BROWN'S CREEK WATERSHED DISTRICT
STATEMENT OF NEED AND REASONABLENESS

Adopted Amendments to Brown's Creek Watershed District Rules

April 9, 2007

I. BACKGROUND

A. Introduction

This Statement of Need and Reasonableness ("SONAR") presents a summary of proposed changes to the following rules of the Brown's Creek Watershed District:

- Definitions
- Rule 2.0: Stormwater Management
- Rule 3.0: Erosion
- Rule 4.0: Lake, Stream & Wetland Buffers
- Rule 5.0: Shoreline & Streambank Alterations
- Rule 6.0: Stream and Lake Crossing
- Rule 7.0: Floodplain and Drainage Alterations

The SONAR provides information to support the District's judgment that the proposed changes are beneficial to the water resources of the District and that any administrative and compliance burdens associated with the changes are reasonable.[1]

B. Legal Authority

The legal authority for the District's Rules derives from Minnesota Statutes Chapters 103B and 103D. Under Minnesota Statutes § 103D.341, subdivision 1, watershed districts must adopt rules "to accomplish the purposes of [the watershed act] and to implement the powers of the managers." These purposes include, among others, conservation of water for public uses; controlling erosion and siltation of lakes, streams and wetlands; and protecting water quality in these bodies. Minn. Stat. § 103D.201, subd. 2. District managers are further authorized to regulate and control the use of water within the watershed district and regulate the use of streams and watercourses to prevent pollution. *Id.* § 103D.335, subds. 10 and 16. Finally, watershed districts in the Twin Cities metropolitan area are authorized to regulate the water resource impacts of land use and development where local government units have not adopted district-approved local water management plans. *Id*. § 103B.211, subd. 1; § 103D.335, subd. 23.

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[1] Various reports, memoranda and other documents were consulted in preparation of the proposed rules and are cited in the SONAR in abbreviated form. All cited documents are listed alphabetically in a bibliographical appendix to the SONAR.

District rules, and revisions to those rules, must be adopted by a majority vote of the Board of Managers, after public notice and hearing. Id. §103D.341, subd. 1(a). Before adoption, a copy of the proposed rules must be provided to the Minnesota Board of Water and Soil Resources (BWSR) and all public transportation authorities for a 45-day period of review and comment. *Id*. §103D.341, subd. 1(b).

C. The Rulemaking Process

As required by Minnesota Statutes §103B.231, the District is completing a substantial revision of its "third generation" watershed management plan. A formal 60-day comment period has been completed, and the Board held a public hearing on the plan on September 11, 2006. The plan presently is in final review by BWSR, the Metropolitan Council, and state resource agencies.

The District's present rules were adopted on October 28, 1999, and took effect on January 1, 2000. For its watershed management plan revision, the District has pursued a combined planning and rule revision process to ensure that its Rules accurately reflect the goals and policies of the revised plan. The District has developed both the Plan and the proposed rule revisions in coordination with the Citizen's Advisory Committee (an advisory group consisting of District residents). Also, in January 2006 the District established a Technical Advisory Committee, consisting of technical representatives of government agencies and municipalities, for the express purpose of developing the Plan revision and associated rule changes. This body has provided review and comment throughout the planning process.

Some of the more significant proposed rule changes are the result of the District's plan revision process and its identification of goals, strategies and implementation actions for the next ten-year period. In addition, a number of changes, some more substantial and some less so, follow from the District's seven years of experience applying its present rules. Many of the proposed changes clarify present standards, incorporate explicitly into the Rules interpretations that have developed over time, and address gaps or specific problem areas that have come to light in the past seven years.

The proposed revisions encompass the following:

- Revision of standards for peak runoff and runoff volume management relating to land disturbances, with a greater emphasis on use of natural site infiltration capacity.
- Changing the water quality standard for phosphorus control from a receiving water concentration basis to an annual loading basis.
- Adopting requirements to limit thermal impacts of runoff on groundwater-dependent natural resources (GDNR's).
- Clarifying the application of the stormwater management rule to redevelopment.
- Refining erosion and sedimentation control standards and prescribing site management standards for winter work and reduced winter inspection frequency.

- Expanding the application of the vegetated buffer requirement to include all wetlands one acre or larger and all GDNR's.
- Clarifying the expansion of buffer width when steep slopes or mapped natural communities are encountered.
- Creating an obligation to establish buffer vegetation in cases where preexisting cover is inadequate.
- Limiting the siting of stormwater management basins within buffers.
- Introducing a more comprehensive standard to permit buffer averaging.
- Clarifying submittal requirements for shoreline and streambank installation permits.
- Requiring that culverts and other surface water conveyancing structures be subject to a permanent maintenance commitment.
- Establishing more stringent volume control and freeboard requirements within landlocked basins.
- Expanding freeboard requirements to apply to artificial basins.
- Clarifying District approval requirement for changes to surface drainage patterns.
- Revising existing definitions and adding new terms.

The following sections describe the proposed changes and the rationale for each change. This document does not cover all details of the proposed rule revisions. The interested reader is directed to the accompanying rule text that shows all proposed changes in redline.

