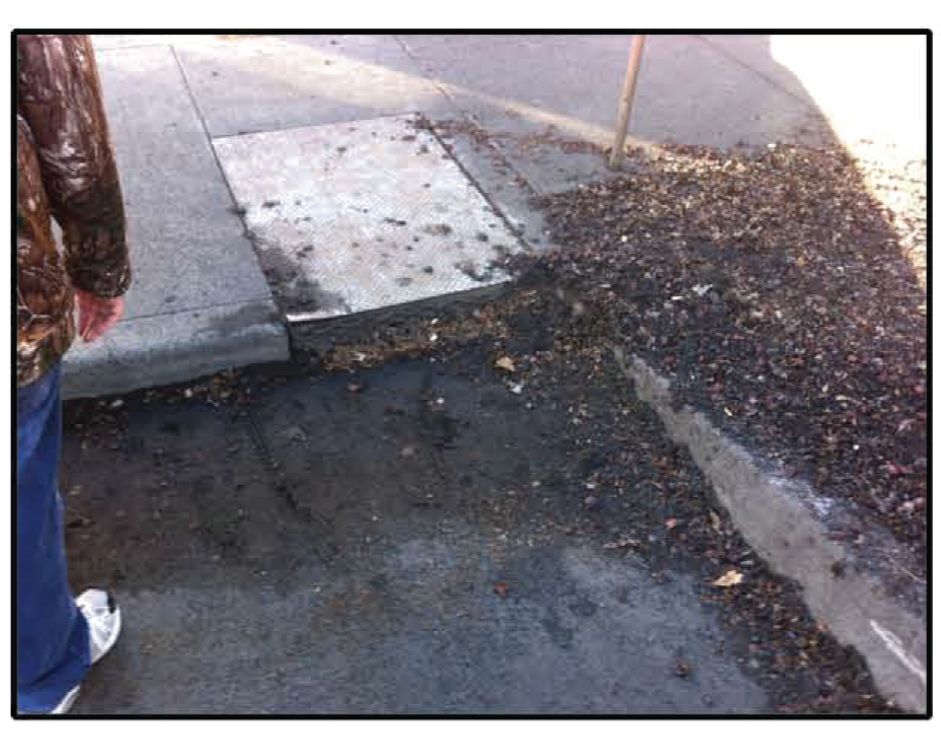


4. Parking lot with great potential to be a center of the housing area. Very gental slopes and receives a significant amount of sunlight year round. there is also a wooded area on both side of the lot.
+

5. Corner of Sweet and Deakin. Large old Willow. Large vacant area is in need of gathering amenities. Great opportunities for landscape rec area.
+

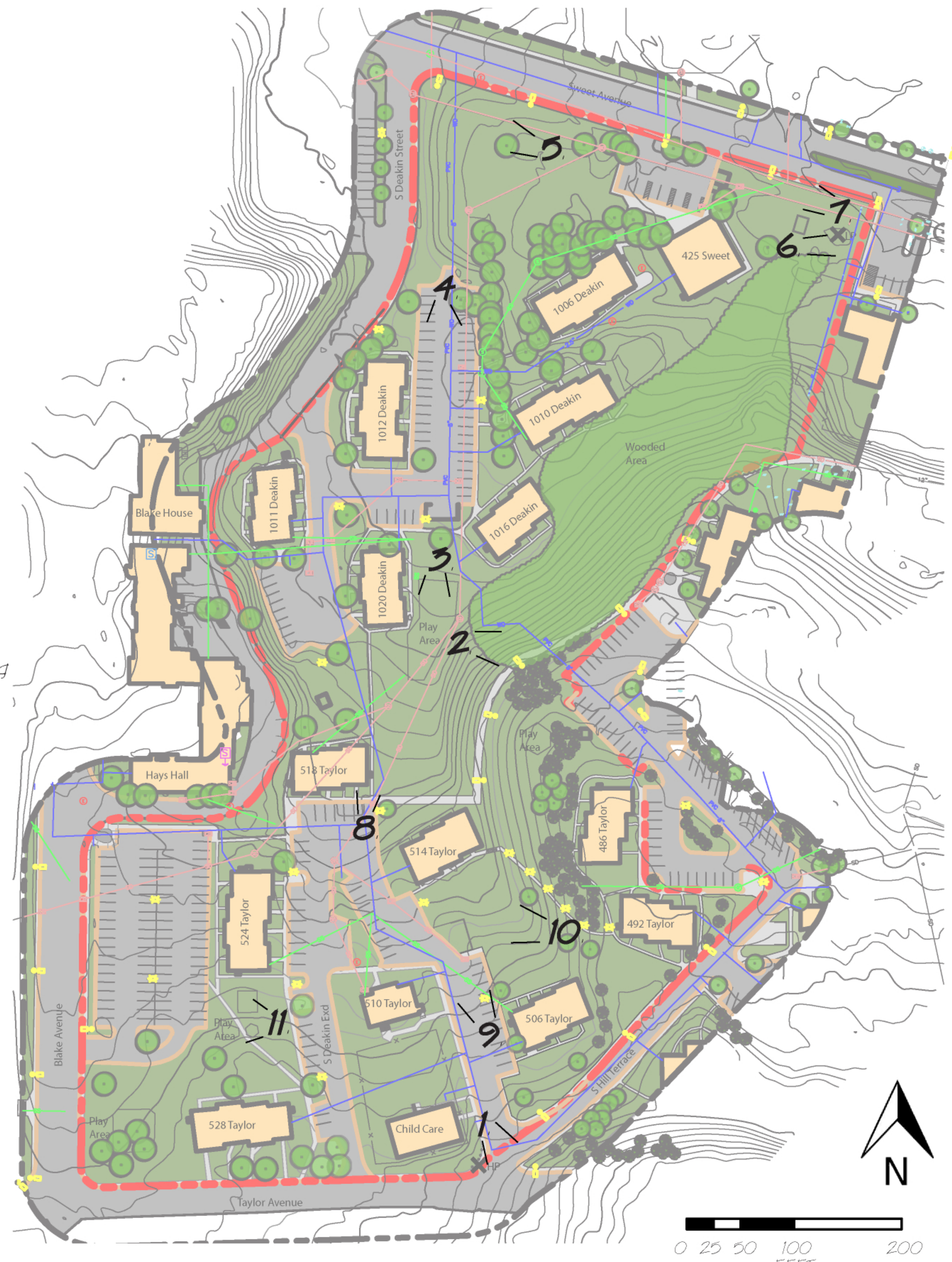
6. Transformers at the low point on the site. This is a prime are for gathering because of its location on Sweet Ave.
+

