Continuing Education Course #209
Green Irrigation Fundamentals
Balancing Aquifer Recharge and Withdrawal

1. The balanced irrigation water demand is based mainly on (hint: water created by the improvements):
- a. water from the aquifer
- b. water from stormwater runoff
- c. net recharge to aquifer
- d. surface water inflow

2. The proposed balanced irrigation water demand methodology applies to which of the following? (hint: methodology)
- a. residential home
- b. commercial development
- c. residential subdivision
- d. condominium structures
- e. all of the above

3. Which is the most desirable drainage basin condition for the balanced irrigation water demand analysis? (hint: internally drained)
- a. Condition 1: closed drainage basin
- b. Condition 2: drainage basin with some surface discharge
- c. Condition 3: drainage basin with discharge & artesian aquifer

4. Which is the least desirable drainage basin condition for the balanced irrigation water demand analysis? (hint: coastline communities)
- a. Condition 1: closed drainage basin
- b. Condition 2: drainage basin with some surface discharge
- c. Condition 3: drainage basin with discharge & artesian aquifer

5. Groundwater use for irrigation in Florida has been recognized as beneficial use of water when it comes to protecting the aquifer systems in Florida. (hint: water use).
- a. True
- b. False

6. In the balanced irrigation water demand calculations presented in this course, which is the primary "source" of water used? (hint: water sources)
- a. shallow aquifer
- b. Floridan aquifer
- c. rainfall
- d. public water supply
- e. surface water

7. Some of the coastal communities in Florida are developed with large wet detention ponds where the stormwater runoff is temporarily detailed and then discharged to the drainage canals or creeks that flow into the intercostal waterways. The detention ponds are built for water quality treatment and detention time. Will this balanced irrigation water demand analysis be applicable to projects developed with wet detention ponds? (hint: coastal communities).

- a. Yes
- b. No

8. As presented in this course, the rainfall data for most areas in Florida is relatively easy to obtain from government and/or private company sources. (hint: weather station).

- a. True
- b. False

9. Most areas in Florida have radar rainfall data that can be downloaded for any point, area or region. (hint: radar).

- a. True
- b. False

10. As with rainfall data, the evaporation and evapotranspiration rates (water losses) for various open water bodies, land uses, ground surfaces and vegetation covers are easy to obtain. (hint: water losses)

- a. True
- b. False

11. In Dr. Eslinger's literature review, he states: "In estimating evaporation (E) and evapotranspiration (ET) from the use/land cover types, three groups with similar data availability/hydrologic considerations emerge". Which of the following is not included in the list? (hint: approach)

- a. open water/wetland
- b. Aquifer water
- c. Impervious surfaces
- d. Pervious/vegetated surfaces

12. Pan evaporation is referred to as the - (hint: pan evaporation)

- a. Field measurements of evaporation from standardized open pans
- b. Field measurements of evaporation losses from lakes
- c. Field measurements of evapotranspiration from plants grown in standardized pans or pots
- d. Direct evaporation measurements in laboratory controlled instruments (pans)

13. According to Dr. Eslinger's data, evaporation from impervious surfaces is generally estimated by water budget techniques and not direct measurement. (hint: methodology overview).

- a. True
- b. False

14. Dr. Eslinger states that "Runoff from impervious surfaces, such as roofs, roads, sidewalks, parking lots, etc., frequently is estimated using the SCS curve number approach put forward in Technical Reference-55 (USDA NRCS, 1984), using a curve number, CN, of 98. One of the variables in the runoff calculation is the *initial abstraction*, defined as all losses from rainfall before runoff begins: evaporation, infiltration, storage in interstitial spaces, interception by vegetation, etc.". Is this method to calculate evaporation losses from impervious surface accurate and recommended by Dr. Eslinger? (hint: initial abstraction)

- a. Yes
- b. No

15. In Dr. Eslinger's report on evaporative losses from rooftops, what was the annual percentage of rain that evaporates from roofs with 50° roof slope? (hint: rooftops)

