CE 3354 Engineering Hydrology
Team Project 1

Problem Statement

Figure 1 is a map of a portion of Concho County, Texas. In the Southeast corner of the map is Eden, Texas. A US highway runs nearly East-West through Eden, and another US highway runs North-South. To the East of town, a culvert system is to be replaced by a bridge. The

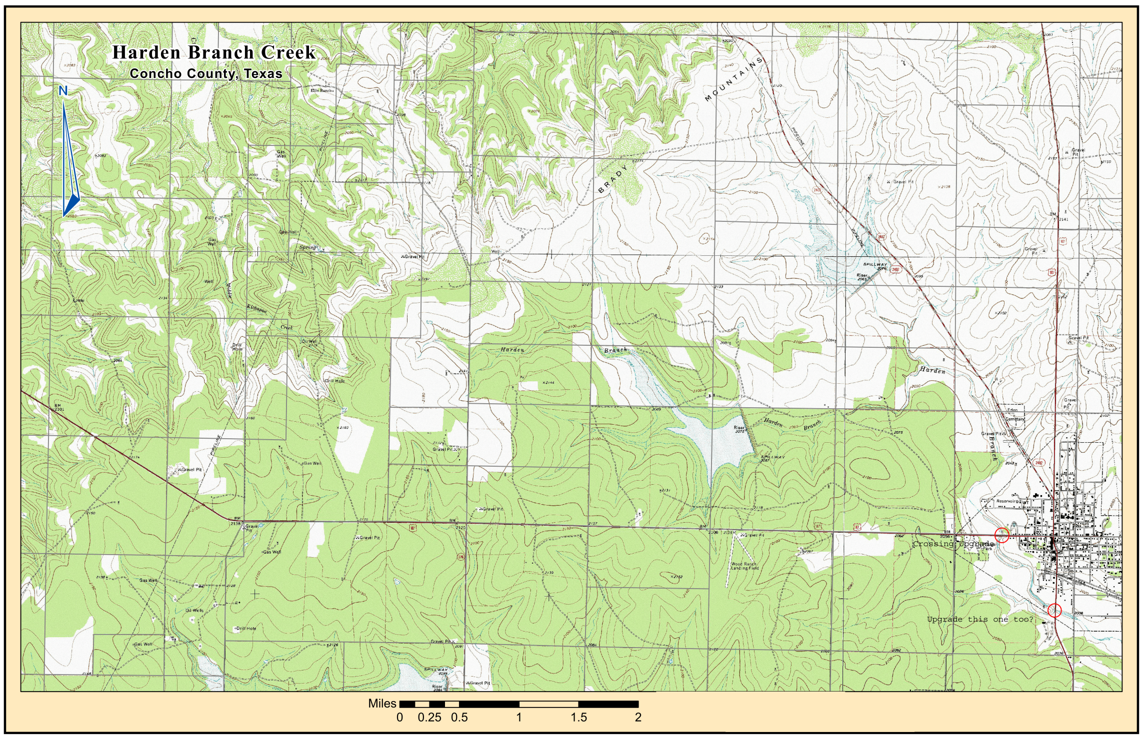

Figure 1: Harden Branch Creek near Eden, Texas

removal of the culvert is anticipated to reduce temporary storage on the upstream side of the East-West highway and convey water to another crossing South of town.

The overall task is to assess the impact of the increased conveyance conferred by the bridge (in place of the existing 3-barrel 8X8 box culvert system) on the downstream portion of the stream between the bridge and the next downstream crossing.

Questions to be addressed are:

1. Does the downstream structure also need change to maintain the pre-development (current) conditions?

2. If the downstream is unchanged, is there substantial change in inundation potential for the structures on the Southwest corner of Eden (see the map).
3. The area between the two roads is currently a golf course – a reasonably compatible land use for an area that from time to time is inundated. A developer desires to build executive homes adjacent to the golf course, where should those homes be located? (i.e. estimate a regulatory base-flood-elevation)

Perform and document a study in an engineering report, with appendices as necessary that contain the underlying data or assumptions employed. The analysis anticipates that HEC-HMS will be used for hydrology up to the culvert system (or bridge) on US 87, and to the next structure on US 83

Report Requirements:

The engineering project report should consist of the following (minimal) contents.