II. RULE 2.0: STORMWATER MANAGEMENT

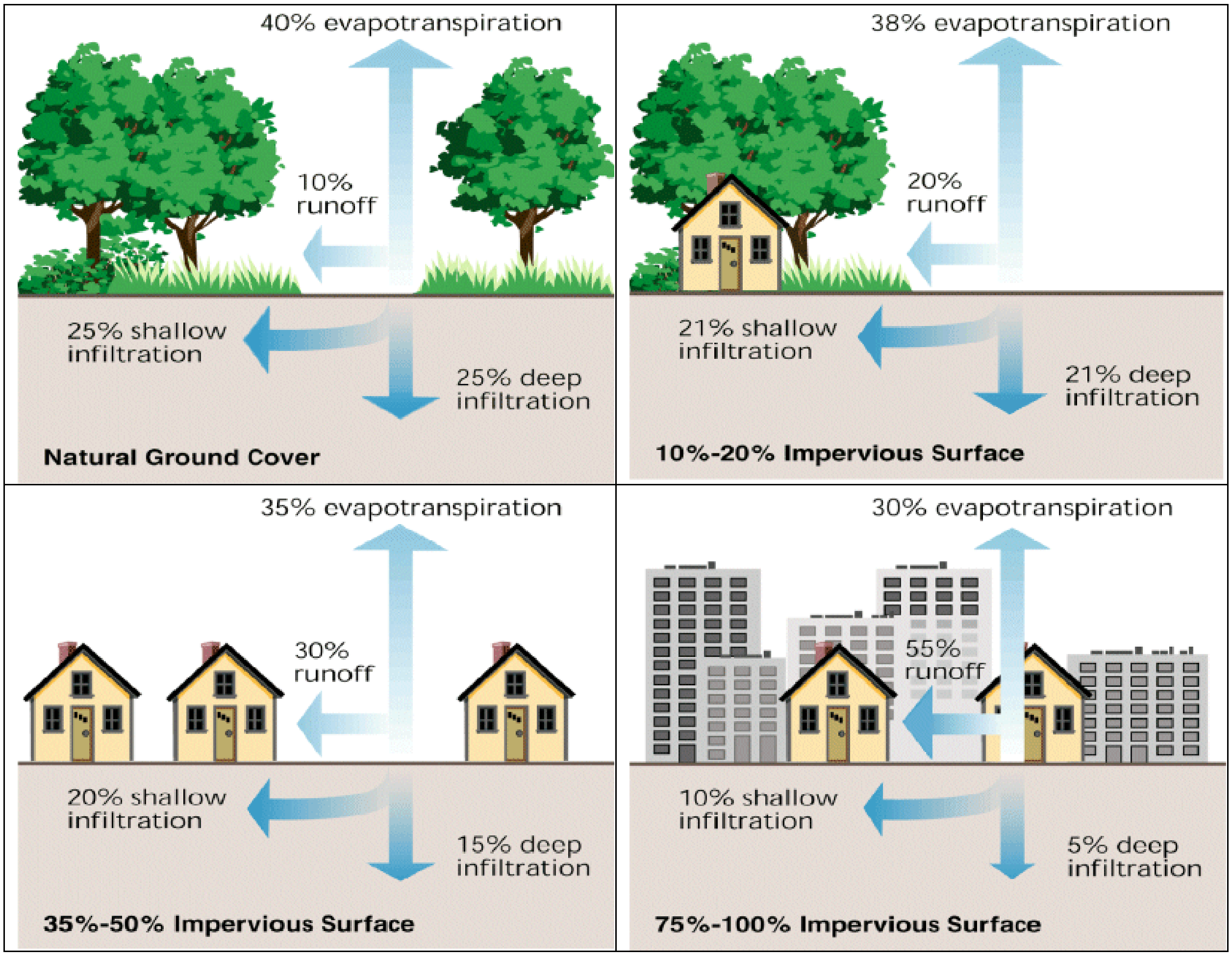
A. Introduction

The proposed revisions to the District's stormwater management rule in large part are oriented toward preserving and restoring as much as possible the natural surface and groundwater systems and the dynamic equilibrium that the natural systems represent.

Under pre-settlement conditions, a portion of any precipitation event infiltrates the soil column. Water filtering into the soil recharges groundwater and feeds groundwater- dependent natural resources. As the soil becomes saturated, excess water flows over the land as runoff and collects in rivers, streams, lakes, wetlands, and other low areas. The type of soil and its vegetative cover can alter the volume of infiltration. Bare clay, for instance, typically has a higher volume of runoff than sandy soil covered with dense grass. Under developed conditions, less rainfall is able to filter into the soil column. Roadways, roofs, sidewalks, compacted lawns and parking lots all reduce the amount of water that can infiltrate into the soil.

