City of Fayetteville

Drainage Improvements Report and Calculations

Forest Hills Drive

Culvert 64” CMAP Outlet & 3 x 36” RCP Culvert Entrance

September 23, 2011

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Forest Hills Drive
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Introduction

The City of Fayetteville has experienced multiple instances of street and yard flooding along a drainage corridor that runs from upstream of Spruce Street to Little Cross Creek downstream of Forest Hills Drive. Intermediate crossings are Stamper Road and Acorn Street. The watershed draining to this area originates in the vicinity of William Clark Road and Tally Ho Drive from where it flows generally northeastward to the project area before discharging into Little Cross Creek. Exhibit 1 provides an overview of the watershed. Watershed area at the system outlet is about 142 acres.

At the request of the City of Fayetteville, JEWELL Engineering Consultants (JEWELL) has studied the primary drainage system from Spruce Street to Forest Hills Drive and has prepared conceptual designs for upgrading the primary system to reduce the flooding problems of this area. The primary drainage system at Forest Hills Drive consists of the main culvert crossing, as well as the channels and pipes that connect at the crossings. Incidental drainage structures that convey surface runoff to the primary system were not addressed in this study. Those incidental connections will be addressed in the next phase of work which is anticipated to include more extensive detailed design for construction of drainage improvements.

Design Standards

City Design Standards include ensuring that a culvert system will pass stormwater runoff from the 25-yr design storm without overtopping the street and without causing water surface elevations (WSELs) to reach critical elevations of nearby, permanent structures. Where appropriate, culvert design also includes compliance with NCDOT culvert design guidelines. Analyses and designs are performed based on anticipated fully developed watershed conditions as determined from current zoning of the watershed.

Existing System

The existing culvert under Forest Hills Drive is a triple 36-inch RCP culvert under the street and connects by a manhole to a 64” span x 52” rise CMP which then discharges at the system outlet to Little Cross Creek. There is an existing sanitary sewer main crossing under the 64” span x 52” rise CMP. PWC has some concern as to maintaining their easement access along the 21-inch sanitary line.

Analyses

Hydrologic Analysis

Precipitation data was obtained from the National Oceanic and Atmospheric Administration (NOAA) website for this location. Topographic and current zoning data was obtained from the Cumberland County GIS website. Hydrologic soil data was obtained from the US Department of Agriculture, Natural Resources Conservation Service (USDA NRCS), Cumberland County Soil Survey. The watersheds draining to the project area were delineated for each road crossing and

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times of concentration were calculated using the Kirpich equation. Runoff Curve Numbers were calculated for each sub-watershed with land-use based on current zoning. Use of current zoning as a basis for watershed land-use results in a "full built-out" or future conditions analysis. Using the aforementioned data and applying the USDA NRCS Curve Number hydrologic analysis methodology, the US Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Modeling System (HEC-HMS) model, version 3.4, was used to model the watershed and determine design flows. These flows were then used in the hydraulic analyses to conceptually design system improvements.

The following table lists pertinent data from the hydrologic analysis:

Location	*25-year Design Flow*	*Total Watershed Area*	*Hw/D*
Forest Hills Dr	420.7 CFS	140.4Acres	1.17

Hydraulic Analysis

In general, this system will operate in a sub-critical flow régime with the downstream hydraulic grade line (HGL) influencing or controlling the upstream water surface elevation. Inlet control is the result at the upstream headwall using a double barrel 12-ft span x 3-foot rise. The resulting Hw/D is 1.17 which is within the NCDOT recommendation of 1.2. Surveyed site information was provided by Moorman, Kizer and Reitzel, Inc and Duncan-Kennedy Land Surveying, PLLC. In accordance with City direction, a replacement culvert under Forest Hills Drive and a restored stream channel drainage system, has been designed.

The hydraulic analysis was started at the downstream end of the Forest Hills Drive culvert where an initial starting water surface elevation (WSEL) was determined through normal depth analysis in the discharge channel. The US Department of Transportation, Federal Highway Administration's HY-8 culvert analysis computer program was used to size the replacement, precast, concrete box culvert configuration of 2-barrels, with 12-foot span by 3-foot rise. A limiting factor in this design is the low clearance dimension from the upstream channel invert to the low point in the street.

