Memorandum

To: Paul Woodard

From: Robert Montgomery, Linda Severson

Date: December 12, 2007

Re: Comments on the Planning Commission's 5 Stormwater Considerations

---

Introduction

This memo provides some discussion of the five "Stormwater Considerations" resulting from City Planning Commission review of the Northeast Neighborhood Plan. We are providing this memo to you to assist in providing information to the Planning Commission.

As you know, these five stormwater management questions were identified during review of the neighborhood plan, which is necessarily fairly general. The stormwater management plan developed by Rukert/Mielke provides appropriate general criteria for water resource management, but does not address the additional questions that have developed. Our approach in developing a water management strategy for the Northeast Neighborhood has added design elements related to runoff management, wetlands and water feature restoration, groundwater recharge and municipal water supply conservation that we believe address the concerns expressed.

We believe the appropriate standard for review of these issues is to make sure that the proposed neighborhood plan does not preclude achievement of goals that could be developed based on each of these issues. Later in the process, at the CDP review stage, a more appropriate standard would be to make sure that good outcomes regarding water and environmental management can be expected based on the proposed design.

Response to Stormwater Considerations

Our responses to the comments are in their numbered order:

1. *Address the effects of added runoff to surface waters, stream morphology, and wetland systems (e.g. Pasley property), and springs to the east.*

Increases in runoff discharge and decreases in storm water runoff quality create the eroded stream channels, poor water quality, and degraded wetlands observed in many urban areas. The key to minimizing impacts such as these on the water resources downstream of the Northeast Neighborhood is to 1) hold peak discharges to existing rates, 2) maintain or improve stormwater runoff quality and 3) to minimize changes to stormwater runoff volume.

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

The first two of these three criteria are the subject of municipal and county ordinances as well as State Administrative Code requirements. The City's stormwater ordinance requires control of peak discharges to predevelopment conditions for storm events up to and including the 100-year storm. Changes in water quality important in this project are the potential reduction of nutrient (especially phosphorus) loading produced by the conversion from agricultural use, and the control of sediment loss and pollutants related to the development land use. The analysis that the City prepared indicates that phosphorus loading to runoff leaving the Northeast Neighborhood will be substantially lower than current conditions after development. Control of sediment loading and urban stormwater pollutants is regulated in State Administrative Code section NR 151.

The third issue, minimization of changes in runoff volume, is more difficult to achieve because it requires that runoff generated by impervious surfaces be either evapotranspiration, infiltrated, or otherwise diverted from the surface water discharge points of the project. We are not aware of any community that specifies that increases of runoff volume are completely controlled by on-site practices. Reduction in runoff volume is partially addressed in the requirements of NR 151, and in the Dane County ordinance regarding the recharge objective. However, if the objective of a drainage design is to minimize the potential for downstream watercourse morphologic or habitat quality impacts, control of runoff volume increase in excess of State of Wisconsin and Dane County requirements will be necessary.

Our proposed approach to surface water management for the Northeast neighborhood is to place heavy emphasis on incorporating low impact development techniques throughout the project. The key issues in this approach are providing multiple points of treatment and infiltration of runoff as close to the impervious surfaces as possible, integrating water management throughout the project drainage system, incorporating design approaches that minimize the extent of runoff-producing surfaces, and incorporating management and maintenance approaches that address specific urban pollutants and provide for long-term performance. Certainly, controlling runoff volume will be an important part of the design objectives. Control of runoff volume by infiltration has the additional benefit of providing recharge to the local groundwater system, which supplies water for springs, wetlands and stream base flow down gradient of the project.

We have conducted additional review of the wetlands and drainage features east and south of the Northeast neighborhood, and believe that the design approach described above is appropriate, considering the character of the downstream streams and wetlands.

In summary, strong commitment to low impact development design approaches for the Northeast Neighborhood will provide for control of peak stormwater discharge rate, improved water quality, and control of stormwater volume changes. These issues will likely also be reviewed by the Capital Area Regional Planning Commission during the course of the urban service area extension request which will follow approval of the neighborhood plan. Our understanding is that the design approach described above will be compatible with the goals and objectives of service area extension review. Detailed designs and analyses will then be prepared for review by City staff and the Planning Commission at the CDP stage of the project.