Changing the course that water travels following a precipitation event amounts to an alteration of the hydrologic cycle. Under pre-settlement conditions, only a small percentage of total rainfall enters streams and other water bodies as surface runoff. Most rainfall evaporates, is taken up by plants and released through transpiration, or infiltrates. Infiltrated water either discharges to streams or travels deeper into soils to replenish groundwater aquifers. Development activities lead to the removal of vegetation and the creation of impervious surfaces, resulting in less water moving though the system as interflow or groundwater, and reduced evaporation/transpiration. The percent of rainfall entering streams and other water bodies as surface runoff increases greatly as imperviousness within the watershed increases. ***Figure 1*** summarizes these changes.

Figure 1: Hydrologic Cycle – Pre-settlement and Developed Conditions (Fairfax County, VA, 2006)



Increased volumes of surface runoff can degrade the stability and function of rivers and streams, increase pollutant loads, and lead to flooding, especially in landlocked basins. There exists a direct correlation between the volume of runoff and the length of time that a waterbody remains inundated when water levels are elevated after a precipitation event. Both runoff from impervious surfaces and storm water outflow from ponds are heated to higher temperatures, and can increase the temperature of a stream and harm cold-water fish populations such as trout. Volume control practices tend to encourage infiltration and transpiration, minimizing surface runoff of warmed waters.

Increased runoff volume also signifies a decreased infiltration of water into the soil and into the groundwater. Groundwater baseflow sustains the cold-water fishery of Brown's Creek and groundwater supports the function and value of groundwater-dependent natural resources. Residents also depend on groundwater as a source of water for household use. For these reasons, it is important to ensure that adequate water filters down through the soil and replenishes aquifers and groundwater-dependent surface resources.

The following subsections describe proposed rule changes directed not exclusively, but primarily, to protecting the integrity of the groundwater system.

B. Peak Flow and Volume Control Standards and Modeling Methodology

1. Change standard for preserving off-site peak flow and flow volume from "pre-development" to "pre-settlement" condition.

Rule 2.0 imposes a number of requirements for stormwater management, all designed to address the negative impacts that land-altering activity has on stormwater flow patterns and stormwater quality. Terrain alteration and the replacement of natural, vegetated cover with impervious surface such as roadway, rooftop, parking area or sidewalk have several effects of concern. They increase stormwater flow velocity; reduce the proportion of stormwater flow that infiltrates into the ground on site; and increase the transport of both sediments and man-made pollutants-- oil and grease, antifreeze, deicing materials, metal and rubber particles from motor vehicles, fertilizers and herbicides-- into downgradient surface waters.

The rule currently requires that when engaging in land-altering activity, applicants must ensure that under the proposed condition, the peak rate and volume of stormwater runoff at the parcel boundary will not exceed "pre-development" levels. The rule defines "pre-development" as "the time preceding the creation of impervious surfaces or substantial changes in hydrology or infiltration by an alteration of site vegetation or contour." The rule requires that applicants use hydrologic modeling to determine the difference in peak runoff rate and runoff volume from the pre-development to the proposed condition, and take measures to reduce impacts to the pre-development condition. "Pre-development" curve numbers (numbers reflecting the proportion of precipitation that moves as surface runoff) typically are those for pasture, open space, and woods-grass uses as appropriate to the apparent pre-development land use (Table 1).

Table 1: Curve Numbers Typically Used to Calculate Stormwater Runoff Under Pre-Development Conditions

Hydrologic Soil Group	*A*	*B*	*C*	*D*
Runoff Curve Number for Pasture in Good Condition	39	61	74	80
Runoff Curve Number for Open Space in Good Condition	39	61	74	80
Runoff Curve Number for Woods-Grass in Good Condition	32	58	72	79

The District proposes to amend its rule to require the use of "pre-settlement" curve numbers instead of "pre-development" curve numbers.

First, the District has found the term "pre-development" to be ambiguous. Sometimes it is understood as equivalent to the "existing condition," and sometimes it is assumed to reflect agricultural conditions. The proposed change would eliminate confusion. As part of the revision, the District would provide specific curve numbers for use in calculating "pre-settlement" conditions, thereby ensuring consistency among applications.

Secondly, the goal of stormwater management is to mimic natural conditions -- and the natural dynamic equilibrium -- as much as possible to cause the least impact to downstream resources. By requiring applicants to meet "pre-development" conditions, however, the rule currently uses as its standard the altered hydrologic conditions that resulted from large-scale land use changes after European settlement. Peak rate and volume control standards set at a pre-settlement level will result in a higher level of protection that more closely approaches the conditions that sustained the District's resources in the past.

The revised rules would define "pre-settlement condition" as the vegetation community at the time preceding the European settlement of Minnesota as defined by the Marschner map (USDA, 1974), and would specifically identify the pre-settlement curve numbers that applicants must use to calculate runoff peak rate and volume.

The Marschner map is used extensively in Minnesota as a reliable reference on pre-settlement land condition. It is based on the notes taken from 1847 through 1907 for the Public Land Survey, which were summarized and mapped in 1930 by Francis J. Marschner and published in 1974 by the United States Department of Agriculture. The United States Geological Survey (USGS) used Public Land Survey data to define and map pre-settlement vegetative communities in the Mississippi River floodplain and throughout the Great Lakes region to evaluate changes over time. The USGS floodplain study relied on the Public Land Survey because it is the only known source of quantifiable data on the vegetative communities present at European settlement (Nelson et al., 1998). In the Great Lakes study, the USGS found that the Public Land Survey data were representative of pre-settlement conditions when evaluated against fossil pollen data (Cole et al., 1998).