1. Letter of Transmittal
2. Executive Summary
3. Introduction (background information, methods and procedures, etc.)
4. Hydrologic Analyses of Existing System including:
    - Watershed Delineation: There are two "points" of interest. The crossing at US 87 and the crossing at US 83, these are the red circles on Figure 1. The two upstream reservoirs themselves become points of interest as they have their own sub-basins that are part of the larger system. A reasonable delineation will likely identify four sub-basins: two for each reservoir, one that drains directly to the culvert/bridge on US 87, and one for the area between US 87 and US 83.
    - Annual Recurrence Interval: Select from the Hydraulic Design Manual of appropriate risk levels for the crossings. Bear in mind, we would like the crossings to convey the "design risk" without overtopping the roadway. The 1% chance is also to be considered, in this study to examine the impact on the golf course area. In this project, the 1% chance event, if necessary can overtop the system, but the design risk should pass both structures. The relevant section of the Hydraulic Design Manual is attached.
    - Design Storm: Determine an appropriate design storm based on the ARI above and the watershed area. Include explanation of how storm duration was selected.
    - Loss (Runoff Generation) Model: Determine an appropriate loss model based on watershed size and land cover. Document how you determined parameters of your selected loss model.

- Transformation Model: Using the SCS unit hydrograph model, determine appropriate parameterization for each of the sub-basins. Document how you determined the model parameters.
- Routing Model: Explain how reservoir flows are routed to the structure(s). For example there will be routing from the two reservoirs to the US 87 culvert, then routing from US 87 to US 83.
- Water Surface Elevations: The culvert system on US 87 is a 3- barrel 6 X 6 box culvert system. The culvert system on US 83 is a 5-barrel 6-foot diameter circular culvert system. Document how you estimate the water surface elevations at the culvert systems under different design conditions. If you choose a routing model that can report depths, state so in the report.

5. System Design Modifications
   - Compare the pre-development conditions with the post development conditions. You can assume the bridge behaves as if the channel is unobstructed – you can estimate width from the map.
   - Repeat the analysis (run a model with modified routing) to determine the impact at the US 83 crossing and the possible development described in the problem statement.
6. Summary and Recommendations
7. References
8. Appendix (sample calculations, data, etc.)

Additional Guidance:

The two reservoirs are SCS reservoirs designed to capture and release water over 7 days. That is, once full but not over the spillway, the reservoir should drain in about a week. Use that information to approximate an appropriate release mechanism in the simulation model(s). (Probably an orifice and weir arrangement, but read the user manual for other possibilities)

You will have to construct some kind of storage curves for the reservoirs and may have to use algebra and curve fitting to complete such curves. Pursuant to those curves, there will be some kind of stage-discharge relationship. You may assume that the spillways crest about 4 feet below the dam crests and the spillways are about 50 feet wide.

Figure 2, is an aerial image of the area for some additional geomorphic context.

Figure 2: Harden Branch Creek near Eden, Texas

Figure 3, is a map of the area for showing the two points of interest without any annotations.

