City of Fairview Heights, Illinois

FAIRVIEW HEIGHTS
Crossroads of Prosperity

Fox Creek Subdivision

Investigation into Drainage and Local Flooding

Phase 2 May 2015

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Public Works Committee
City of Fairview Heights Illinois
10205 Bunkum Road
Fairview Heights, Illinois 62208

Subject: Fox Creek Subdivision
Stormwater Problem Investigation Phase 2
Report - Hydraulic Analysis and Recommendations

Background:

Fox Creek Subdivision is located along the headwaters of the northwest tributary of Richland Creek, which flows east beyond the Fairview Heights city limits and southward towards Belleville.

In Phase 1, we reviewed problem reports, flooding photographs and hydraulic analyses submitted for plan approval for the several plats which make up the Fox Creek Subdivision. We also examined items of correspondence and earlier reports dealing with this problem, and began a computer model to simulate the behavior of the many separate portions of the Fox Creek drainage system. In this Phase 2, we populated the model with details from the drainage reports, construction plans and additional onsite observations.

Objective of this Analysis:

Given the ongoing situation of recurrent flooding in the Fox Creek Subdivision, the use of a detailed model afforded the opportunity to simulate behavior of the drainage systems embodied in the various additions that comprise Fox Creek and determine the behavior of each of their components. In particular it could be used to demonstrate where the actual problem were occurring and what change(s) could be made to improve the flooding problems.

Methodology:

- Model Used:

  Given the need to handle both the runoff rates and the volumes associated with the design storms, and to include the storm sewer above, the subdivision was modeled using the latest version of the EPA Storm Water Management Model (SWMM v. 5.1, Release 5.1.007)

  This program allows dynamic modeling and multidirectional flow, accounting for both storage and for backwater effects and provides a graphical user interface. It is available on the EPA website http://www2.epa.gov/water-research/storm-water-management-model-swmm?

- Rainfall:
  The 24-hour, 10-year storm using a Type II distribution was the source of rainfall for runoff, with 4.76" in rainfall, and a peak intensity of 5.255 inches per hour. This distribution includes not only the volume for a 24 hour storm, but "nested" within it are volumes for storms of lesser durations, so that using it in the model also allows consideration of higher rates of rainfall during shorter, more intense storms.

- Runoff:
  Runoff within the model was computed using the SCS (NRCS) curve cumber methodology because it is widely accepted and understood among practicing engineers and uses readily available parameters for soil and land use.

  The process is explained in great depth in the section **Modeling Summary.**

  [For a totally independent "reasonableness" check after determining runoff rates to the principal locations including the Old Collinsville Road culvert and the double 66-inch culverts from the model, the USGS "Illinois Streamstats" http://streamstatsags.cr.usgs.gov/il_ss/default.aspx?stabbr=il&dt=1426629099176 was used to find flows at the same points. This USGS website allows the user to select a point on the map and then automatically determines the tributary boundary, computes the drainage area within it, determines the stream slope at the 10 and 85 percent of stream distance, and the average soil permeability in inches per hour. It then uses the Illinois Regression equations for ungagged watersheds to determine the peak 2,5,10,25, 50, 100, and 500-year frequency flows. Screenshots with the mapped area and runoff rates are included the section **USGS Streamstats**.

OBSERVATIONS

The model was run with the 2-year, 5-year, and 10-year 24-hour type II distribution storms for Section 8, southwestern Illinois per the ISWS Bulletin 71, Rainfall Frequency Atlas of the Midwest. With all elements within the model defined to represent current existing conditions the model begins to exhibit flooding during hour 12:15 of the 5-year storm (total precipitation 4.13 inches) at the triple inlets on either side of the Northwestern sag. Overall depth of flooding is approximately 0.5'. This pattern of flooding reflects the observations and complaints from homeowners.

When run on the 10-year storm (total precipitation 4.76 inches) similar flooding can be seen at the Northwestern sag inlets with additional flooding occurring above the southern storm inlets on Pepperdine Ct. Note that when viewing the profile of this drainage, the 4'x6' box culvert underneath Old Collinsville Rd. is not flowing at capacity indicating that this culvert is not substantially restricting flow. Even during the peak hour of flooding the 4'x6' culvert flows less than full. No flooding is observed downstream of this culvert, even when the eastern creek outlet is flowing full at the beginning of the storm. This conclusion differs from that made in the 2009 Phase I investigation and

earler Hoelscher and Dunnill Engineering reports, although if 50- and 100-year storms are the included in the investigation then this culvert may be regarded as inadequate, If major roadwork is performed on Old Collinsville Road, replacement of the culvert with a larger one should still be considered.