Figure 2 shows the portion of the Marschner map relevant to Washington County. Pre-settlement, the District's most prevalent vegetative community was Oak Openings and Barrens, with small portions of Forested Communities, Prairie Communities, and Wet Prairie Communities.

Table 2, drawn from NRCS Technical Release 55, identifies the curve numbers associated with each upland community type and each soil type. Lakes and wetland communities require a case-by-case evaluation because conditions vary among wetland types. The curve numbers chosen to represent pre-settlement forests are for forests in "good condition." As defined by NRCS, "good condition" means woods protected from grazing and having litter and brush adequately covering the soil. For prairie, the curve numbers selected apply to meadows that are protected from grazing. The curve numbers for oak openings and barrens fall between the numbers for woods and meadow, reflecting the combination of the two in this type of plant community.

Because there is little difference in curve numbers for the three upland categories and because Oak Openings and Barrens cover much of the Brown's Creek watershed, the District proposes to use the curve numbers for Oak Openings and Barrens as the pre-settlement standard for all portions of the District. The District's assessment suggests that this simplification will not have any measurable impact on compliance burden.

Table 2: Curve Numbers to be used to Calculate Stormwater Runoff from Upland Areas Under Pre-Settlement Conditions

Hydrologic Soil Group	*A*	*B*	*C*	*D*
Runoff Curve Number for Forested Communities	30	55	70	77
Runoff Curve Number for Oak Opening and Barrens Communities	30	57	70	77
Runoff Curve Number for Prairie Communities	30	58	71	78

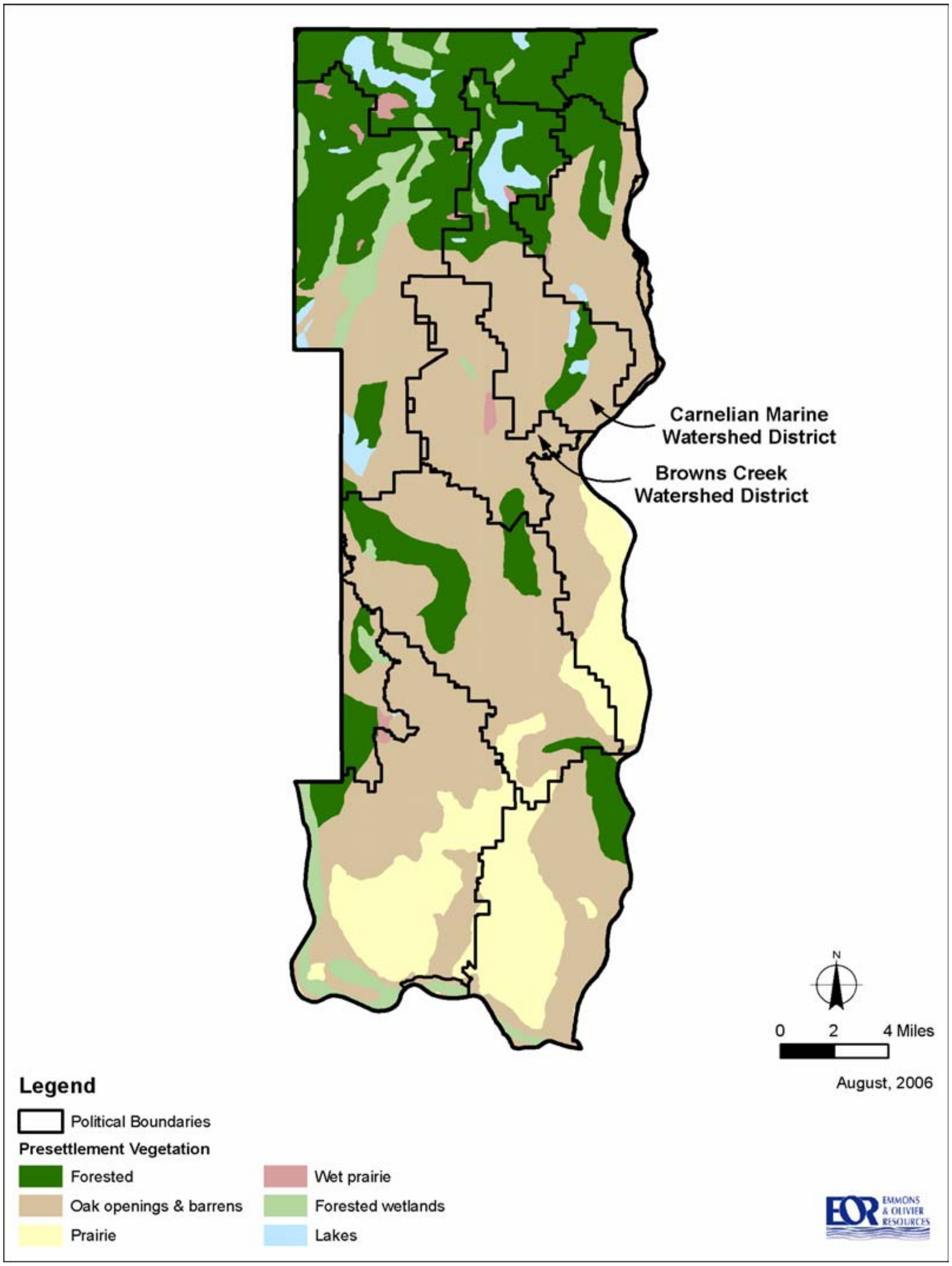


Figure 2: Pre-Settlement Vegetation Communities for Washington County (Marschner, 1974).