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

2. *Provide an opinion on what occurs with groundwater infiltration occurring east of the drawdown area. This assumes infiltration as noted by Public Works will occur.*

The City's analysis of groundwater supply issues described in the Public Works memorandum of October 17, 2007 provides a practical discussion of the impacts of the Northeast Neighborhood on the City's municipal water supply system, and concludes that water withdrawal from wells near the Northeast Neighborhood would likely be similar, regardless of whether or not the Northeast Neighborhood was developed. A simple analysis comparing the projected 200,000 gallons per day demand from the Northeast Neighborhood (taken from the memorandum) to a regional estimate of existing groundwater recharge (7.6 inches per year over the approximately 900 acres of the Northeast Neighborhood = ~490,000 gallons per day) indicates the development of the project would not produce an overall groundwater deficit. However, the location of recharge and municipal water supply well withdrawal are different, both in geographic location, and the aquifer that is affected. This is the issue we discuss below.

As you have shared with us, the City has recently completed sampling and isotope testing of water from City wells and the Deep Spring, which is located in the wetland complex at the south end of Lake Waubesa, to further investigate groundwater source and age. We understand that you conducted this work in consultation with Ken Bradbury at the Wisconsin Geological and Natural History Survey. Although analyses are still being completed, analysis results that we have seen lead to several preliminary conclusions. Results from several samples at Deep Spring indicate that the groundwater supply is younger than approximately 50 years, and therefore very likely derived from relatively shallow groundwater flow in glacial soils and the upper bedrock aquifer. In contrast, water from City Well 10 appears to be much older, consistent with water derived from the lower bedrock aquifer, below the Eau Clare shale. These results indicate that maintaining recharge rates at the Northeast Neighborhood after development will supply to the same upper aquifer system that is the source for Deep Spring. Additionally, the results indicate that the City of Fitchburg well water supply drawn from the deep sandstone aquifer is relatively isolated from recharge and flow in the surficial glacial aquifer and the upper bedrock aquifers. Therefore, the hydraulic effects of municipal water supply withdrawal are distributed over a much wider area. Based on regional modeling results, the source of recharge water for the City's water supply wells likely extends several miles to the west of the City.

In our view, maintenance of ground water recharge at the Northeast Neighborhood location is a good objective for supply of the local groundwater system that discharges to the east, regardless of its location with respect to the recharge area for the municipal water supply system wells. Recharge from the Northeast neighborhood may or may not form part of the supply to Deep Spring. Based on our analyses today, we think it is more likely that recharge at the Northeast Neighborhood discharges to the wetland area east of Larsen Road or to Lake Waubesa directly.

The issue of groundwater withdrawal, water table decline, and reduction of discharge to springs, rivers and lakes in Dane County is important. However, it is very clearly a regional issue, which will require the collaboration and cooperation of all of the county's municipalities together with state and regional planning agencies to address. Although the Northeast Neighborhood covers several hundred acres, the effects of additional municipal water supply requirements for this development are not large compared to the City's total water supply pumping, not to mention the pumping of Madison, McFarland and other

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

nearby communities. We support the concept of a municipal working group being formed to discuss this issue.

Regardless of the presence or absence of a regional groundwater management strategy, our approach for the Northeast Neighborhood is to "think regionally but act locally". Our proposed water management plan includes encouragement of municipal water conservation.

Given this proposed approach, placing consideration of the Northeast Neighborhood "on hold" because of regional groundwater management concerns is not warranted. We suggest that an appropriate approach for the Planning Commission is to approve the neighborhood plan including an objective of maintaining groundwater recharge, and recommending appropriate municipal water supply conservation practices. Additionally, the Planning Commission could recommend that the City participate in regional aquifer management planning discussions, as they develop.

3. *Provide a report examining the rate of infiltration under Meadow conditions, and how this affects pond sizing.*

The effect of the definition of predevelopment conditions on stormwater pond sizing is a result of the difference between "existing" and "proposed" land use on predevelopment versus post-development peak stormwater discharge rates. Peak stormwater discharge control is based on providing enough storage to contain post-development runoff so that it can be discharged at the lower pre-development rate, for the range of design storms specified. Various approaches have been taken to provide "conservatism" in stormwater discharge requirements. Some communities require "over detention", where, for example, the 10-year storm runoff under post-development conditions is restricted to be no greater than the 2-year storm runoff under predevelopment conditions. Another approach is to specify what the predevelopment land use condition is, in order to produce a lower calculated predevelopment discharge rate. This approach (with some justification) has been taken by Dane County and the City of Fitchburg in their stormwater ordinance, for analysis of conversions of agricultural land. The ordinance requires that a minimum SCS "curve number" be used in calculating runoff rates from agricultural land, if it is being converted to an urban use. Requiring a "Meadow" land use condition for calculating runoff rates would result in even lower calculated discharge, and larger detention volume requirements.