7. The low point on the site with a drain the brings water under sweet Ave.
—



8. Drain to help water escape the parking lot during storm events. Clearly clogged and poorly managed.
—

9. Looking in from Taylor Ave. Water flows directly towards buildings, bypassing drains because of poor placement.
—

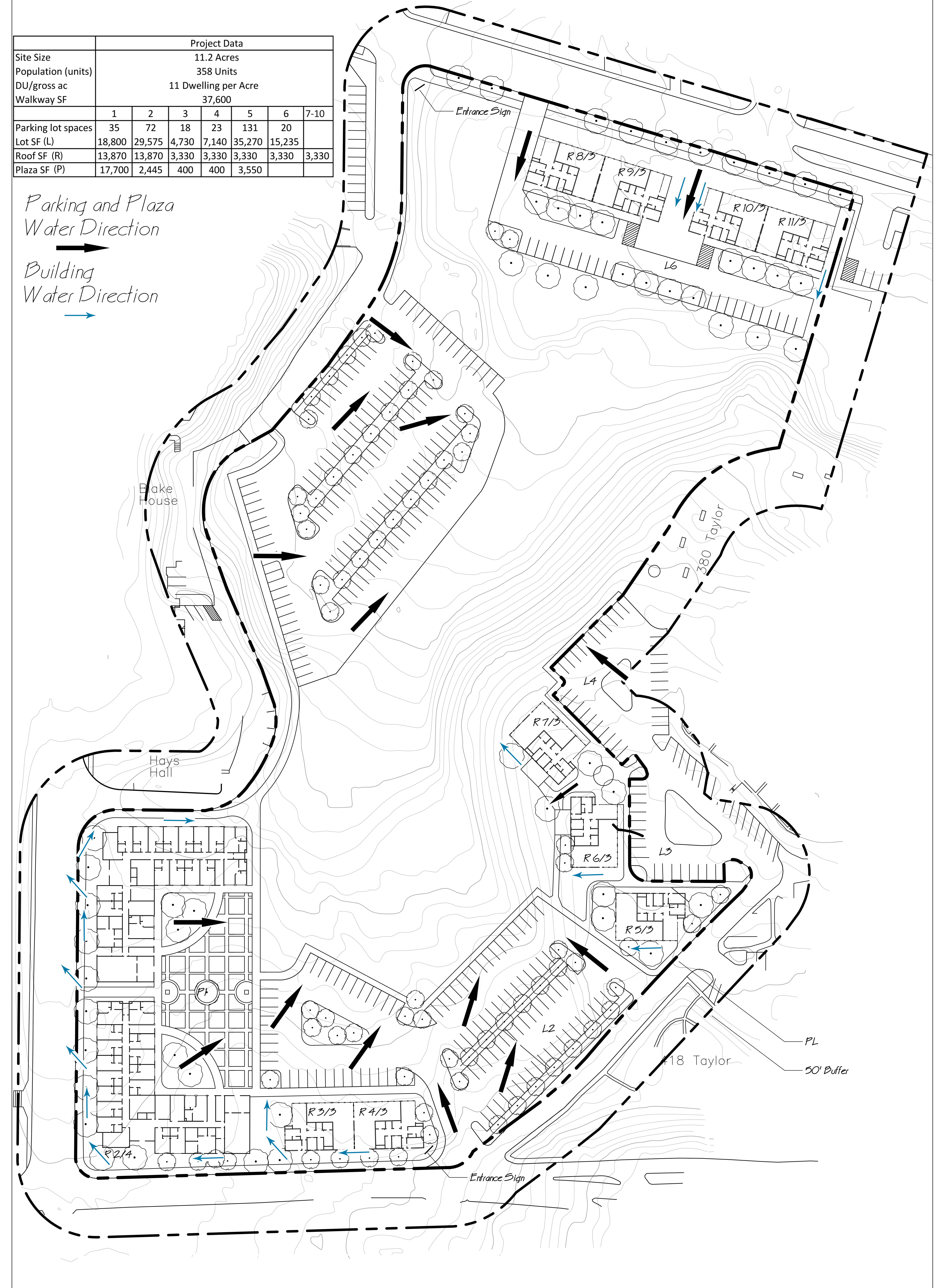


10. Entire grassy area drains to door step of apartments. Large wasted grassy space.
—

11. Small gazebo and basketball court. Not very inviting.
—

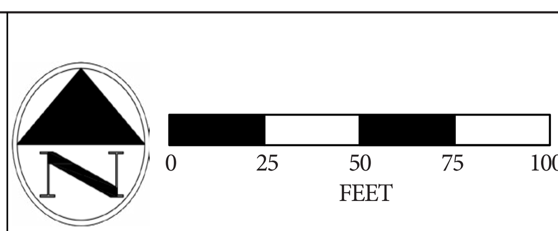
LARC 380 Managing Water in the Landscape
Spring 2014
Instructor: Gary Austin
Robbie Quinn, Tyler Chambers, Jeff Gose, Kevin O'Hair, Kyle Moen, Jase Brooks

	Project Data						
Site Size	11.2 Acres						
Population (units)	358 Units						
DU/gross ac	11 Dwelling per Acre						
Walkway SF	37,600						
	1	2	3	4	5	6	7-10
Parking lot spaces	35	72	18	23	131	20	
Lot SF (L)	18,800	29,575	4,730	7,140	35,270	15,235	
Roof SF (R)	13,870	13,870	3,330	3,330	3,330	3,330	3,330
Plaza SF (P)	17,700	2,445	400	400	3,550		



Southhill Student Complex

Site Layout



University of Idaho
Dept of Landscape Architecture
LARC 380 Managing Water in the Landscape
Instructor: Gary Austin
Students: Robbie Quinn, Kevin O'Hair, Kyle Moen, Jeff Gose, Tyler Chambers, & Jase Brooks

Task 2

SouthHill Redevelopment

Pre/Post Development Rates

	Peak Runoff CFS	Time of Peak Runoff (hr)	Runoff Depth (in)	Runoff Depth (ft)	Runoff Volume (ft³)
Pre-Development					
1" Event	n/a	n/a	n/a	n/a	n/a
2 Year	1.5	12.12	0.19	0.016	7,806
10 Year	4.94	12.09	0.442	0.037	18,051
25 Year	3.36	12.09	0.541	0.045	21,954

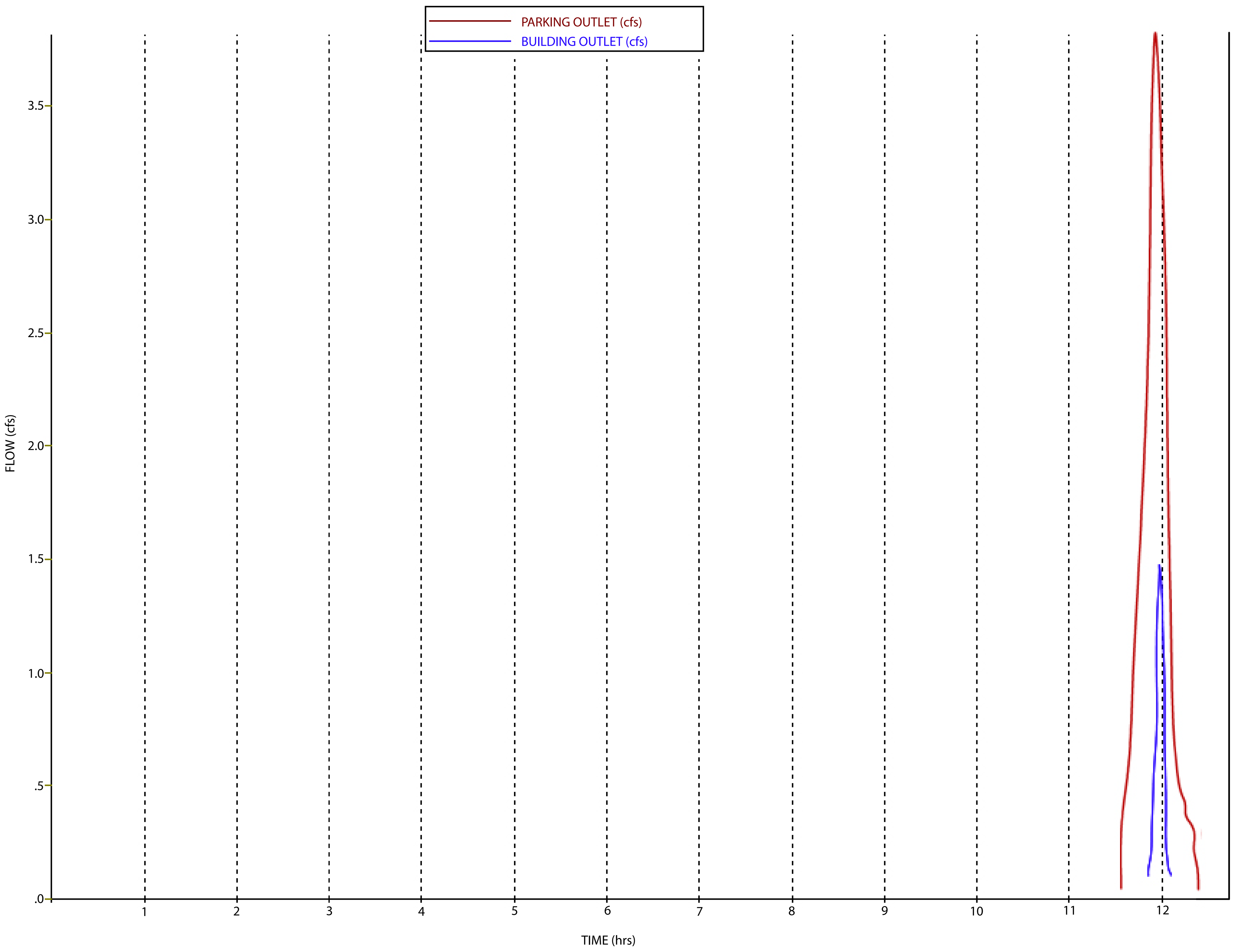
	Runoff Volume (ft³)		Runoff Volume (ft³)	Runoff Volume Diff (ft³)
Pre-Development		Post-Development		
1" Event	n/a	1" Event	5,853	5,853
2 Year	7,806	2 Year	18,208	10,402
10 Year	18,051	10 Year	33,088	15,037
25 Year	21,954	25 Year	37,843	15,889