Further investigation of the flow profile indicates that the limiting element causing water to back-up is the 42" storm conduit running south to north along Northwestern Ave. Furthermore an investigative report performed by Dunnil Engineering in 2004 suggested that this 42" conduit is undersized, having a maximum capacity of 29.40 cfs when unpressurized. Even during the 5-year storm the model is showing this conduit having a peak flow of 60 cfs with a peak velocity of 6.8 fps under pressurized conditions which results in a headloss of approximately 4.5 ft from friction losses accounting for any entrance, exit, or minor losses.

Recommended Solutions for Northwestern Sag:

1.) Increase capacity for area served by the 42" conduit by supplementing it with a relief storm sewer running west-east parallel to the existing 36" sewer between lots 98 and 99 (lots on the north of Clemson Avenue and the west of Northwestern avenue, then crossing Northwestern Avenue and proceeding between lots 168 and 169 (the southern two lots on the east side of Northwestern Avenue) to the western edge of Old Collinsville Road, then proceeding north along Old Collinsville Road to a point in the roadside ditch near the discharge of the existing 42" sewer.

2.) Redefine Southern Detention Basin and restrict the outlet. Currently there are two 30" conduits exiting the basin with a 1' restrictor plate installed on the northern conduit. The model shows the basin only filling to approximately half of the full available depth. In this case restricting the outlets may provide some downstream relief however it should be noted that the available capacity of the Southern Basin is not clear and field observations indicate that the capacity of the basin is less than what has been reported. Before further modifications are made to this basin it will be important to verify available capacity and depth as restricting the outlet may force detained water onto private properties.

Recommended Solutions for Pepperdine Ct.:

Drainage through the Northern Channel appears to flow freely despite the mass of debris that has collected in the downstream segments. Regardless of what other future improvements are pursued it is recommended that brush be removed from the Northern Channel.

Potential Downstream Flooding

Additionally it should be added that during the H&S survey one of the crew members observed that the area between the eastern drainage creek and the area to the northeast of the Owl Creek Ln. cul-de-sac appears to be constantly saturated as

indicated by damaged ground vegetation and observed soil moisture. The survey shows that this location is a low spot in the southern creek bank and should be further investigated as an area of potential flooding if alterations are made upstream.

Following the assembly of the model to demonstrate behavior of Fox Creek drainage in the same manner as reported incidents, we made changes to improve the system and reduce flooding. The initial primary change was to "double up" the 42" storm sewer along the sag at Northwestern by adding a parallel 42" pipe. This approach offered specific advantages over replacing it with a larger pipe. First, in actual application it would allow the existing pipes to remain in place for most of the improvement project while the new pipe were installed, something not possible if the pipe had to be removed and replaced. Second, it is more likely that the existing diameter will allow for other utilities to pass over or under the pipe, again something that might not be possible if the pipe were replaced with a larger diameter section If the final design surveys indicated that there is vertical clearance to allow the additional pipe to be a 48", that increase could be accomplished at little additional cost. However, a more practical alternative was selected, the relief sewer described above which combined the addition of greater capacity with even less disruption that either adding another 42" or replacing it with a larger on the same alignment.

Following the pipe "replacement" the northern and southern detention basins were modified to control low flow with a minimum orifice and allow larger flows only after a significant portion of the detention volume was utilized.

The flow under Old Collinsville Road was shown to increase from the existing discharge of approximately 175 cfs to slightly over 205 cfs. The modifications to the detention basins reduced this slightly to approximately 195 cfs. The relatively minor increase in flow is not expected to adversely impact the downstream areas beyond Fairview Heights City limits into Swansea, but there is one low point just beyond the condos that should be re-examined to ascertain if this is just a low area of ground or if any structures are close enough to be affected.