In order to illustrate the effects of predevelopment land use conditions on calculated detention basin size, an analysis of a hypothetical 100-acre site was performed. The SCS curve number methodology was used which characterizes sites based on a curve number (CN). The higher the curve number, the more runoff a site will generate. The Par Fore study site is mainly comprised of hydrologic soil group “B” soils. The CN for agricultural row crops for type “B” soils is a 78. As described above, the county and the City stormwater ordinance mandates that a Curve Number of 68 be used for agricultural land uses if they are the predevelopment condition. Meadow land uses are characterized by a CN of 58. The post-development condition was assumed to be residential with average lot size of 1/8 acre, producing a curve number of 85. The following table summarizes the resulting detention pond volume requirements:

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

Pre-Development Land Use Designation	HSG	CN	Post-development Peak 100-yr Discharge	Estimated Detention Basin Storage Required
Agriculture Row Crop (per actual land use and SCS guidance)	B	78	~ 410 cfs	~ 2 ac-ft
Agriculture Row Crop (as required by Ordinance)	B	68	~295 cfs	~3.6 ac-ft
Meadow (assumed)	B	58	~175 cfs	~10.4 ac-ft

Use of meadow as the basis for determining required post-development peak flow rates would require a stormwater basin approximately 2.9 times larger than required by the City ordinance and over 5 times larger than then would be calculated based on actual existing conditions. Also note that the City ordinance already requires the basin to be 1.8 times larger than existing conditions due to the mandated CN for agricultural land use.

We conducted additional analyses on runoff volumes from various land covers on an annual basis as a general indication of runoff response. Note, however, that it is difficult to draw conclusions about natural recharge from calculations of runoff rate, due to the substantial effects of evapotranspiration. Model runs using the Madison 1981 rainfall record from 03/12/81 to 12/02/81 (28.81 inches) produced the following calculated runoff depths for these three curve numbers.

Landuse	Condition	HSG	CN	Rainfall Depth (in)	Runoff Depth (in)
Agriculture Row Crop (per actual land use and SCS guidance)	Good	B	78	28.81	4.1
Agriculture Row Crop (as required by Ordinance)	Good	B	68	28.81	1.8
Meadow (assumed)	Good	B	58	28.81	0.6

Based on the above analysis, the actual existing agricultural land use produces over twice the average annual runoff volume than the mandated CN for agricultural practices and almost seven times the runoff volume as assumed meadow conditions.

The concept of requiring "Meadow" conditions for calculating predevelopment runoff rates, regardless of the actual existing conditions, could be viewed as an attempt to "re-create" predevelopment runoff response. However, we believe it is more appropriate to consider specific design approaches for peak discharge control given realistic land use assumptions, and separately consider the issues of stormwater volume infiltration and recharge to the local aquifer. Specifying only one of these parameters will not necessarily produce the desired outcome of controlled peak discharges and groundwater recharge at or above existing rates.

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

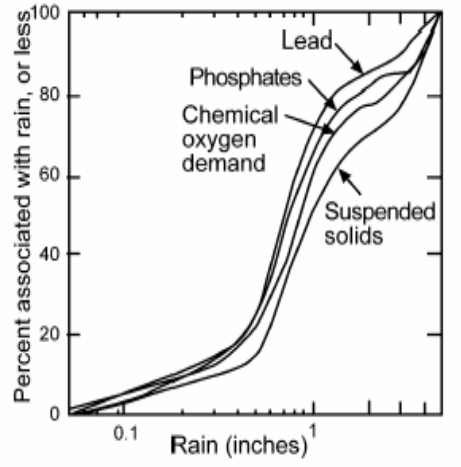
We suggest that the Planning Commission recommend continued evaluation of achievable goals for controlling peak discharge and maintaining groundwater recharge in their approval of the Neighborhood Plan, so that these issues can be developed in more detail in CDP submittals.

4. *Provide a report on pollutant loading for varied storm events (2, 5, 10, 50, and 100 year) to compare effects on pond size and thermal characteristics and related matters.*

Based on urban stormwater studies, relatively small storm events (1.5 inches or less, with return periods of less than two years) produce most of the mass of stormwater pollutant loading. Larger storms, such as the 2- through 100-years storms, do not produce the bulk of stormwater pollutant loading. Analysis of these larger storm events is more appropriate when considering peak discharge control for flood mitigation or channel erosion protection. The following discussion provides additional detail on stormwater pollutant loading rates.