		Peak Runoff CFS	Time of Peak Runoff (hr)	Runoff Depth (in)	Runoff Depth (ft)	Runoff Volume (ft³)
Post-Development						
1" Event						
	Parking 1	0.43	11.93	0.381	0.032	512.38
	Parking 2	0.39	11.93	0.369	0.031	448.17
	Parking 3	0.47	11.93	0.387	0.032	462.59
	Parking 4	0.49	11.93	0.391	0.033	598.42
	Parking 5	0.45	11.93	0.385	0.032	545.6
	Parking 6	0.29	11.93	0.341	0.028	303.86
	Parking 7	0.19	11.93	0.319	0.027	185.3
	Parking 8	0.21	11.93	0.324	0.027	207.6
	Parking 9	0.43	11.93	0.381	0.032	521.63
	Parking 10	0.47	11.93	0.387	0.032	550.78
	Outlet	3.82		0.373	0.031	4,310
	Building 1	0.37	11.93	0.365	0.03	415
	Building 2	0.37	11.93	0.365	0.03	415
	Building 3	0.16	11.93	0.304	0.025	157.45
	Building 4	0.08	11.93	0.215	0.018	56.7
	Building 5	0.08	11.93	0.215	0.018	56.7
	Building 6	0.08	11.93	0.215	0.018	56.7
	Building 7	0.16	11.93	0.304	0.025	157.45
	Building 8	0.06	11.93	0.304	0.025	157.45
	Natural Veg	0	n/a	0	0	0
	Outlet	1.48		0.057	0.005	1,543.35
	Total					5,853.35
2 Year						
	Parking 1	0.83	11.93	0.874	0.073	1,168.87
	Parking 2	0.74	11.93	0.839	0.069	997.53
	Parking 3	0.9	11.93	0.897	0.075	1084.2
	Parking 4	0.94	11.93	0.91	0.076	1,378.18
	Parking 5	0.87	11.93	0.888	0.074	1261.7
	Parking 6	0.56	11.93	0.77	0.064	694.52
	Parking 7	0.36	11.93	0.695	0.058	398.05
	Parking 8	0.4	11.93	0.716	0.059	453.65
	Parking 9	0.83	11.93	0.874	0.073	1,189.97
	Parking 10	0.9	11.93	0.897	0.075	1,291.57
	Outlet	7.31		0.857	0.071	9,871.48
	Building 1	0.71	11.93	0.827	0.069	954.89
	Building 2	0.71	11.93	0.827	0.069	954.89
	Building 3	0.31	11.93	0.673	0.056	352.69
	Building 4	0.16	11.93	0.586	0.049	154.35
	Building 5	0.16	11.93	0.586	0.049	154.35
	Building 6	0.16	11.93	0.586	0.049	154.34
	Building 7	0.31	11.93	0.673	0.056	352.69
	Building 8	0.31	11.93	0.673	0.056	352.69
	Natural Veg	2.21	12.03	0.315	0.026	6,568.85
	Outlet	4.45		0.39	0.033	8,337.38
	Total					18,208.86