The pre-settlement curve numbers proposed by the District are slightly lower than those identified for the pre-development condition, which means that the revised rule will result in lower maximum allowable rates and volumes. For permit applicants, the extent of the burden resulting from this change will depend on the site's soil types, pre-development condition, and proposed final land uses. Generally, however, the change in standard will result in the need for some amount of additional infiltration. To illustrate, **Table 3** compares the percent of site runoff volume requiring infiltration for a hypothetical 10-acre site under pre-development and pre-settlement standards, where the site is open space in good condition and the pre-settlement condition is oak openings and barrens, under each of two development scenarios: (a) ½-acre residential; and (b) commercial with 85 percent impervious surface coverage.

If the proposed land use is ½-acre residential and the site has soils from Hydrologic Soil Group B, 52 percent of the runoff produced under proposed conditions must be infiltrated to mimic the pre-development condition and 76 percent of the runoff produced must be infiltrated to mimic the pre-settlement condition. The exact type and size of stormwater facility needed to meet the pre-settlement condition will depend on site conditions. Some final land uses will be equivalent to the pre-settlement land use in the application of this standard. These land uses would include existing forest, existing prairie, and land that has been fallow for a number of years (see Table 2). For all soil groups other than Group A, additional infiltration is required under the proposed pre-settlement standard.

Table 3: Comparison of Pre-Development and Pre-Settlement Standards: Percent of Volume Generated that is Required to be Infiltrated

	Hydrologic Soil Group							
	A		*B*		*C*		*D*	
	Pre-Development	**Pre-Settlement**	**Pre-Development**	**Pre-Settlement**	**Pre-Development**	**Pre-Settlement**	**Pre-Development**	**Pre-Settlement**
½-acre Residential	100%	100%	52%	76%	29%	45%	23%	34%
Commercial (85% impervious)	100%	100%	85%	93%	64%	72%	51%	59%

The District engineer recently completed a study evaluating the feasibility and cost of infiltration-focused stormwater management design in the City of Lakeville. In part on the basis of that work, the District has a basis to conclude that the additional level of volume reduction required for compliance with a "pre-settlement" standard can be achieved in a wide range of development circumstances without an excessive impact on development cost or land consumption. Comments are invited on this question; if a comment expresses concern about the compliance impact of this change, specificity as to the circumstances and impacts of concern particularly is encouraged. The Lakeville study is available at http://www.eorinc.com/resources LID.htm.

2. Change peak flow and volume modeling methodology from "composited" to "distributed" curve number approach.

The present District rule (paragraph 2.5.3) requires that applicants use one of two methods to demonstrate off-site flow under pre- and post-development scenarios. One of these methods is the Soil Conservation Service TR-20 method, which uses a weighted average of curve numbers (CN's) to generate estimates of site runoff volume. This averaging technique, known as compositing, underestimates runoff volume because it fails to account for the non-linear nature of the relationship between CN value and run-off. This effect is most pronounced where there exists across a given site a wide CN range or low CN values. It also is most pronounced when modeling smaller precipitation events, but minimal when modeling larger design storms. Many researchers have investigated and commented on this phenomenon. A brief, non-exhaustive list of published technical documents discussing it is included in Appendix A attached to this SONAR. There was not as much understanding of this phenomenon in the hydrologic community when the District's Rules first were adopted in 1999.

A proposed revision of Rule 2.5.3 would require that when using the SCS TR-20 method, applicants use a "distributed" curve number approach instead of the "composited" approach. Here, rather than relying on averages, the distributed CN approach calculates the runoff for each hydrologic runoff group in a site and aggregates the calculations, resulting in a more accurate estimate under the scenarios of concern. Although technically more complex, the distributed CN approach is now much simpler to apply with the advancement of GIS systems and computer processing speeds.

In those scenarios where the composited method results in error, use of the distributed method will result in higher runoff estimates and therefore a higher level of management requirements. However, the proposed change simply facilitates a more accurate calculation of actual runoff conditions, and therefore any additional compliance burden is not unwarranted.

The second method, "direct estimate using soil permeability classes," is proposed to be eliminated as it is not applicable to runoff calculation for a pre-settlement, rather than pre-development, scenario.

3. Change from 1.5- to two-year precipitation event for peak flow, flow volume, bounce and duration of inundation standards.