The reason that small storms that occur frequently produce the bulk of pollutant loading rates is that they produce the runoff events that mobilize pollutants that have accumulated on the land surface. Between storm events, surfaces accumulate stormwater pollutants through varied means such as atmospheric and vehicular deposition. Rainfall impact dislodges pollutant particulates from the surface and transports them in the stormwater runoff. The great majority of rainfall events that produce runoff, and hence pollutant wash off, have a depths of less than 1 inch. The result is that the great majority of urban pollutant loading to streams and lakes is delivered by relatively small storms.

The graph below shows measured pollutant loads with varying rainfall depths measured in Milwaukee, Wisconsin for a medium density residential area. This data was published by Roger Bannerman of the Wisconsin DNR, and others, from data collected as part of the 1981 NURP study[1]. As illustrated in the graph below, between 60 and 80% of total annual pollutant loadings for various parameters is the result of runoff from rainfall depths of 1 inch or less.



The primary stormwater quality treatment mechanism proposed in the Northeast Neighborhood is infiltration in rain gardens, biofiltration areas and infiltration basins. Infiltration facilities tend to be

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

most beneficial for smaller, more frequent storm events which are associated with the highest pollutant loadings. Research has shown that infiltration basins are extremely effective in treating stormwater pollutants. The table below shows typical pollutant removal rates for bioretention facilities. The data below was compiled by the Wisconsin Department of Natural Resources from work done by Prince George's County, as well as work done by Davis and others[2,3,4].

Table 2.1 Typical Pollutant Removal Rates for Bioretention Facilities

Pollutant	Removal Rate (%)[1]
Total Suspended Solids (TSS)	90[2]
Metals (Cu, Zn, Pb)	>95[3]
Total Phosphorus	80[3]
Total Kjeldahl Nitrogen	65-75[4]
Ammonium	60-80[4]
Organics	90[2]
Bacteria	90[2]

1. Data Compiled by Wisconsin DNR (Bioretention Tech. Note 1004, draft)
2. Prince George's County, Md., Department of Environmental Resources, 1999
3. Davis et al. 2003
4. Davis et al. 2001

Additionally, stormwater management plans that emphasize infiltration and naturalized surface runoff systems are very effective in reducing thermal loading due to stormwater runoff from hot surfaces.

The stormwater pollutants associated with the larger events (i.e. 100-year event) tend to be associated with total suspended solids caused by surface erosion within the watershed and bank erosion within water courses. The proposed approach to the Northeast Neighborhood design will incorporate both construction-time erosion control and post-construction restoration practices to minimize erosion both during and after construction. The final development plan will meet all applicable ordinance criteria.

Analyses describing the pollutant load reduction and the sensitivity of channels, both on-site and off-site, to peak discharges will be submitted as part of the detailed stormwater management plans that will accompany the CDP submittals.

5. *Is there a need for a stormwater easement from Pasley based on the proposed stormwater management system from the original stormwater report? If so what is location and size of easement. This is also related to stormwater item #1 above.*

Water draining off the Par Fore site will be managed to exceed state and local ordinance criteria for water quality, peak discharge rates, and runoff volumes. Therefore, areas receiving runoff flow from the project should not experience substantial change compared to existing conditions. Specifically, the drainage way on the Pasley property will experience similar discharge characteristics in post-development conditions as are currently observed in the drainage way. We suggest that if the Pasley property were to develop in the future, the City could then require a public easement be provided at that time for future maintenance that may be required.

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586

Conclusion

We would be happy to provide you with additional detail of our analysis work to date. We expect to have additional technical data available for discussion with you on this subject next week. Please contact us to discuss how we can provide additional information on these issues, as necessary.

References

[1] Bannerman, R., K. Baun, M. Bohn, P.E. Hughes, and D.A. Graczyk. Evaluation of Urban Nonpoint Source Pollution Management in Milwaukee County, Wisconsin, Vol. I. PB 84-114164. US Environmental Protection Agency, Water Planning Division, November 1983.

[2] Prince George's County, Md., Department of Environmental Resources. July 1999. Low-Impact Development Hydrologic Analysis.

[3] Davis, A. P., et al. 2001. Laboratory Study of Biological Retention for Urban Stormwater Management. Wat. Envir. Res. 73(1):5-14.

[4] Davis, A. P., et al. 2003. Water Quality Improvement through Bioretention: Lead, Copper and Zinc Removal. Wat. Envir. Res. 75(1):73-82.

2820 Walton Commons West, Suite 135 • Madison, WI 53718 ph 608.223.9585 fx 608.223.9586