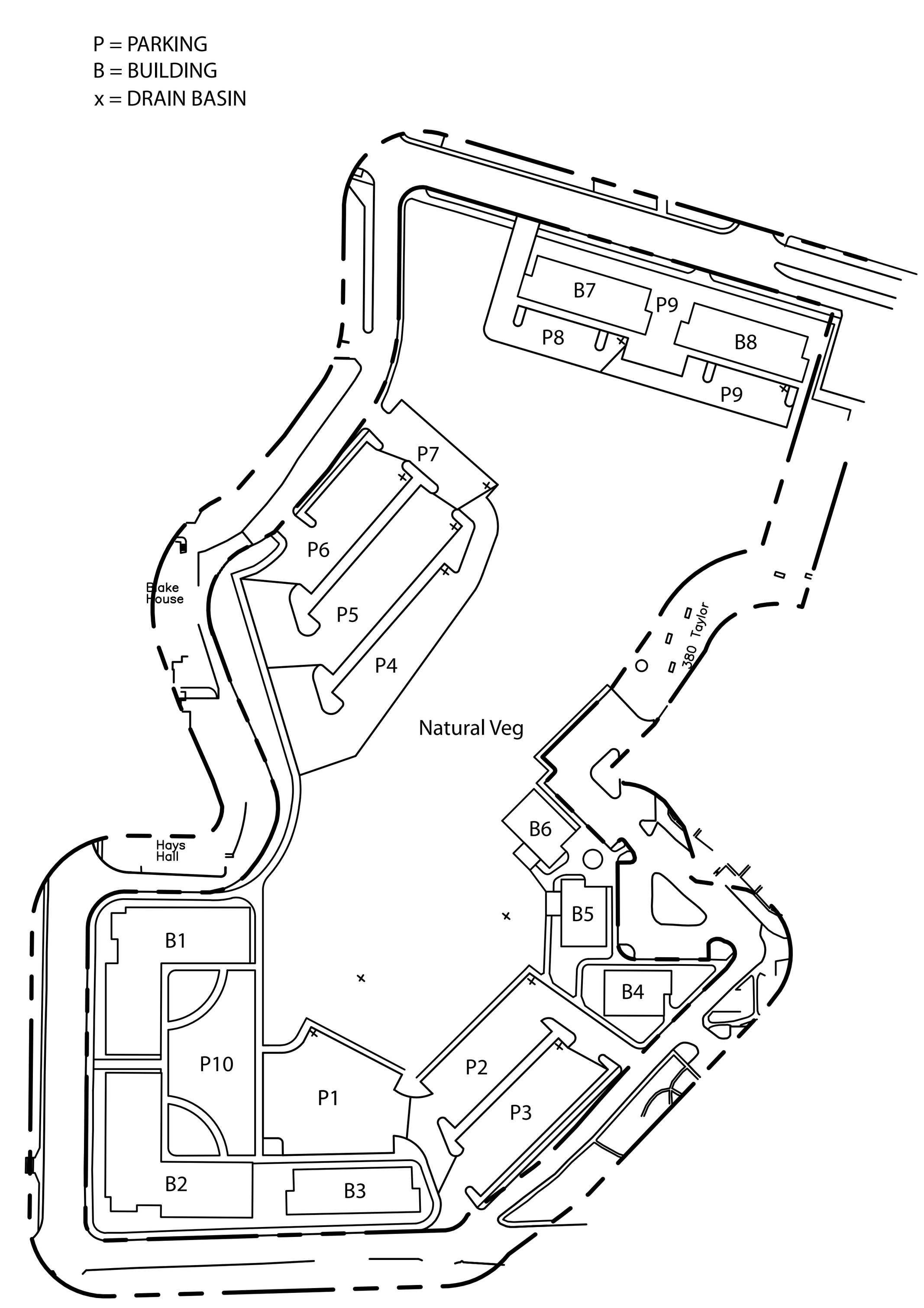
		Peak Runoff CFS	Time of Peak Runoff (hr)	Runoff Depth (in)	Runoff Depth (ft)	Runoff Volume (ft³)
Post-Development						
10 Year						
	Parking 1	1.12	11.93	1.317	0.109	1,745.31
	Parking 2	1	11.93	1.267	0.106	1,532.44
	Parking 3	1.21	11.93	1.352	0.113	1,922.65
	Parking 4	1.27	11.93	1.367	0.114	2,067.27
	Parking 5	1.18	11.93	1.339	0.112	1,909.60
	Parking 6	0.75	11.93	1.148	0.096	1,041.79
	Parking 7	0.48	11.93	1.014	0.085	583.35
	Parking 8	0.54	11.93	1.04	0.087	668.94
	Parking 9	1.12	11.93	1.317	0.109	1,776.81
	Parking 10	1.21	11.93	1.352	0.133	2,290.39
	Outlet	9.89		1.287	0.107	14,876.75
	Building 1	0.96	11.93	1.247	0.104	1,439.26
	Building 2	0.96	11.93	1.247	0.104	1,439.26
	Building 3	0.42	11.93	0.987	0.082	516.43
	Building 4	0.21	11.93	0.857	0.071	223.65
	Building 5	0.21	11.93	0.857	0.071	223.65
	Building 6	0.21	11.93	0.857	0.071	223.65
	Building 7	0.42	11.93	0.987	0.082	516.43
	Building 8	0.42	11.93	0.987	0.082	516.43
	Natural Veg	4.9	12.02	0.634	0.053	13,390.34
	Outlet	8.1		0.717	0.059	18,211.53
	Total					33,088.28
25 Year						
	Parking 1	1.21	11.93	1.471	0.123	1,969.48
	Parking 2	1.09	11.93	1.481	0.123	1,778.21
	Parking 3	1.32	11.93	1.506	0.126	1,821.45
	Parking 4	1.38	11.93	1.528	0.127	2,303.02
	Parking 5	1.28	11.93	1.491	0.124	2,114.20
	Parking 6	0.82	11.93	1.289	0.107	1,161.16
	Parking 7	0.52	11.93	1.125	0.094	645.12
	Parking 8	0.59	11.93	1.148	0.096	738.14
	Parking 9	1.21	11.93	1.471	0.123	2,005.02
	Parking 10	1.32	11.93	1.506	0.126	2,169.85
	Outlet	10.75		1.436	0.119	16,545.17
	Building 1	1.05	11.93	1.401	0.117	1,619.16
	Building 2	1.05	11.93	1.401	0.117	1,619.16
	Building 3	0.46	11.93	1.096	0.091	573.12
	Building 4	0.23	11.93	0.94	0.078	245.7
	Building 5	0.23	11.93	0.94	0.078	245.7
	Building 6	0.23	11.93	0.94	0.078	245.7
	Building 7	0.46	11.93	1.096	0.091	573.12
	Building 8	0.46	11.93	1.096	0.091	573.12
	Natural Veg	5.92	12.01	0.755	0.063	15,916.82
	Outlet	9.44	12.01	0.839	0.069	21,298.23
	Total					37,843.40