Paragraphs 2.4.1(a) and 2.4.1(b) of current Rule 2.0 require that land-altering activities not increase peak stormwater flow or stormwater flow volume from a site for each of three 24-hour precipitation scenarios, corresponding to the statistical probability of recurring every 1.5, 10 and 100 years. Similarly, paragraph 2.4.1(d) forbids land-altering activities from increasing "bounce" (a precipitation event-prompted rise in water level) or duration of inundation (the time for water level to return nearly to the pre-event elevation) for these precipitation events. The District proposes to revise the most probable scenario from the 1.5- to the two-year recurrence interval.

The 1.5- to two-year event is the event that most directly determines the character and stability of a natural stream channel. This is one specific respect in which the change would somewhat enhance resource protection.

Further, the change will address a certain variability associated with the District's standard. Whereas the two-year event is based on published rainfall data summarized in the USDA Hydrology Guide for Minnesota, the 1.5-year event is not published in the USDA Hydrology

Guide for Minnesota and is simply taken as an average between the published one-year and two-year events.

Similarly, the change will bring the District's rules into conformity with other watershed management organizations in Washington County that impose a small-scale event standard, standardizing the assessment for permit applicants working in multiple jurisdictions and simplifying regional water resource planning efforts. Making this change furthers Washington County policy favoring regulatory uniformity among the standards of the seven watershed districts and three joint powers watershed management organizations within the County.

4. Define stormwater infiltration practices and revise soil permeability figures.

The District's stormwater management rule states an order of preference for stormwater management techniques. Consistent with the requirement to limit total flow volume from the site, an applicant first must apply site design practices and on-site infiltration to the degree feasible. Where feasible site design practices do not alone suffice for compliance with peak flow, flow volume and stormwater quality standards, the rule next prefers engineered on-site infiltration and off-site infiltration. Only once all feasible means of preserving pre-development ground- to surface water proportions are exhausted may an applicant turn to above-ground means of detaining and treating stormwater. Applicants must demonstrate that the proposed management scenario will meet certain specified standards for peak flow, flow volume, water quality, water elevation "bounce" in downgradient receiving waters, and inundation period for those waters.

The District proposes to revise its rules concerning infiltration practices in several ways. First, the District would add the following definition of "infiltration system" to clarify that such a system must reflect an intentional design:

> "Infiltration system" means a device or practice such as a basin, trench, underground system, rain garden or swale designed specifically to encourage infiltration, but does not include natural infiltration in pervious surfaces such as lawns, redirecting of rooftop downspouts onto lawns or minimal infiltration from practices such as swales or roadside channels designed primarily for conveyance and pollutant removal.

The District also proposes to update the infiltration rates by soil type specified in Rule 2.0 for use in designing infiltration practices and determining that practices will allow for Rule 2.0 standards to be met. The current rates, stated in Appendix 2.4, were taken from the Washington County Soil Survey (SCS, 1980) to represent the expected infiltration capacity of the soil in its natural state. The District has collected a considerable amount of infiltration data since adopting its original rules in 1999. These data suggest that some changes to the appendix are warranted.

The Minnesota Stormwater Manual contains a table of design infiltration rates for use in the design and construction of infiltration practices (or of practices containing an infiltration component). In compiling these recommended infiltration rates, the manual's authors reviewed thirty guidance manuals and many other stormwater references. All of these sources use the following studies as the basis for recommended infiltration rates: Rawls, Brakensiek and Saxton (1982); Rawls, Gimenez and Grossman (1988); Bouwer and Rice (1984); and Urban Hydrology for Small Watersheds (NRCS). The District's proposed infiltration table is based on all of these sources as well as eight years of infiltration monitoring data collected from various stormwater management practices located in the South Washington Watershed District. These rates are intended to represent the long-term infiltration capacity of a practice after it has been constructed, and presuming adequate maintenance.

5. Adjust soil permeability figures to account for construction disturbance.

Vehicle and equipment traffic associated with construction activities causes compaction of onsite soils. Soil compaction increases runoff because water cannot enter the soil as easily. Additionally, soil compaction decreases root growth, reduces nutrient availability, and limits the storage of water in the soils. Compacted soils act as soils that are of a lower permeability class than uncompacted, native soils of the same type (Ocean County Soil Conservation District et al., 2001; Pitt et al., 1999; Pitt et al., 2002).

The District proposes to revise Rule 2.5.3 to require that hydrologic estimates use curve numbers adjusted to reflect the impact of construction activities on the permeability of the soils under proposed site conditions. For disturbed areas, the rule would require applicants to use a curve number corresponding to the permeability class one class lower than the native soils. As part of this revision, the District also proposes to define "Disturbed Area" as "the area of land subjected to removal of vegetative cover or earthmoving activities including filling." The rule creates an incentive to minimize construction boundaries and employ site design principles to maintain a compact development footprint.

Further, soil compaction can be mitigated through soil amendments such as plowing, subsoil tilling, and the incorporation of compost. The Dane County Wisconsin Land Conservation Department (Balousek, 2003) found that chisel-plowing with deep tilling reduced runoff volumes by 36% to 53%, and subsequently incorporating compost reduced runoff volumes by 74% to 91%. Vegetation also covered more soil area when compost was incorporated. Thus, soil amendments can restore much of the permeability to the disturbed soils. The rule would include an exception to the permeability class modification rule where soil structure is restored to pre-developed conditions through measures such as tilling and soil amendments approved as a part of the permit.

