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Memorandum

To: Holly Neill
From: Beth Wentzel
Date: July 6, 2008
Re: James River Basin Design Charrette Stormwater Analysis Summary

Conceptual level hydrologic modeling of the conventional plan and the conservation development plan for the proposed development site on the James River was conducted to determine the relative effectiveness of each plan with respect to water quantity management. PondPack v. 10, which uses the TR-55 methodology, was utilized for the analysis. Design storms representing the 2 yr 24 hr, 10 yr 24 hr, and 100 yr 24 hr were modeled for each scenario. The rainfall quantities were 3.9 in, 5.8 in, and 8.0 in, respectively, and they were distributed according to the NRCS Type II distribution. The magnitude and distribution of these design storms were based on the NRCS TR-55 manual.

The portion of the project area proposed for development was divided into 3 subwatersheds. Watershed inputs to the model, particularly impervious area, were based on the information gathered from the plans and summarized in the previously submitted Memorandum of Charrette Activities dated May 24, 2008. For the purposes of our analysis we assumed that the land use within the open space where a golf course is being considered is the same for each plan. As such we assumed the runoff conditions for this area would be identical and we only modeled the developed portion of the site (~370 acres).

The curve number method was used to determine runoff volume and rates. Composite curve numbers (CN) were developed for each of the 3 subwatersheds based on the assumption that the pervious areas in the conventional plan would be maintained primarily as turf grass in good condition. Of the 370 acres of development, the conventional plan would have 204 acres of impervious area (55%), and the conservation development would have 92 acres of impervious area (25%). The pervious areas in the conservation development plan were assumed to be comprised of 60% prairie and 40% turf grass in good condition. The calculated composite curve numbers input to the model are shown in Table 1 below. Curve numbers are based on a scale of 0 to 100, and higher curve numbers reflect conditions that produce higher volumes of surface runoff while lower curve numbers reflect conditions that produce lower volumes of surface runoff.

For conceptual level analysis we assume the time of concentration of runoff flows is 10 minutes for each of the watersheds.

Table 1 – Composite Curve Numbers

Subwatershed	Conventional CN	Conservation CN
1	85	75
2	85	75
3	86	77

For the conventional development, it was assumed that the runoff water would be conveyed to the stormwater management areas through storm sewer pipe with no opportunity to infiltrate. For the conservation development, the primary conveyance element is a bioswale that does infiltrate water. Further, smaller infiltration areas including raingardens are incorporated into the conservation development. The plan drawings at conceptual level scale do not show these elements, but we assumed that approximately 1% of the developed area could be devoted to landscape features that would enhance infiltration (including bioswales and raingardens). The assumed infiltration rate is fairly low (0.5 in/hr) to reflect the assumption that amended soils would not be used. Without amended soils, the costs of these areas fit into the overall landscaping budget.

The stormwater detention features are different for the two development scenarios. Conventional stormwater detention ponds typically are relatively deep, have steep side slopes, predominantly open water, and experience dramatic water level fluctuations during storm events that often inhibit vegetative success on the banks of the ponds. We modeled these ponds as having maximum fluctuations of 6 ft and determined the storage volume available based on the area designated in the plan and maximum slopes of 3:1.

The conservation development detention wetlands are typically relatively shallow, have shallower side slopes, predominantly diverse emergent and wet prairie vegetation, and experience smaller water level fluctuations. We modeled these wetlands as having a maximum fluctuation of 3 ft and determined storage volume available based on the area designated in the plan and maximum slopes of 5:1.

Table 2 below shows the peak flow rates from the conventional and the conservation developments. For comparison, we also modeled a watershed of comparable size that is currently row crop agriculture. This would be roughly comparable to the pre-development conditions. From the table, it is clear that the peak discharge rates from the conservation development are very comparable to the pre-development condition. In fact, by modifying the outlet structure, it is likely that pre-development runoff rates could be achieved for all storms in the conservation development. The conventional development runoff rates, on the other hand, are significantly greater. These increases in runoff rates can cause erosion in streams due to increased shear stresses associated with more frequent higher flows.

Table 2 – Peak Runoff Rates

Storm event	Peak Flow Rates, cfs		
	Conventional Development	Conservation Development	Pre-Development
2-yr 24 hr	606	329	469
10 yr 24 hr	1280	844	954
100 yr 24 hr	2100	1616	1558

In addition to runoff rates, total water runoff quantity was modeled to determine the extent to which the development scenarios mimic infiltration characteristics of the pre-development condition. Table 3 shows the total hydrograph volume for each scenario compared to the pre-development estimate. Again, this table shows that the conservation development modeled should maintain the existing localized water balance, while the conventional development would cause significant increases in surface runoff and decreases in infiltration. This decrease in infiltration would result in lower base flows to the stream between rain events.

Table 3 – Total Stormwater Runoff from Site

Storm event	Total Hydrograph Volume, acre-ft		
	Conventional Development	Conservation Development	Pre-Development
2-yr 24 hr	74	46	47
10 yr 24 hr	128	94	93
100 yr 24 hr	193	153	152

Finally, actual water level fluctuations within the stormwater detention features are shown in Table 4 to provide a comparison of the potential fluctuation for the various storm events. To ensure establishment and survival of diverse and stable vegetation within the detention elements, water level fluctuation should be minimized. For detention wetlands, it is recommended that the 2 yr 24 hr storm not cause a water level rise of greater than 2 ft, while for the 100 year storm a rise of not greater than 3 ft is recommended.

Table 4 – Water Level Fluctuation, ft

Storm event	Conventional Development			Conservation Development		
	Ponds in WS 1	Ponds in WS 2	Ponds in WS 3	Wetlands in WS 1	Wetlands in WS 2	Wetlands in WS 3
2-yr 24 hr	3.5	3.0	3.6	1.1	1.1	1.5
10 yr 24 hr	4.8	4.5	4.9	2.0	2.0	2.3
100 yr 24 hr	5.9	5.7	6.0	2.8	2.9	3.0

The summary output from the conventional model and the conservation development model is attached as Appendices A and B, respectively.

Summary

The hydrologic analysis demonstrates that the conventional development modeled would not be as protective of the receiving stream as the conservation development. The conservation development and its associated stormwater management system would maximize infiltration by clustering development and minimizing impervious surfaces to decrease overall runoff. It also would incorporate infiltration areas such as raingardens and bioswales that further enhance infiltration and pollutant retention. Finally, the wetland detention elements would minimize peak runoff rates while also supporting diverse vegetation that would provide better habitat for a variety of wildlife. The minimal water level fluctuations in these wetlands ensure the recruitment and long term viability of this vegetation.

The conventional development, as modeled, would increase overall volume of surface runoff as it reduces the infiltration capacity of the landscape. This would result in flashy stream systems that experience more frequent high erosive forces and lower flows during dry periods. The stormwater elements are less habitable to diverse native vegetation and wildlife due to the steep slopes and extreme water level fluctuations.