POST-DEVELOPMENT CONDITION FOR 1" EVENT

* PRE-DEVELOPMENT RATES DID NOT REGISTER FOR A 1" EVENT



WATERSHED KEY

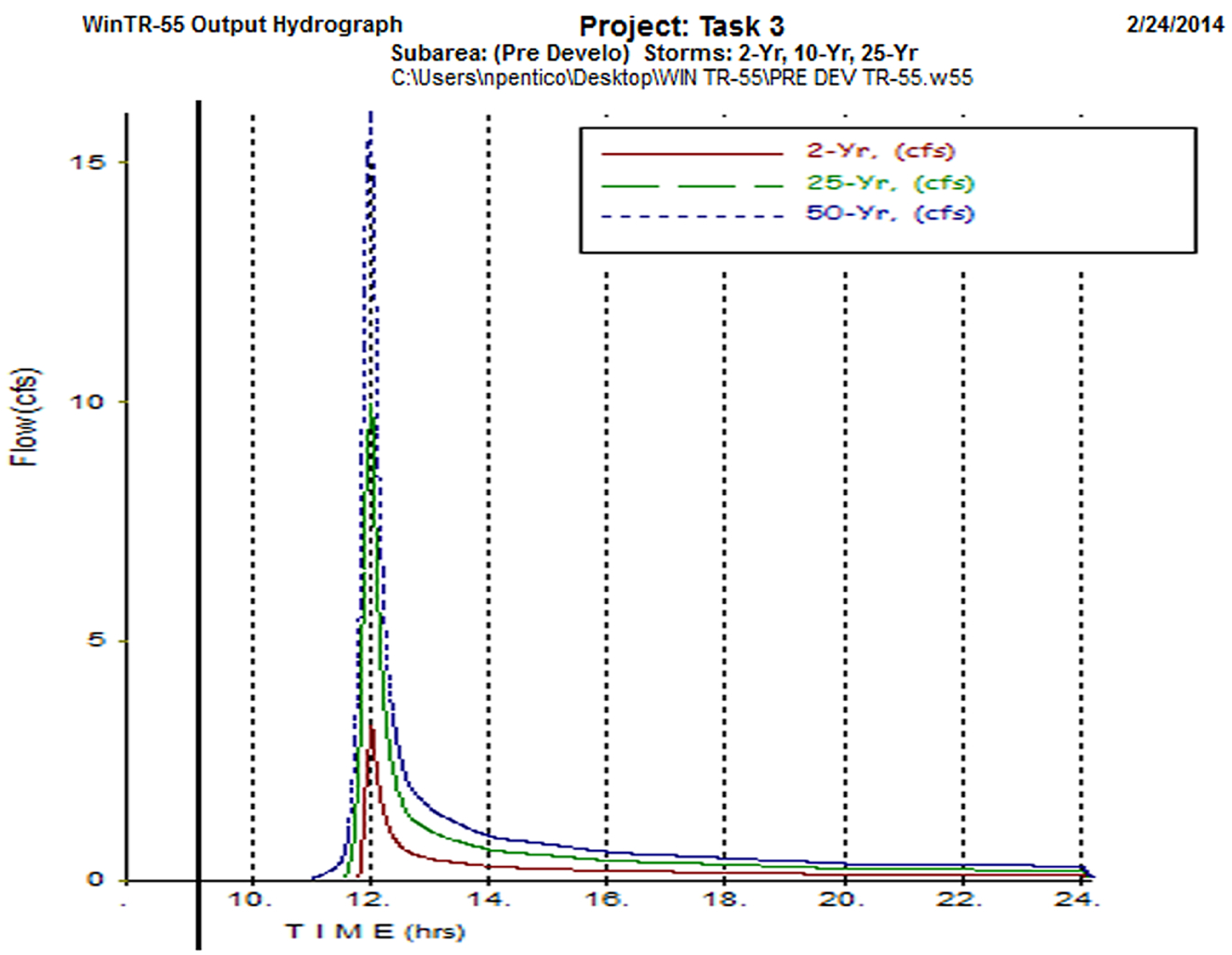


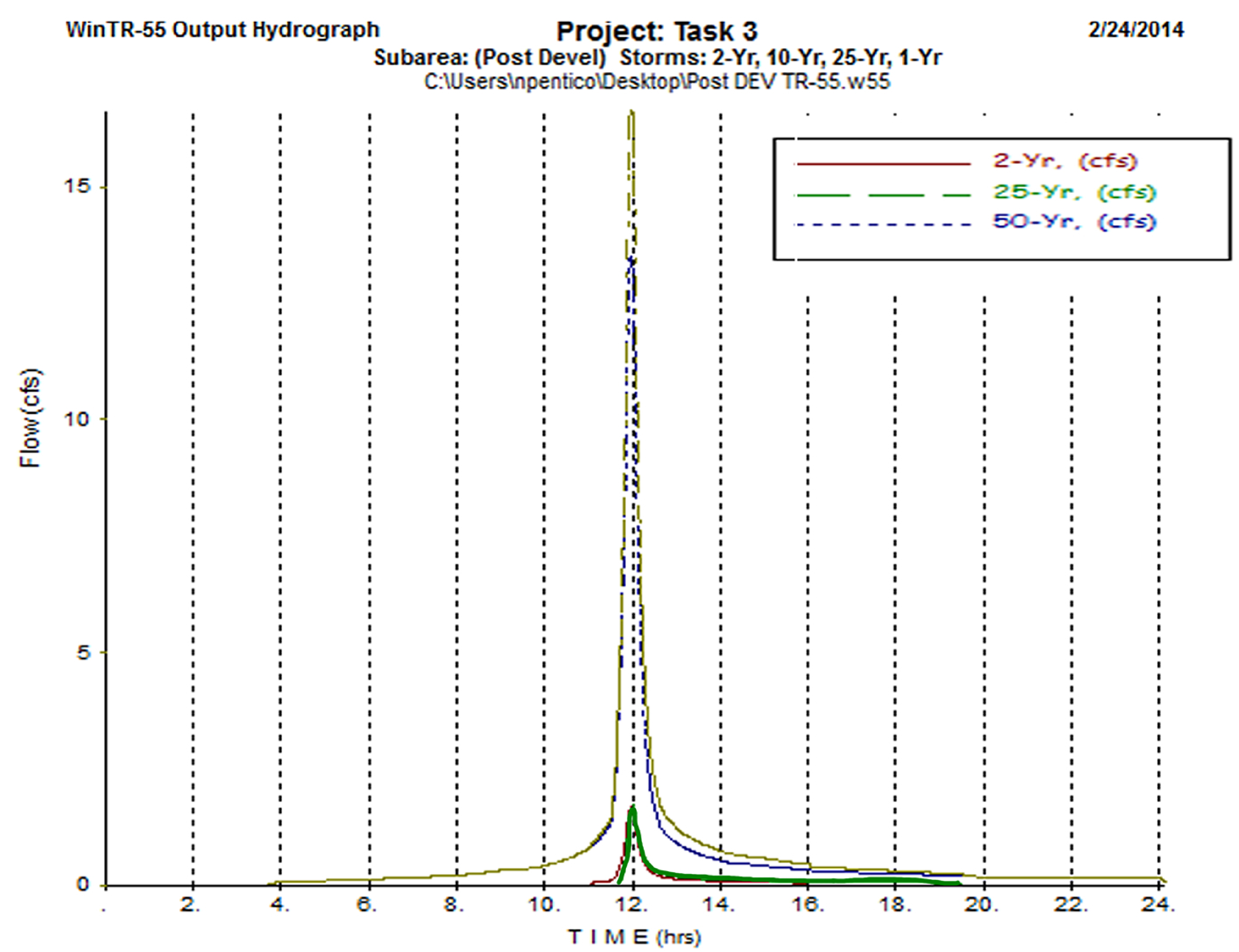
LARC 380 Managing Water in the Landscape
Spring 2014
Instructor: Gary Austin
Student Team One:
Robbie Quinn & Jeff Gose,