- a. 9.0%
- b. 14.7%

- ○ c. 24.7%
- ○ d. 30%
- ○ e. 39%

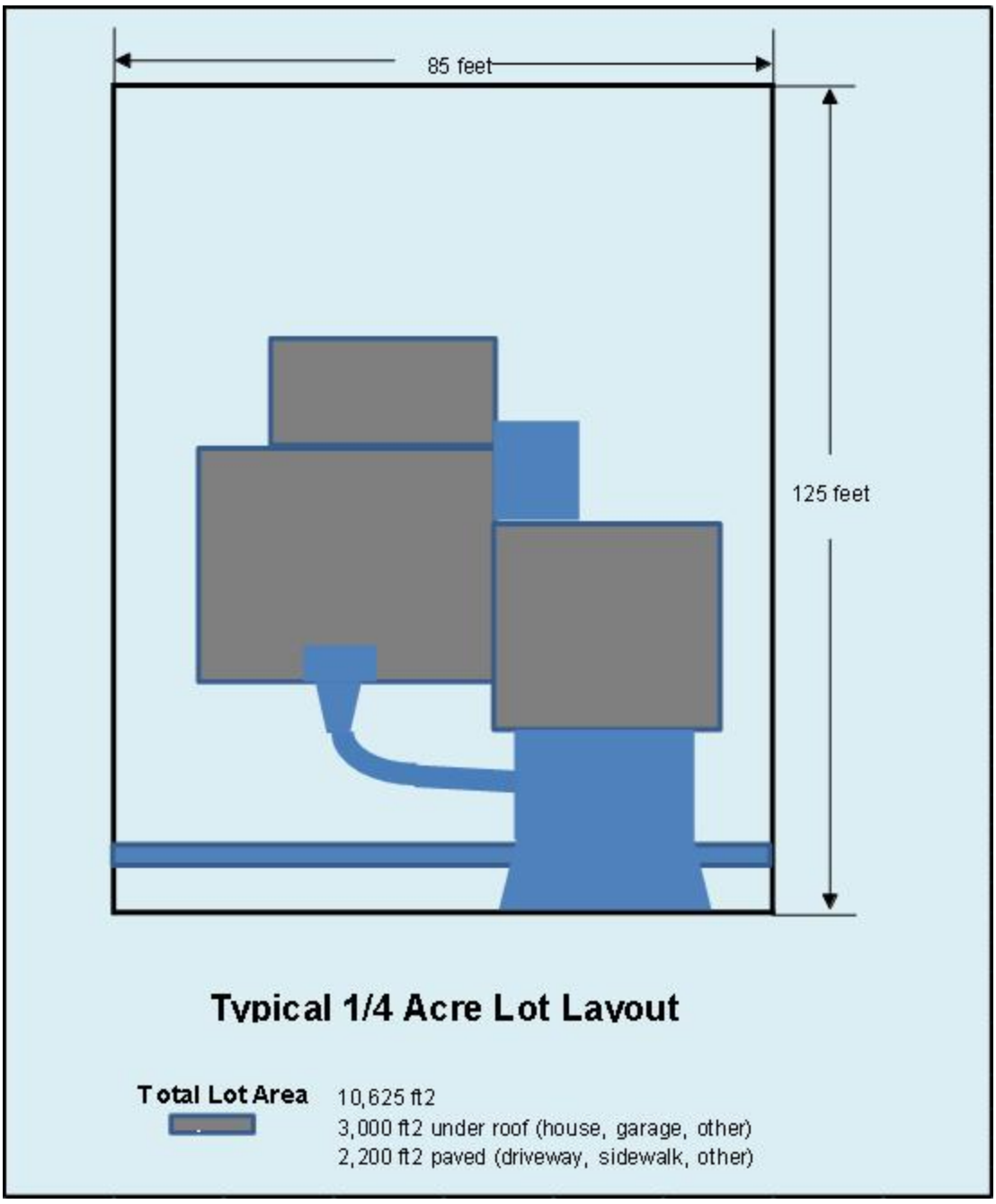
16. In the water table effects and wet versus dry seasonal factors section of Dr. Eslinger's report, he states "Water table depth also influences E and ET, and, in turn, may be influenced by management practices. The maximum evapotranspiration has been expressed by an exponentially decreasing function of distance to ground water table (Tibbals, 1978)" and presents a graphical relationship in Figure 1. Using Figure 1, what would be the approximate maximum evapotranspiration rate for a site with a groundwater depth of 5 feet? (hint: seasonal factors)

- ○ a. 29.5 in/year
- ○ b. 35.0 in/year
- ○ c. 37.5 in/year
- ○ d. 40.5 in/year

17. In Example 1, what was the type of drainage basin used to analyze the effects of constructing a single family residential home? (hint: Example 1)