The use of soil amendments therefore is recognized in how compliance with stormwater peak rate and volume controls is determined under Rule 2.0. For the purpose of determining compliance with the water quality standard, to determine required treatment efficiency the permit applicant will use the soil type found on the site under existing conditions, and will not revise this to reflect any soil amendment.

6. Eliminate five-percent impervious allowance under volume control rule.

Under the District's current rule, in demonstrating no increase in stormwater flow volume as the result of a proposed development, an applicant may deduct the amount of increased volume from impervious cover on five percent of the site. As described in the 1999 SONAR supporting this rule, the District relied on research showing that, as a general principle, degradation of water resources occurs when subwatershed impervious surface coverage approaches 10 percent.

Since that time, there is a growing understanding in the field that subwatershed impairment can occur with substantially less than ten percent imperviousness. Further, the District contains significant impervious surface coverage in the form of houses, roads and other infrastructure, that existed before adoption of the stormwater management rule and the construction of which was not accompanied by adequate stormwater management design. Conversely, low-impact site design and stormwater management practices continue to mature, making on-site stormwater volume control more practical and cost-effective. Consequently, the District believes that the five-percent allowance is a leniency that no longer is warranted or necessary.

As noted earlier, over the past several years Washington County has developed a groundwater management program that, among other things, encourages consistency in regulatory standards among the watershed districts and watershed management organizations within the County. None of these entities other than the District has a volume control standard providing for a five percent hard surface allowance. The District's elimination of the allowance would help to promote the County goal.

7. Require pretreatment of runoff to infiltration facilities.

Under the proposed rule, infiltration facility design must provide for pretreatment of runoff draining to infiltration areas. A pretreatment standard is necessary to protect infiltration practices, lengthen their performance period, and reduce their maintenance frequency. Numerous studies have observed that infiltration practices are susceptible to soil clogging and are susceptible to failure due to a lack of pretreatment.

Over time, an infiltration practice will need to be regularly maintained to restore its original infiltration capacity. Restoration may include actions such as removal of the top layer of material, removal and replacement of a gravel filter or deep tilling. The purpose of the pretreatment requirement is to protect the infiltration system from clogging before scheduled maintenance and to protect groundwater from contamination. Pretreatment is a standard practice to ensure the longer life of an infiltration practice by removing the sediment that can clog soils and limit infiltration potential. Under the proposed rule's relatively broad definition, pretreatment would include any Best Management Practice that removes settleable or particulate material or other contaminating pollutants. The rule imposes a minimum requirement that pretreatment include the use of a skimmer.

The rule would define "pretreatment" in the following way:

> Any Best Management Practice (BMP) that is used to remove settleable or particulate material, or otherwise contaminating pollutants, from runoff prior to that runoff entering an infiltration BMP. Pretreatment BMPs can include, but are not limited to, sediment pool/forebay, vegetated waterway, sweeping, self-contained hydraulic and separation structures, or any other device designed to reduce inflowing solids by at least 50% and other pollutants to a level that can be treated satisfactorily in an infiltration practice. At a minimum, pretreatment practices should incorporate the use of a skimmer to remove floating debris, oils and grease. In the event a BMP is constructed in the vicinity of a potential hot spot, the skimmer will keep spill material at the surface of the pretreatment area to provide the opportunity for clean-up.

As noted, a performance standard of 50 percent pollutant removal is stated. However, no study examines what the pretreatment performance standard should be. For example, the Minnesota Pollution Control Agency's (MPCA) NPDES General Stormwater Permit for Construction Activity states that "to prevent clogging of the infiltration or filtration system, a pretreatment device such as a vegetated filter strip, small sedimentation basin, or water quality inlet (e.g. grit chamber) must be used to settle particulates before the stormwater discharges to the infiltration or filtration system," but does not specify the level of pretreatment required.

Other communities have adopted a pretreatment standard of 85 percent removal of total suspended solids (TSS) for the long-term viability of infiltration practices. The Stormwater Management Standards adopted by River Falls, Wisconsin, for instance, require pretreatment that results in 85 percent TSS removal. The City of Inver Grove Heights, Minnesota, is in the process of adopting an identical pretreatment standard similarly to ensure the long-term efficacy of stormwater infiltration practices designed and constructed to serve as the primary stormwater management technique in a landlocked system.

Comparing the District's proposed overall stormwater management standards to the Cities of River Falls and Inver Grove Heights suggests that the District's level of protection falls in the middle. The City of River Falls has an infiltration pretreatment standard of 85 percent TSS removal based on the average annual rainfall, and a volume control standard that requires matching pre-development volumes for the 1.5-inch rainfall event (less than a one-year, 24-hour event). The total land area required to meet the City of River Fall's standards will be less than that to meet the District's standards, since the overall management standard is lower. The District's water quality standard, with the changes proposed, is more protective, despite a less-demanding pretreatment standard. A 50 percent TSS removal standard represents a District decision to concentrate land consumption requirements of the regulations on volume control itself, given that the infiltration practice ultimately can be rehabilitated by long-term maintenance activities.