N

Pre- and Post-Development Runoff and Volume

Nicholas Pentico, Brian Edwards / LArc 380 / Gary Austin/Spring 2014

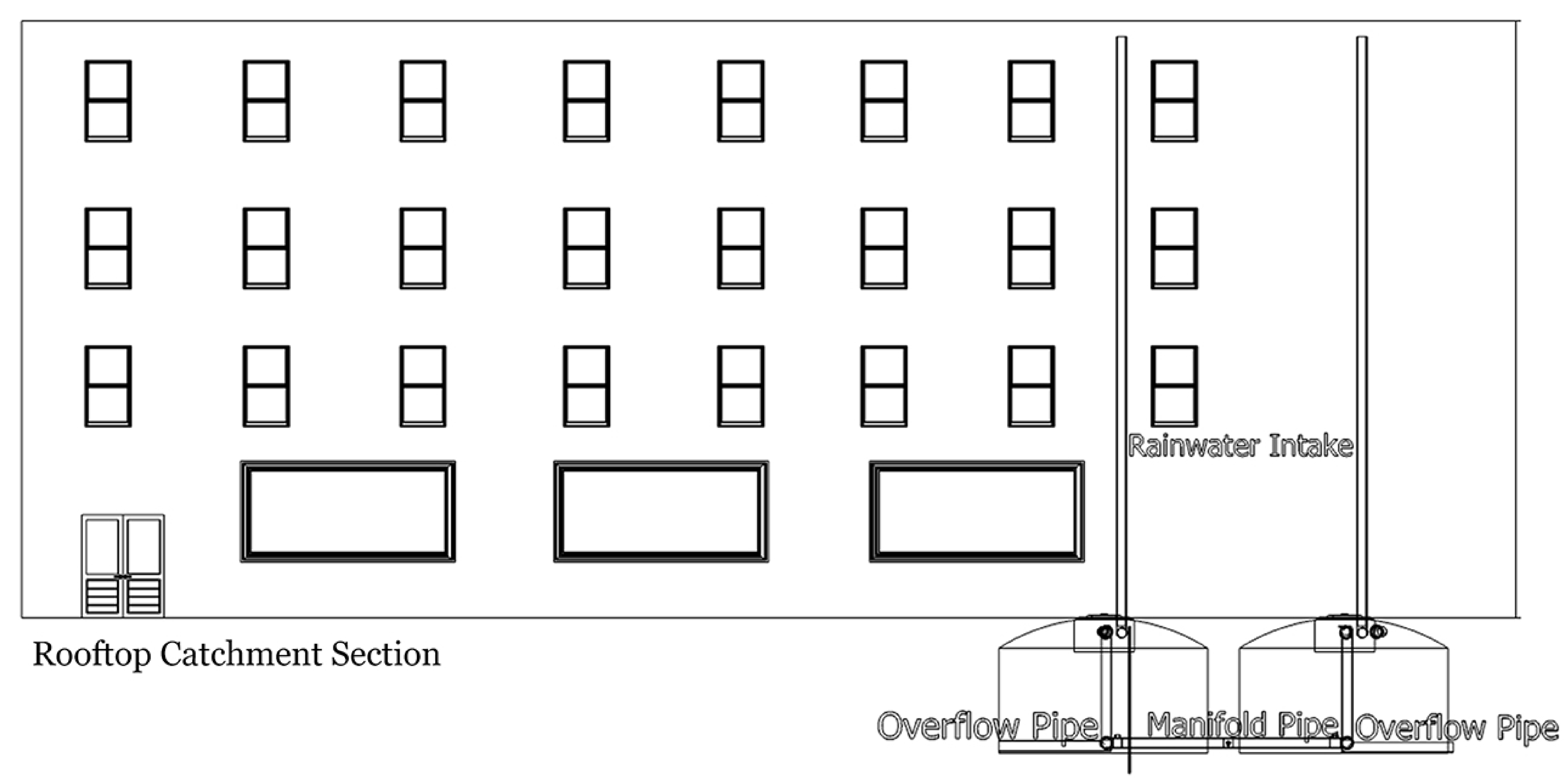




Monthly Rooftop runoff

		(L-Bldng) Impervious Harvesting monthly (gal)	Pinwheel Impervious Bldng Harvesting Monthly (gal)	(L-Bldng) Greenroof Harvesting monthly (gal)	Pinwheel Greenroof Bldng Harvesting Monthly (gal)	L-Bldng Toilet Flush water usage (gal)	Pinwheel Toilet Flush water usage (gal)
Jan	3.23	380526	271804	363614	259724	15624	15624
Feb	2.01	236798	169141	226273	161624	14112	14112
Mar	1.96	230907	164934	220645	157603	15624	15624
Apr	1.79	210880	150629	206190	143934	14112	14112
May	1.77	208523	148946	199256	145636	15624	15624
Jun	1.72	202633	144738	193627	138305	5040	5040
Jul	0.58	68329	48807	65293	46638	5208	5208
Aug	0.85	100138	71527	95688	68349	5208	5208
Sep	1.19	140194	100139	133963	95688	14112	14112
Oct	1.90	223839	159885	213890	152779	15624	15624
Nov	3.02	355786	254133	339973	242838	14112	14112
Dec	3.35	394663	281903	377123	269373	15624	15624
Total	23.37	2753220	1966586	2630854	1879182	150024	150024
Run-off Coefficient		90%	90%	86%	86%		

Post Development Plan
- Sub areas denoted with blue catch stormwater run-off



Rooftop Catchment Section

		Peak Run-off CFS	Run-off depth Inches	Time Peak Run-off	Run-off depth in Feet
Pre Development	2 Yr	3.21	0.261	12.03	0.021
	10 Yr	9.95	0.665	12.02	0.055
	25 Yr	16.07	1.037	12.01	0.086
Post Development	2 Yr	1.68	0.718	12	0.14
	10 Yr	4.11	0.901	12.02	0.34
	25 Yr	6.13	1.331	12.01	0.51

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Larc 380 - Water Conservation Technologies - Spring 2014 – Austin

Quiz One

Water Supply Introduction

1. What is the current annual rate of decline in the level of the Grand Ronde aquifer?
    a. About 1’
    b. About 2’
    c. About 3’
    d. About 4’
    e. About 5’

2. What is the daily per capita water use (in gallons) in Moscow?
    a. About 67
    b. About 87
    c. About 107
    d. About 127
    e. About 157

3. What is the average annual per capita water use for flushing toilets (in gallons, assuming 1.6 gallons per flush?
    a. About 920 gallons
    b. About 1,920 gallons
    c. About 2,920 gallons
    d. About 3,920 gallons
    e. About 4,920 gallons

4. Evaporation stress exceeds annual precipitation in Moscow, Idaho.
    a. True
    b. False

5. What is the average annual precipitation for Moscow (in inches)?
    a. About 13.4”
    b. About 20.4”
    c. About 23.4”
    d. About 28.4”
    e. About 33.4”

Water Harvesting from Roofs

6. In the Contec Engineering example of the impact of roof, surface and cooling system capture of non-potable water, what were the effects on potable water requirements?
    a. Potable water use was reduced form 3.1 million gallons to 1.25 million.
    b. Potable water use was reduced form 3.3 million gallons to 3.1 million.
    c. Potable water use was reduced form 0.3 million gallons to 0.125 million.
    d. Potable water use was reduced form 1. 3 million gallons to 1.25 million.
    e. Potable water use was reduced form 1.25 million gallons to 0.25 million.

7. Green roofs produce lower quality runoff than metal roofs.
    a. True
    b. False

8. About how many gallons of water per 100 square feet of roof area represent the first flush?
    a. 0.1
    b. 0.5
    c. 0.7
    d. 1
    e. 1.5

9. Calculate the gallons of water that can be collected from a 2,000 sq. ft. roof in and area with 24” of precipitation and with a runoff coefficient of 90%.
    a. 481
    b. 4,000
    c. 5,775
    d. 26,928
    e. 323,136

10. The water harvested for the Santa Ursula project supplied water for both laundry and irrigation.
    a. True
    b. False

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Quiz Two

1. The techniques discussed in the harvesting water from the landscape tutorial disconnect impervious surfaces.
    a. True
    b. False
2. What is the porosity of 2" drain rock?
    a. 20%
    b. 30%
    c. 40%
    d. 50%
    e. 60%
3. How far beyond their drip lines (canopy) should tree catchment basins extend?
    a. 6"
    b. 1'
    c. 2'
    d. 3'
    e. 4'
4. Calculate the volume (in cubic feet) of water held behind a berm on a slope if a basin is 8' wide, 2' deep, and 60' long. Show your work.
    a. 960
    b. 400
    c. 480
    d. 3,590
5. For only the Natural Vegetation column below which set of percentages correctly represent the hydrology of an area with natural vegetation.

	Natural Vegetation	Urban Area with 75% Imperviousness
Evaporation	a. 40% b. 20% c. 10% d. 15%	a. 60% b. 30% c. 50% d. 20%
Runoff	a. 10% b. 20% c. 35% d. 20%	a. 10% b. 55% c. 20% d. 30%
Shallow infiltration	a. 25% b. 30% c. 35% d. 25%	a. 20% b. 10% c. 25% d. 35%
Deep infiltration	a. 25% b. 30% c. 20% d. 40%	a. 10% b. 5% c. 5% d. 15%

6. For only the column above labeled the Urban Area with 75% Imperviousness, which set of percentages correctly represent the hydrology of an urban area.