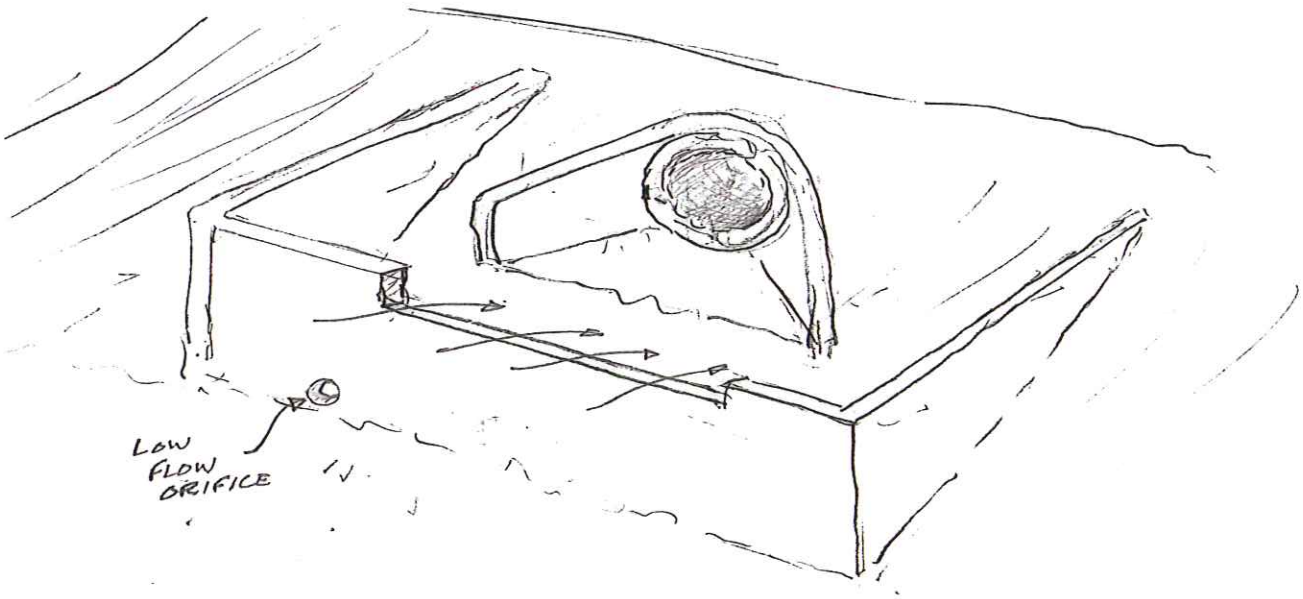
The additional capacity was seen to lower the hydraulic grade at the "Northwestern sag" by at least two feet. "Tweaking" the pipe design and the detention features may further improve the basin performance. Two items are remain as described in the preliminary report of 2009:

<u>Ineffective flow reduction from Northern Detention basin:</u>

Practical application of detention has not been carried out to maximize the effectiveness of the detention located west of DePaul Drive north of Old Dominion Court. The basin outlet has been equipped with an orifice plate, but which provides only minimal reduction below the capacity of the pipe that crosses DePaul. A basin which simply shaves the peak from rapidly building storm runoff has an effect only in the first few hundred yards from the basin itself. There is virtually no effect a few hundred yards downstream where natural attenuation of the storm peak would have occurred anyway;

the basin behaves as a "wide spot in a ditch" and allows the detained runoff to discharge nearly as quickly as it enters.

The volume available at the basin site can be used to the maximum extent by installation of a wall slightly lower than the depth of the basin, placed in front of the outlet pipe. The wall would be penetrated by a very small opening at the bottom, equivalent to (for example) a 6-inch diameter opening. The entire basin could fill to the level of the "wall" and bleed out only as allowed by the small orifice. Once the basin has filled to the maximum, a portion of the wall will act as a weir, allowing outflow to match the remaining inflow but only after utilizing the full storage in the basin, by which time the peak is likely to have passed. Even after the high level of discharge is reached, as soon the basin level drops back to the weir height, flow resumes at a significantly lower discharge than through the present restrictor plate.