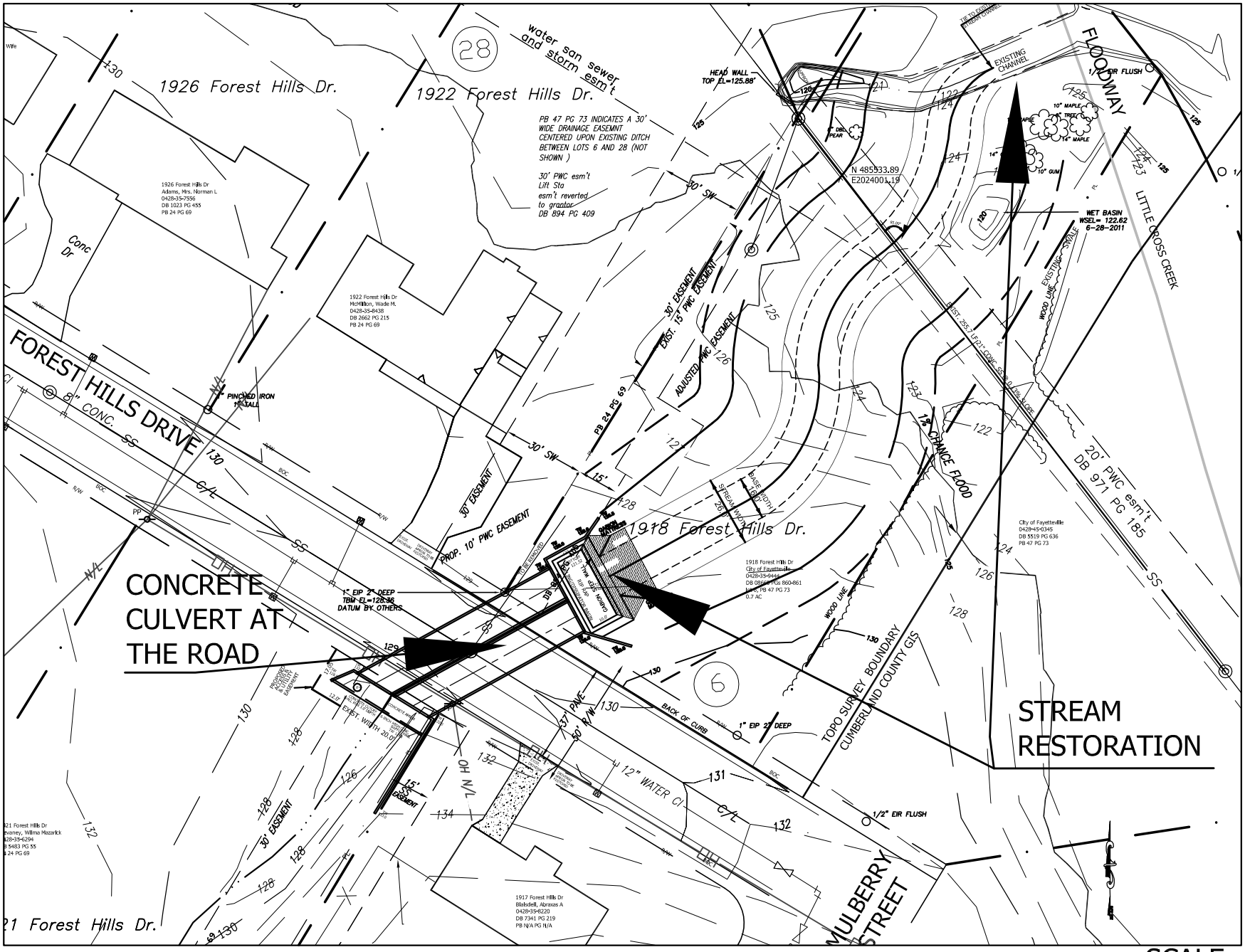
A review of these recommendations was held with City Staff on August 31st, 2010. At that meeting, two directives were provided by the City: 1) JEWELL will proceed to develop the recommendation to replace existing culverts with pre-cast, reinforced concrete, box culverts (see Exhibit 2). 2) It was discussed that there may be cost savings if a portion of the piped system is daylighted and restored (see Exhibit 3).

Cost Estimates

A cost estimate has been prepared for the described above and is presented at the end of this report. It is important to understand that this cost estimate is no more than a reasonable preliminary estimate of future costs.

Recommendations

The existing culverts in the Spruce Street to Forest Hills drainage system lack adequate capacity for the 25-year design storm.



NOT FOR CONSTRUCTION

SCALE: 1" = 50'

CULVERT/STREAM LAYOUT PLAN

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REVISIONS	JOB NO.	CITY OF FAYETTEVILLE DRAINAGE IMPROVEMENTS	"C"
	DESIGNED 08-31-11 BY BAF		
	CONST. SURVEY BY	FOREST HILLS DRIVE FAYETTEVILLE, NC	SHEET NO.
	CHECKED BY CDJ		5.0 "Exh."
	SCALE: NONE		

Work in the street rights-of-way will require traffic control and safety considerations for the residences located there. Construction work will impact streets and driveways near the culvert replacement locations. Temporary construction easements may be required to accomplish portions of the work, but much of the work will occur within the right-of-way or within assumed stormwater drainage easements. The City has obtained the lot at 1918 Forest Hills Drive to allow the downstream portion of the drainage system be opened with an open channel restored stream. The CMP and headwall outlet at Little Cross Creek are adjacent to an existing sanitary manhole with the headwall currently over a 21-inch gravity sanitary outfall. Other underground utilities such as power lines, gas lines, and telephone/TV/internet cables will likely be encountered in the work area.

Enclosed in this report are exhibits of the analysis area and preliminary cost estimate for the stormwater system improvements.