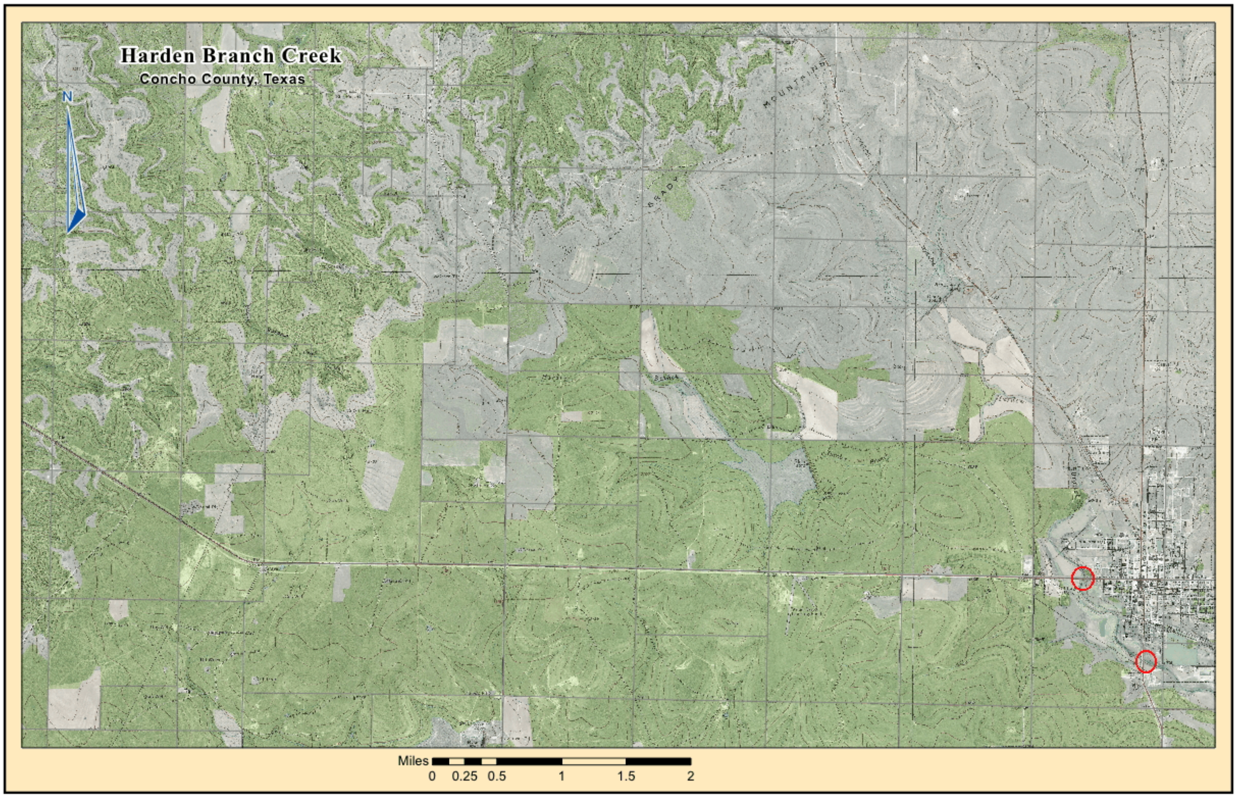

Figure 3: Harden Branch Creek near Eden, Texas

Figure 4, is a map of the study area broken into suggested sub-basins for hydrologic/hydraulic analysis. The software in the image is a digitizer that predates easy access to GIS, but helps accomplish the same tasks.

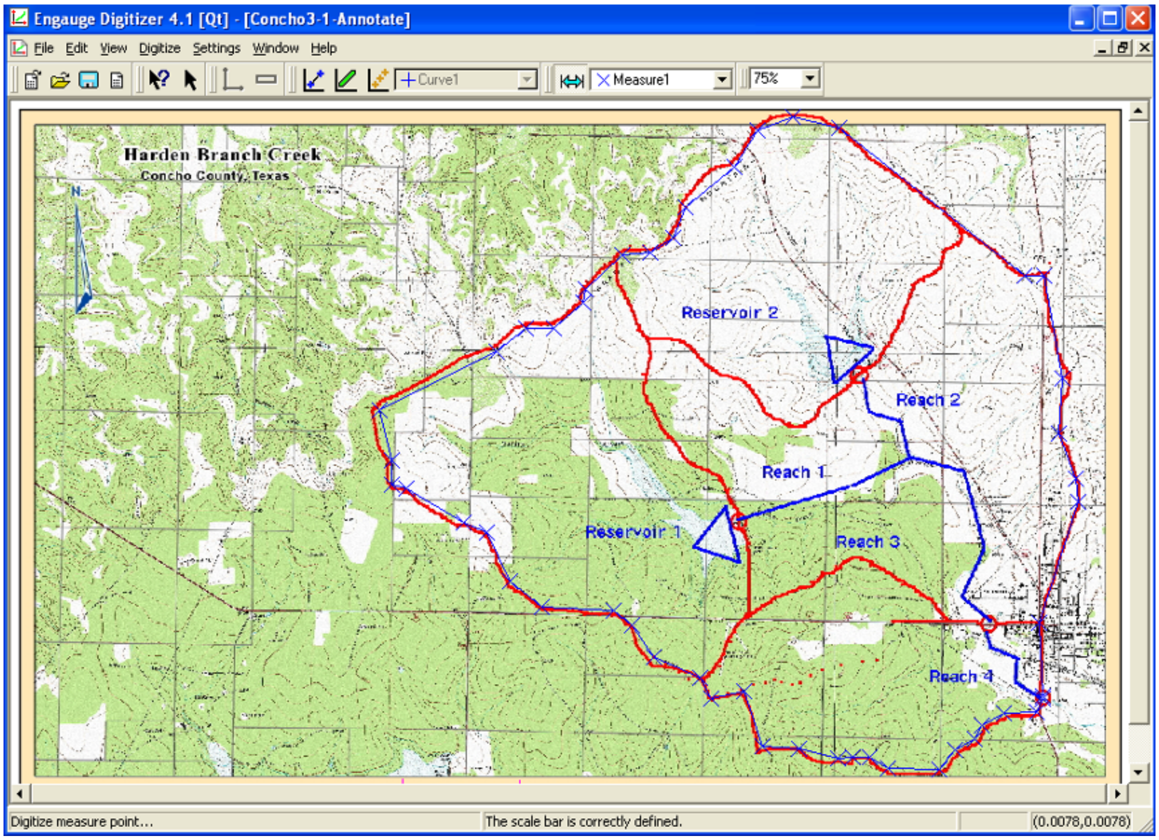

Figure 4: Harden Branch Creek HEC-HMS Layout near Eden, Texas

Figure 5, is a suggested effort sheet to use to manage your team's project. The sheet should be updated weekly (and the weekly sheets included in the report appendix)