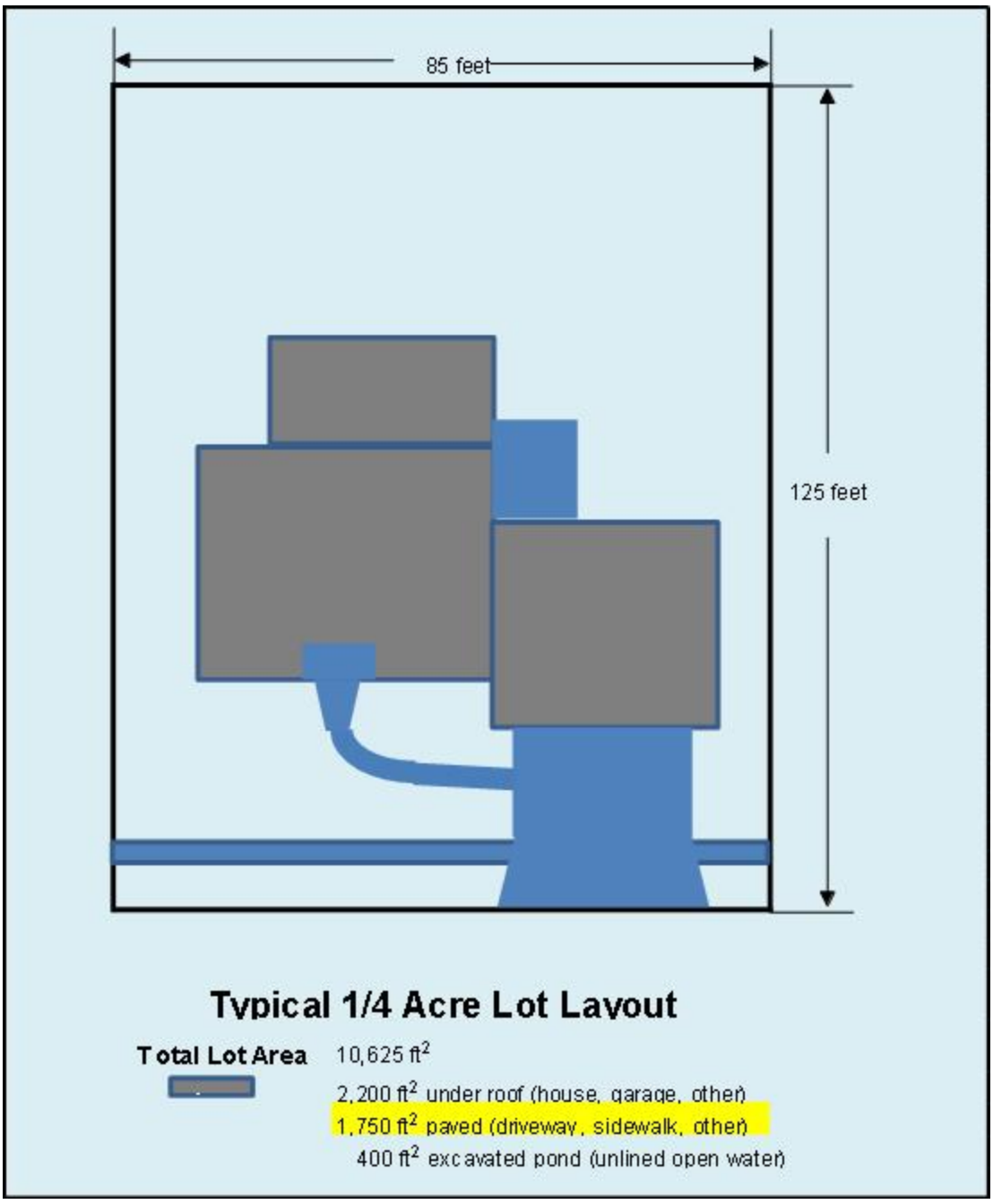
- ○ a. Condition 1: closed drainage basin
- ○ b. Condition 2: drainage basin with some surface
- ○ c. Condition 3: drainage basin with discharge & artesian aquifer

18. In Example 1, change the rooftops to a total of 3,000 ft^2 and the total of paved surfaces to 2,200 ft^2, see revised figure below. Recalculate the approximate "Maximum Irrigated Surface Area" (assume the same 36 in/year for irrigation rate). (hint: Example 1)



- ○ a. 3100 ft^2
- ○ b. 4100 ft^2
- ○ c. 5,100 ft^2
- ○ d. 6,100 ft^2
- ○ e. 7,100 ft^2

19. Using the data of Example 2, keep all parameters the same except for the paved area (total of driveways, sidewalks, pads, etc.) and calculate the paved area needed to allow irrigation of the entire unpaved surface of the lot (note that the pervious area available to irrigation decreases as you increase the paved impervious area): (hint: Example 2)



- a. 2,850 ft^2
- b. 3,000 ft^2
- c. 3,300 ft^2
- d. 4,400 ft^2
- e. 5,300 ft^2

20. In Example 3, large volume of excess water was generated by the high density subdivision conditions. The irrigation demand on the property was demonstrated to be a fraction of the available water for irrigation. Assume that the 155 residential lots will utilize an annual average irrigation water of 250 gallons per day (gpd). Calculate the total annual irrigation water demand for all 155 lots and then subtract it from the total excess water generated under the post development conditions (net post-pre volume). What is the remaining volume of water that will still be available for either additional aquifer recharge or reuse for other purposes, assuming that a balanced water system will be maintained in terms of pre and post net recharge conditions (rounded to the nearest 1,000)? (hint: Example 3)