7. Stormwater management focuses on the reduction of which two stormwater characteristics?
    a. Total suspended solids and nitrogen
    b. Biological oxygen demand and total suspended solids
    c. Non-point source pollution and sediment
    d. Non-point source pollution and pathogenic bacteria
    e. Volume and peak rate of runoff

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Quiz Three

18. What is the chance that a 5-year, 24-hour storm will occur during any year?
    a. 1%
    b. 2%
    c. 5%
    d. 20%
    e. 50%

19. What is a "design storm"?
    a. An attractive snowfall
    b. The 2-year 24-hour storm
    c. A storm magnitude defined by a regulatory agency
    d. The water quality storm

20. Which two factors determine a runoff curve number (CN)?
    a. Climate and region
    b. Climate and slope
    c. Land cover type and degree of imperviousness
    d. Soil type and land cover type
    e. Initial abstraction and land cover type

Quiz Four

21. Define the primary stormwater purpose of the detention pond.
    a. To protect streams and rivers from increased volume and velocity
    b. To permanently hold stormwater runoff on-site
    c. To detain sediment temporarily to avoid sedimentation of streams and rivers
    d. To improve water quality of stormwater runoff before it reaches streams and rivers
    e. To provide detain first flush pollutants
22. What is the purpose of a multi-stage outlet?
    a. To provide multiple openings in case one gets clogged with debris
    b. To provide a controlled flow outlet for each design storm
    c. To accommodate the 50-year, 24-hour storm
    d. To allow “big box” retailers to construct acres of impervious surfaces
    e. To allow vegetation to grow in stage one and water outflow in stage 2
23. List one advantage of detention basins as a stormwater management solution.
    a. The provide design jobs for beginning engineers
    b. They provide wildlife habitat
    c. They improve water quality
    d. They are recreation and aesthetic resources
    e. They don’t take much space compared to other stormwater management solutions
24. What is the percentage difference in pollution removal for a six-batch retention basin compared to a one-batch basin?
    a. 20%
    b. 30%
    c. 40%
    d. 50%
    e. 60%
25. In the study of the Australian wet pond/wetland comparison, what was the percentage of fecal bacteria removed by the wet pond? What percentage was removed by the wetland?
    a. The wet pond removed -2.5% and the wetland removed 79%
    b. The wet pond removed 2.5% and the wetland removed 79%
    c. The wet pond removed 25% and the wetland removed 79%
    d. The wet pond removed 79% and the wetland removed 25%
26. The study of the bioretention basin in Charlotte, North Carolina revealed that the peak runoff was reduced by what percentage?
    a. 16%
    b. 36%
    c. 56%
    d. 76%
    e. 96%
27. The study of the University of New Hampshire bioretention basin demonstrated a delay in the peak runoff. What was the delay in minutes?
    a. 42 minutes
    b. 92 minutes
    c. 142 minutes
    d. 192 minutes

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Quiz Five

28. Rooted macrophytes (wetland plants) generally require water depth less than ______ feet?
    a. 1
    b. 2
    c. 3
    d. 4
    e. 5

29. Conventional development of the Inland Empire Utilities Agency headquarters would have required which stormwater device at what cost?
    a. Sky hook at $10 million
    b. Activate sludge reactor at $10 million
    c. Box culvert $2 million
    d. 1 mile pipeline at $1 million

30. The Chino Creek Wetlands are designed to retain the ______ -year design storm.
    a. 2
    b. 10
    c. 25
    d. 50
    e. 100

31. At the Chino Creek wetlands what technique is used in the marsh to mix and redistribute water to the vegetated benches?
    a. Booster pumps
    b. End suction centrifugal pumps
    c. Deep water trenches
    d. Siphon chambers
    e. Capillary tubes

32. The Chino Creek wetlands demonstrated that a stormwater treatment park is a cost effective way of managing and treating stormwater compared to capture and treatment on individual parcels within the watershed?
    a. True
    b. False

33. How much cooler is the ASLA green roof than conventional black roofs?
   a. 2ºF
   b. 12ºF
   c. 22ºF
   d. 32ºF
   e. 42ºF

34. What is the typical soil depth for an extensive roof?
   a. 1”
   b. 3”
   c. 5”
   d. 7”
   e. 9”

35. How much does a 3-inch depth of wet soil media weigh?
   a. 1.5 pounds
   b. 4.5 pounds
   c. 7.5 pounds
   d. 10.5 pounds
   e. 13.5 pounds

36. Extensive roofs can retain about ________" of rainfall per inch of soil.
   a. 0.1”
   b. 0.3”
   c. 0.5”
   d. 0.7”
   e. 0.9”

37. The research of stormwater capture on extensive roofs in Auckland, New Zealand found that _______% of the total amount of rainfall was captured and evaporated or transpired.
   a. 16%
   b. 56%
   c. 76%
   d. 96%

38. How many inches of water does the drain mat on the Academy of Sciences green roof hold?
   a. 0.5”
   b. 1.5”
   c. 2.5”
   d. 4”
   e. 6”

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Quiz Six

39. What is the EPA standard for total suspended solids in secondary sewage effluent?
    a. 1.5 mg/Liter
    b. 5 mg/Liter
    c. 10 mg/Liter
    d. 15 mg/Liter
    e. 30 mg/Liter

40. What does the abbreviation TMDL stand for?
    a. Too Many Damn Labels
    b. Total Milligrams of Dissolved Lithium
    c. Tons of Malleable Lead
    d. Total Maximum Daily Load
    e. Tomas Maximilian del Laria (father of pollution testing)

41. What is the maximum number of colonies of *E. coli* within a 100 mL sample of water for rivers, lakes and coastal waters used for swimming (primary contact)?
    a. 1.6
    b. 29.6
    c. 126
    d. 1620
    e. 1 million

42. Which land-use typically contributes the most Phosphorus (P) to stormwater?
    a. Lawns
    b. Residential streets
    c. Industrial roofs
    d. Commercial streets

43. In the study of watershed streams near Atlanta GA measured the concentration of metals. Lead was at which measurement level?
    a. Below detection
    b. Below regulatory standard
    c. Acute
    d. Chronic

44. Very coarse sand is 2-1 mm in size.
    a. True
    b. False

45. The Seattle SEA streets project features a sidewalk on only one side of a narrow street, sheet flow to a curb and gutter and curb cuts draining water into a wet pond.
    a. True
    b. False

46. The Seattle SEA streets project reduced the volume of stormwater leaving the neighborhood by ______ percent.
    a. 20
    b. 40
    c. 70
    d. 80
    e. 99

47. At Siskiyou street demonstration project the area of infiltration beds were ________ percentage of the catchment area.
    a. 1
    b. 5
    c. 10
    d. 15
    e. 30

48. The bioretention basin in Charlotte, North Carolina demonstrated a very high capacity to remove ammonium and zinc. What was the removal percentage for ammonium?
    a. 73
    b. 80
    c. 93
    d. 99

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Quiz Seven

1. The Wilmington stormwater wetland decreased the fecal coliform bacteria an average of _______ percent.
    a. 10
    b. 31
    c. 55
    d. 77
    e. 99

2. Characterize the effectiveness of the Wilmington stormwater wetland for the removal TSS, ammonium, total phosphorus and nitrate.
    a. Low
    b. Moderate
    c. High

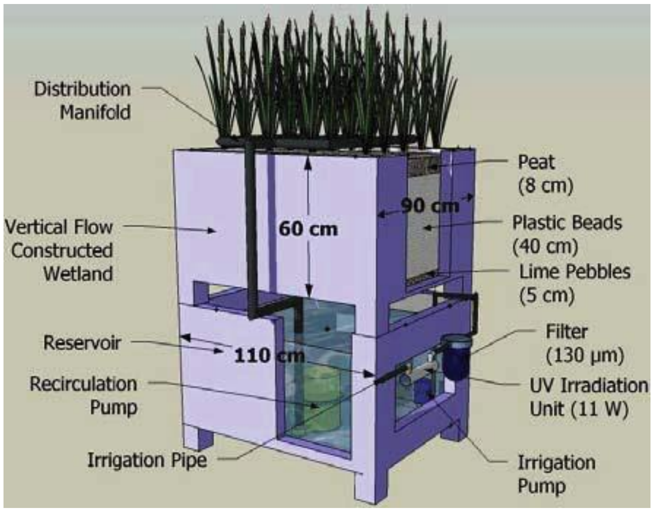
3. What are rotifers?
    a. Rotating bio-filters
    b. Microorganisms
    c. Emergent plants
    d. Fungi