Effort Sheet

Week of:___________________________

Student Name	Tasks Performed	Remarks

We attest that the tasks outlined in the above table represent an accurate depiction of the work performed by the group members. **Use the remarks column to add any comments (e.g., timeliness) or note any disagreements.**

Signatures: **(Must be signed by all group members)**

Name:______________________________ **Signature**____________________________

Name:______________________________ **Signature**____________________________

Name:______________________________ **Signature**____________________________

Name:______________________________ **Signature**____________________________

Name:______________________________ **Signature**____________________________

Date: _______________________________

Figure 5: Project Management Effort Sheet

Section 6 — Design Flood and Check Flood Standards

TxDOT's approach to selecting the design standard for a drainage facility is to use a reference table that specifies a range of design AEPs for different types of facilities. Table 4-2 provides the design frequencies for TxDOT projects. For most types of facilities a range of design frequencies is presented. For those types of facilities with a range of possible design frequencies, usually one design frequency in the range is recommended (indicated by an X with square brackets in Table 4-2). Structures and roadways should be serviceable (not inundated) up to the design standard.

Table 4-2: Recommended Design Standards for Various Drainage Facilities

Functional classification and structure type	Design AEP (Design ARI)				
	50% (2-yr)	**20% (5-yr)**	**10% (10-yr)**	**4% (25-yr)**	**2% (50-yr)**
Freeways (main lanes):					
Culverts					X
Bridges					X
Principal arterials:					
Culverts			X	[X]	X
Small bridges			X	[X]	X
Major river crossings					[X]
Minor arterials and collectors (including frontage roads):					
Culverts		X	[X]	X	
Small bridges			X	[X]	X
Major river crossings				X	[X]
Local roads and streets:					
Culverts	X	X	X		
Small bridges	X	X	X		
Off-system projects:					
Culverts	FHWA policy is "same or slightly better" than existing.				X
Small bridges					X
Storm drain systems on interstates and controlled access highways (main lanes):					
Inlets and drain pipe			X		
Inlets for depressed roadways*					X

Table 4-2: Recommended Design Standards for Various Drainage Facilities

Functional classification and structure type	Design AEP (Design ARI)				
	50% (2-yr)	20% (5-yr)	10% (10-yr)	4% (25-yr)	2% (50-yr)
Storm drain systems on other highways and frontage roads:					
Inlets and drain pipe	X	[X]	X		
Inlets for depressed roadways*				[X]	X
Table 4-2 notes: * A depressed roadway provides nowhere for water to drain even when the curb height is exceeded. [ ] Brackets indicate recommended AEP. Federal directives require interstate highways, bridges, and culverts be designed for the 2% AEP flood event. Storm drains on facilities such as underpasses, depressed roadways, etc., where no overflow relief is available should be designed for the 2% AEP event.					

All facilities must be evaluated to the 1% AEP flood event.

Selecting a design flood is a matter of judgment; it requires balancing the flood risk with budgetary constraints. When considering the standard for a drainage facility, the designer should follow these guidelines:

- Decide on the design standard by considering the importance of the highway, the level of service, potential hazard to adjacent property, future development, and budgetary constraints.
- Develop alternative solutions that satisfy design considerations to varying degrees.
- After evaluating each alternative, select the design that best satisfies the requirements of the structure.
- Consider additional factors such as the design standards of other structures along the same highway corridor to ensure that the new structure is compatible with the rest of the roadway. Also assess the probability of any part of a link of roadway being cut off due to flooding.

The designer should design a facility that will operate:

- Efficiently for floods smaller than the design flood.
- Adequately for the design flood.
- Acceptably for greater floods.

In addition, for all drainage facilities, including storm drain systems, the designer must evaluate the performance for the check flood (1% AEP event). The purpose of the check flood standard is to ensure the safety of the drainage structure and downstream development by identifying significant risk to life or property in the event of capacity exceedance.

The intent of the check flood is not to force the 1% AEP through the storm drain, but to examine where the overflow would travel when this major storm does occur. For example, the water may travel down the gutter to the same creek as the outfall, travel down a driveway and directly into a home, inundate the mainlanes, erode a new drainage path to the outfall, or other problems.

The examination of the check flood should also include assessment of the tailwater. There may be locations on the project that are lower than the 100 year water surface elevation (or tailwater) of the creek. This situation may increase the hydraulic grade line through the storm drain system, or may even cause negative flow through the system. This may cause blowouts which may in turn cause any of the same problems as above.