PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2012
Throckmorton-Purdue Agricultural Center
Tile Drainage Design

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Agricultural & Biological ENGINEERING

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Problem Statement

•Increased runoff

There is increased runoff at the Throckmorton-Purdue Agricultural Center due to newly constructed buildings (See Figures 1 and 2).

•Inadequate drainage system

All of the runoff is currently being directed into a broken six-inch clay tile. The capacity of the tile is inadequate. The clay tile is breaking down and creating blowholes in the field (See Figure 4). Increased erosion and standing water is occurring as a result.

•Potable water wells

Land around two potable water wells on the east side of the project site is currently cultivated with the rest of the field with standard farm practices taking place around the wells. There is a concern for potential water contamination by pesticides (See Figure 3).

A new drainage design is needed to redirect runoff to the open ditch east of the site while protecting existing, underground utilities.

CONSTRAINTS

Design should:

- Protect underground utilities
  - 2 High pressure gas lines
  - 2 Potable water wells
  - Water lines
  - Electrical lines
  - Communication cable
- Allow farm equipment to cross design on east side
- Reduce erosion at ditch outlet on east side of field
- Be easy for farm managers to maintain

Figure 2. Building area

Figure 3. Well

Figure 1. Arial view of site

- Tile needing replacement
- Other tiles (tie into new tile)
- 24 Pair cable
- Wells, known water lines
- Gas Lines
- Electrical line

Figure 4. Tile blowhole and standing water

Figure 5. Well boundary

Chosen Solution

The chosen solution was to replace existing clay tile with 10 inch, plastic, slotted corrugated tile in the same location as the existing tile to prevent future blowholes from the clay tile. This will allow the farm to maintain tillable acres. They also need to observe setbacks with a 50' radius around the potable water wells to ensure water quality (See Figure 5). The setbacks have been flagged so the farm managers can create a boundary line with GPS equipment.

Design Process

Estimating Flow Rate

$$Q = $$

Q = estimated flow rate
A = drainage area
C = runoff coefficient
i = rainfall intensity

Calculating Maximum Allowable Discharge

$$v = \frac{C_u R^{2/3} S_f^{1/2}}{n}$$

v = average flow velocity
C_u = unit conversion
R = hydraulic radius
S_f = friction slope
n = Manning roughness coefficient

$$q = $$

q = maximum allowable discharge
v = average flow velocity
A = cross sectional area of pipe

Final Design

Given the increased runoff, and after considering alternate solutions, the best solution is to replace the existing clay tile with a 10" plastic, slotted tile in the same location as the existing tile. The location of the current and proposed tile is shown in Figure 1, the details for the design are shown in Table 2, and the elevation profile for the tile is illustrated in Figure 6. The estimated cost of this design is shown in Table 1.

Table 2. Design details showing tile elevation, trench depth, grade of tile, and tile cover.

County:	Tippecanoe	Township:	21N	Range:	4W	Section:	5	
Drain Station (ft) - from W of drive	Ground Level elevation (ft)	Drain Elev (ft)	Drain Cut (ft)	Drain Grade ft/ft	Drain Diam. (in)	Drain Cover (ft)	COMMENTS
0.00	732.00	727.02	4.98	-	11.7	4.00	west side of drive
32.00	730.00	726.06	3.94	3.0	11.7	2.96	
120.00	728.50	723.42	5.08	3.0	11.7	4.10	
295.94	723.15	718.15	5.00	3.0	11.7	4.03	
334.86	722.26	716.98	5.29	3.0	11.7	4.31	
417.67	719.73	715.32	4.41	2.0	11.7	3.43	
666.33	714.67	710.35	4.32	2.0	11.7	3.35	
726.46	713.83	709.57	4.27	1.3	11.7	3.29	
870.21	710.49	707.70	2.79	1.3	11.7	1.82	
915.31	710.74	707.70	3.04	0	11.7	2.06	bank of ditch
919.10	707.70	707.70	-	-	-	-	bottom of ditch

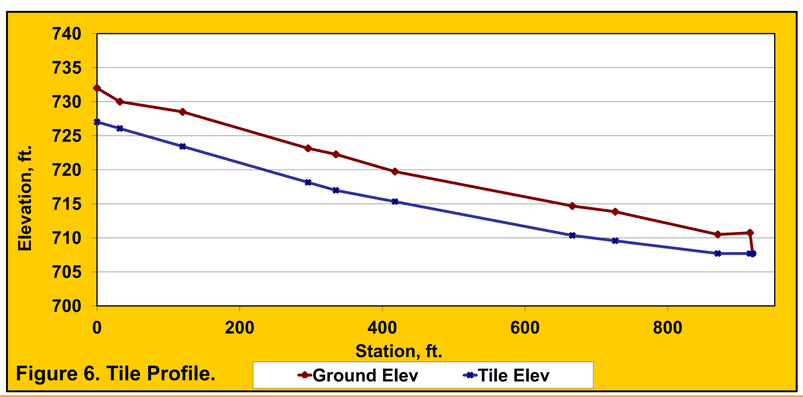

Figure 6. Tile Profile.

Cost Estimate

Table 1. Construction and Materials Cost Estimate.

Item	Qty.	Unit	Cost/unit	Total cost	Source
10" slotted tile	900	feet	$ 3.10	$ 2,790.00	FRATCO contractor prices
10" Smooth core outlet pipe	20	feet	$ 4.40	$ 88.00	FRATCO contractor prices
10" tile installation *	40	hours	$ 86.00	$ 3,440.00	IN LICA 2011 Price Summary (Avg. Cost)*
1 Laborer	40	hours	$ 31.00	$ 1,240.00	IN LICA 2011 Price Summary (Avg. Cost)
RipRap + installation	7	tons	$ 37.00	$ 259.00	IN LICA 2011 Price Summary (Avg. Cost)
4" Riser pipe	1	pipe	$ 35.00	$ 35.00	FRATCO contractor prices
4" tap tees	5	tees	$ 3.50	$ 17.50	FRATCO contractor prices
Seeding **	0.5	acres	$ 1,057.00	$ 528.50	IN LICA 2011 Price Summary (Avg. Cost) **
Total				**$ 8,398.00**	

** assuming 100 hp backhoe, 20-60 feet/hr installed + backfill*

***includes broadcasted seed, broadcasted fertilizer, mulched straw*

Alternative Solutions

- Grass waterway
- Combination of grass waterway with tile replacement
- Replace tile with solid tile instead of slotted
- Additional breather pipes and/or concrete structure for surface drain

The farm managers would prefer subsurface drainage to maintain farmable acres and reduce costs. Since replacing the existing tile can provide the water capacity necessary at the lowest cost, it was the chosen solution.

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