4. What is the purpose of the two, six-foot deep, forebays in the Wilmington stormwater wetland?
    a. To trap nitrates
    b. To trap BOD
    c. To trap sediment
    d. To trap invasive plant seeds
    e. To trap ammonium

5. What device evenly distributes stormwater across the Wilmington stormwater wetland?
    a. A notched weir
    b. A dam
    c. A deep water trench
    d. A 6” perforated pipe
    e. A gravel-filled trench

6. Approximately how much greywater is generated by each person per day?
    a. 15
    b. 35
    c. 55
    d. 100

7. Study the table and the image below. Which column in the table correctly characterizes the performance of the greywater treatment system shown in the image?



	A	B	C	D
How the water is oxygenated	By an aeration pump	By pants submerged in the bottom tank	By water dripping between tanks	By an algae mat
Water recirculation rate	10 gpm	20 gpm	20 gpm	80 gpm
Percent of ammonia removal	11%	41%	81%	81%
Amount of nitrate gain	5 mg/L	15 mg/L	25 mg/L	45 mg/L
Percent of reduction in *E. coli*.	99%	79%	99%	59%

8. The Brazilian example of a constructed wetland system for treating greywater found that at least _______% of the COD was removed from the raw greywater.
   a. 12
   b. 32
   c. 52
   d. 72
   e. 92

9. How does the EPIC greywater reuse system deliver water to the root zone of plants without drip emitters.
   a. Through capillary action
   b. Siphon tubes
   c. Intermittent flooding
   d. Spray heads connected to the underground storage chambers

Quiz Eight

58. Why is activated sludge added to water after the primary treatment phase in a conventional wastewater treatment plant?
    a. To convert phosphorus to phosphate
    b. To eliminate the need to aerate the water
    c. To oxygenate the water
    d. To add bacteria and other microorganisms

59. What are the BOD and TSS secondary treatment standards set by the U.S. EPA?
    a. 10
    b. 20
    c. 30
    d. 40
    e. 50

60. List two features of highly efficient septic tanks.
    a. One round chamber and one rectangular chamber
    b. Two chambers and an aeration pump
    c. Multiple chambers and an effluent filter
    d. An oil/water separator, sludge tank and three holding chambers

61. What percentage of private, small scale septic systems fail?
    a. 30%
    b. 40%
    c. 50%
    d. 60%
    e. 70%

62. Study the table and select the correct set of specifications for a Horizontal Subsurface Flow wetland?

	A	B	C	D
Inlet and outlet trench gravel size	.8-1.2” diameter	¼ - 3/8” diameter	3/8” - ¾” diameter	1 ½” – 3” diameter
Main bed depth	6”-12”	12”-18”	12”-18”	24”-30”
Percent slope on the top and bottom of the bed	1%	0.5%	2%	0%
Residency time required to meet secondary water quality standards	12 hours	1 day	2 days	3 days

63. The performance of the University of New Hampshire gravel wetland demonstrated at least 95% removal of dissolved inorganic nitrogen, total suspended solids, zinc, and total petroleum hydrocarbons and diesel.
    a. True
    b. False

64. How many square feet of HSSF wetland area per person served is required to meet EPA secondary treatment standards in summer and winter?
    a. 21
    b. 5
    c. 50
    d. 30
    e. 2

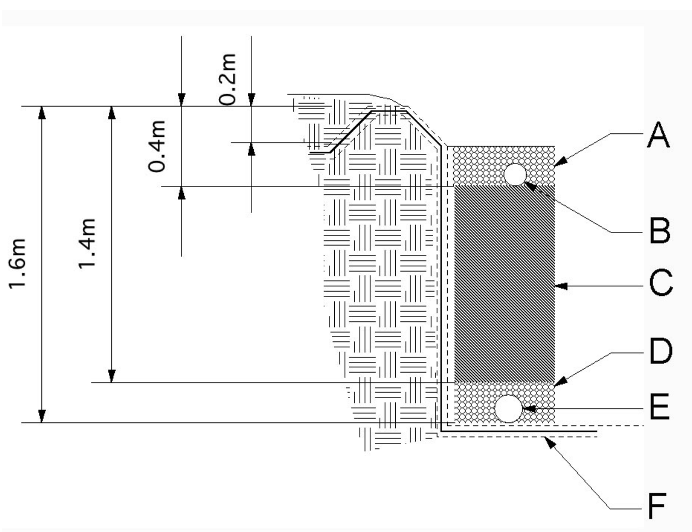
65. Although the porous paving and gravel wetland at the Greenland Meadows shopping center performed better it cost lightly more than a conventional system of stormwater sewers and detention ponds.
    a. True
    b. False

66. The vertical subsurface flow wetland treating wastewater receives continuous water inflow.
    a. True
    b. False

67. For treatment of domestic wastewater, VSSF wetlands require only __________ square feet per person served.
    a. 21.5
    b. 2
    c. 50
    d. 5

68. In the Austrian case study of the two-stage VSSF demonstration wetland, the amount of nitrate increased since VSSF wetlands are aerobic.
    a. True
    b. False

Annotate (provide as much information about the element as you can) the section of the VSSF wetland shown below. 6 points.



Department of Landscape Architecture
Larc 380 - Water Conservation Technologies - Spring 2014 – Austin

1. How many square feet per person served is required for proper sizing of FWS wetlands intended to treat domestic wastewater to secondary standards?
    a. About 5
    b. About 10
    c. About 21
    d. About 30
    e. About 50

2. What kind of outlet structure was used on the Dye Branch stormwater wetland cells?
    a. Multi-stage stand pipe
    b. Free-board outlet device
    c. Broad-crested weir
    d. V-notch weir

3. What element was added to the retention basin in Aarhus, Denmark to cause it to behave more like a hybrid wetland and treat dissolved pollutants?
    a. A planted sand filter just before the outlet structure
    b. A siphon tube
    c. A planted sand filter just after the pond inlet
    d. Planted floating polypropylene islands

4. What are the four categories of ecosystem service articulated by the Millennium Ecosystem Assessment?
    a. Economic, cultural, aesthetic, environmental
    b. Provisioning, regulating, supporting, cultural
    c. Aquatic, atmospheric, geological, terrestrial
    d. Avian, mammalian, reptilian, human

5. The Oaklands Park hybrid wetland provides advanced treatment of domestic wastewater. Which standard did this system meet for concentration of pathogens?
    a. Drinking water standard
    b. Secondary recreational contact standard
    c. Primary recreational contact standard
    d. *E. coli* less than 100 cfu per 100 mL

6. The contemporary hybrid wetland demonstration project in the Czech Republic required ___________square meters per person served.
    a. 1 m^2
    b. 2 m^2
    c. 3 m^2
    d. 4 m^2
    e. 5 m^2

7. The contemporary hybrid wetland demonstration project in the Czech Republic achieved a concentration of ___________ mg/L of nitrate in the effluent.
    a. 0.1
    b. 1.1
    c. 3.3
    d. 4.4

Course website link:

https://www.webpages.uidaho.edu/larc380/