- a. 63,000 cubic feet per year
- b. 385,000 cubic feet per year
- c. 563,000 cubic feet per year
- d. 806,000 cubic feet per year

21. The balanced irrigation water demand analyses presented in this course are very detailed and account for any site conditions and incorporate all potential water sources and water losses for any project across Florida and other parts of the world. (hint: summary)

- a. True
- b. False

22. The proposed analytical approach for a balanced irrigation water demand can be used for which type of project? (hint: summary)

- a. Single family home
- b. multi-family residential subdivision
- c. commercial property
- d. retail shopping center
- e. borrow pit
- f. church
- g. none of the above
- h. all of the above

NOTE: The following question was revised on 27 November 2018

23. Assume that you have purchased a residential home lot in central Florida area and you obtained plans to build a 2,800 ft^2 house. Being aware of the irrigation water concerns in Florida you want to make sure that the contractor and the homeowners association do not make you over-landscape the house and exceed the balanced irrigation water demand. Based on your research and talking to the builder and his architects/engineers, you have gathered the following local data on soil and climate:

1. The land is located in a closed drainage basin area. All runoff goes to a central retention pond that retains 100% of the stormwater runoff from the development.
2. All runoff infiltrates back into the soil on-site or at the retention pond.
3. The lot size is 14,600 ft^2, or about 0.33 acres.
4. The soil on the lot is mostly clean fine sand. The lot is forested with large pine and oak trees and some shrub vegetation.
5. The SCS soil survey maps show the groundwater at about 4 feet below ground surface.
6. The rainfall records indicate that the average rainfall for this area is 50 inches per year.
7. You have estimated that the house, the garage and storage area will have a total of 3,800 ft^2 of roof area.
8. The driveway, walkway, sidewalk and open porch with concrete slab will cover about 1,200 ft^2.
9. To build the home on this lot the plans call for a total clearing area of about 7,500 ft^2. The clearing will include the house and the paved/concreted areas, which results in about 2,500 ft^2 of cleared area over and above the impervious areas (7,500-3,800-1,200).
10. The minimum landscaped areas around the house will have some planted trees, shrubs and grassed lawn.

For the purpose of this analysis assume that you looked through the available data and the literature review report prepared by Dr. Eslinger and you have estimated the evaporation and evapotranspiration rates as following:

Surface Type	Annual ET (in/year)
Rooftops	10
Paved Surfaces	12
Existing lot land with trees and shrub, GWT=4 feet	42
The landscaped and grassed area in the cleared parts of lot	40

Calculate the maximum irrigated surface for this house using the balanced irrigation water demand approach, which you would insist that the builder and the homeowner's association accept as a responsible and green design. (hint: Example 1)

- a. 1,650 ft^2
- b. 1,858 ft^2
- c. 2,612 ft^2
- d. 4,517 ft^2
- e. 5,668 ft^2

24. The very simplest application of this balanced irrigation water demand is to consider only the effects of a structure to estimate the maximum irrigated surface. Assume you are building a large cabin in the woods and plan to install a shallow aquifer well to irrigate some areas around the cabin to grow flowers and decorative trees. You don't have much information on the site conditions other than the property is relatively wet with very shallow groundwater conditions. Your cabin will be about 1,200 ft^2 with slab on grade construction. The access road, driveway and parking spot will all be natural without any clearing or improvement. The rainfall for the area is about 45 inches a year. The ET rate for the cabin area under existing conditions is about 40 inches per year. Due to flat roof and natural cedar shingles assume the ET from the roof area will be 16 inches a year. Calculate the maximum irrigated surface using the balanced irrigation water demand method with the assumption of irrigation rate is 36 in/year. (hint: there is no lot size so only the structure comes into consideration).

- a. 0 ft^2
- b. 50 ft^2
- c. 600 ft^2
- d. 800 ft^2
- e. 1,200 ft^2

25. Similar to question 24 above, assume that a commercial building is proposed to be added to an existing strip shopping center that is located in a water caution area where additional irrigation is not allowed unless a water balance is demonstrated. All other parts of the strip center stay the same except for an addition of a building of 3,000 ft^2. The green areas around the buildings were not irrigated in the past and the owner wishes to landscape part of the green area and install an irrigation system. The rainfall for the area is about 52 inches a year. The ET rate for the surrounding natural surfaces was estimated at 37 inches per year. The rooftop is shingles with a typical slope and the ET rate is estimated at 10 inches a year. Calculate the maximum irrigated surface using the balanced irrigation water demand method with the assumption of irrigation rate is 34 in/year. (hint: Example 24).

- a. 800 ft^2
- b. 1,200 ft^2
- c. 1,765 ft^2
- d. 2,382 ft^2
- e. 3,285 ft^2