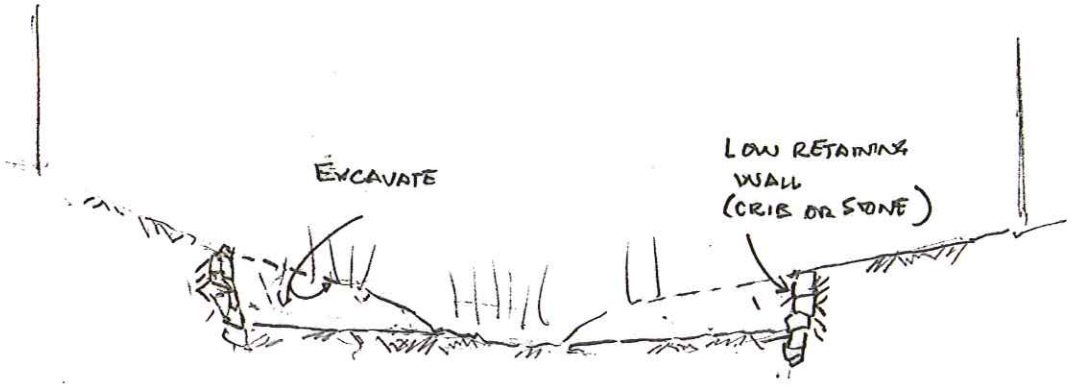


DETENTION BASIN WEIR AND ORIFICE

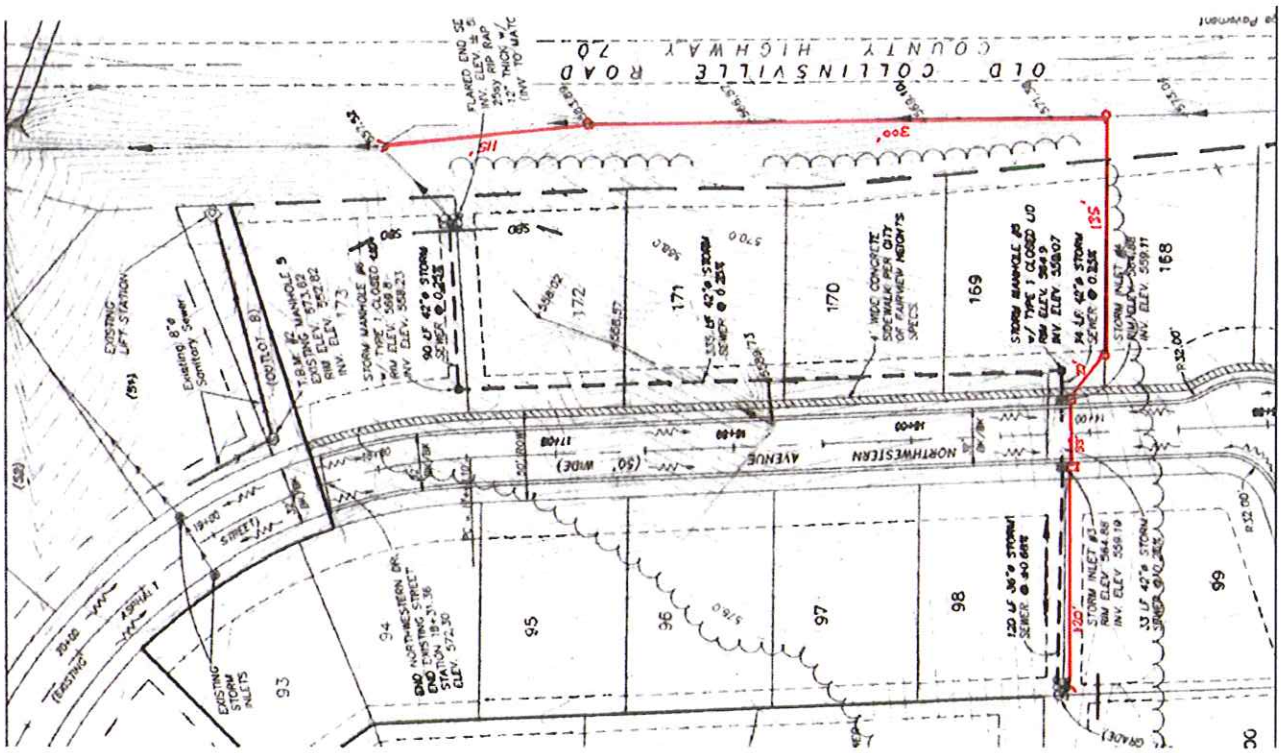
<u>"Backyard flooding" along vegetated swales south of Stanford way and north of Clemson:</u>

This series of streams, pools and swales actually operates as intended to retard all but the very highest flows; the problem is one of perception and aesthetics. Although the system lies in a dedicated storm drainage easement, the wet-adapted vegetation is

mowed because it borders along lawns and is seen as a weedy strip of lawn. A readily-identifiable demarcation and cutting the bank at a well-defined edge would make the swale's function obvious, and set it distinctly apart from the back lawns that it borders. Vegetation can still be allowed, though at the lower, flatter bottom.



SWALE MODIFICATIONS



MAJOR RELIEF STORM SEWER