On the other hand, the District's proposed standards would provide a lower level of protection as compared with the regulations proposed for the Northwest Area of Inver Grove Heights.

The City of Inver Grove Heights is proposing to adopt a volume control standard requiring matching pre-development conditions for the five-year, 24-hour rainfall event and pretreatment removing 85 percent of TSS. However, the City of Inver Grove Heights and the District have differing rationales to adopt these stormwater management standards. The District seeks to protect baseflow and thermal impacts to a trout stream and to minimize water resource impacts associated with imperviousness. The City of Inver Grove Heights is planning for development of a large landlocked area, the economic potential of which rests on avoiding substantial investments, *ad hoc* or after the fact, in corrective water management infrastructure.

8. Within landlocked basins, require on- site control of the five-year storm volume.

Because a landlocked basin does not have an active surface outlet, it can lose water only through evaporation, transpiration and infiltration. As a result, increases in the volume of water remaining as surface water in a land-locked basin—typically caused by increases in imperviousness--can have a cumulative effect on the basin and lead to increases in water surface elevation, with impacts on both developed and developable land. To limit this effect, the District proposes a more stringent volume standard applicable within landlocked basins: namely, that development in a landlocked basin must preserve the pre-settlement stormwater volume on-site not for the two-year, 24-hour rainfall event, but for the five-year (3.5-inch) event.

The District proposes to define "landlocked basin" as:

> Any basin/localized depression that does not have a natural outlet at or below the existing flood elevation as determined by the 100-year 10-day rainfall event (10.8 inches) and the starting water elevation at the level determined by the 2000 Washington County Topographic Survey.

The District evaluated a number of methods for defining a landlocked basin. It is important that the selected rainfall event be a longer-term event than a 24-hour event, given the greater sensitivity of water elevations within landlocked basins to such events. In light of the need to accommodate longer-term precipitation events within landlocked basins and the availability of data to model the regulatory event, the District has selected and is proposing the 100-year 10-day rainfall event. The District's analysis is described in a memorandum prepared by the District engineer that served as the basis for District development of the landlocked basin policy proposed in the accompanying rule. The memorandum is included as Appendix B to this SONAR.

The definition of a landlocked basin also requires identifying the starting elevation of a basin, before the 100-year 10-day event commences. The District proposes to use the water surface elevation in the Washington County 2000 topographic survey as this starting water level. The survey was completed in April 2000 and provides a consistent baseline for analysis of the District's basins. Rainfall in 1999 and 2000 was near normal (1999) to up to 10 inches above normal (2000) in the area of the Brown's Creek watershed.

Choice of the five-year event for the volume control requirement provides for on-site abstraction of over 99 percent of rainfall recorded at the Minneapolis/St. Paul Airport over the last 30 years. Events larger than 3.5 inches occur very rarely; requiring the landowner to manage the excess precipitation from such an event would increase the burden on the applicant without a measurable increase in protection for the landlocked basin. A hydrologic and hydraulic model prepared by the City of Inver Grove Heights concluded that if climate conditions remain stable, volume control for the five-year event would maintain the current water surface elevations in landlocked basins studied.

C. Water Quality

1. Replace phosphorus concentration standard with annual loading standard.

Under paragraph 2.4.1(c) of the present District Rules, proposed land-altering activity must not increase site loading of total suspended solids (TSS), total nitrogen (TN), or heavy metals, or contribute to a downstream receiving water exceeding a specified phosphorous concentration. Phosphorous concentrations in runoff are modeled on the basis of the general topography and hydrology of the contributing area, existing land uses and the proposed disturbance. Annual precipitation data, runoff coefficients and phosphorus generation on the basis of land use are inputs to predict the amount of phosphorous produced at the site and moving downgradient.

The District proposes to amend this rule to substitute, in the place of phosphorus concentration, a standard that requires control of pounds of phosphorus that leave the site on an annual basis. Compliance will be determined by modeling land uses and hydrologic soil types. Compared to the existing phosphorous-concentration standard, a total phosphorus-loading standard is a more direct and accurate way to account for impacts to a waterbody. A standard of phosphorus concentration in runoff is ineffective when runoff volume increases due to increases in impervious area with development. It is counterproductive in that it constitutes an incentive to maximize the amount of runoff discharged from a site. A shift to a loading-based standard also is consistent with the approach of the federal Total Maximum Daily Load program to determine loading reductions needed to achieve water quality use-based standards and allocate those reductions among point- and nonpoint-source phosphorus dischargers.

In conjunction with the rule revision, the District will provide guidance on using the PONDNET and P8 models to model phosphorus loading. Both models are widely used in Minnesota and throughout the United States. They are easy to obtain, comparatively simple to use, and appropriate for a range of development types and land areas. The proposed guidance is included in Appendix C to this SONAR.

As a part of the revision, the District would incorporate a new Appendix 2.2 to specify runoff curve numbers per land-use category. The appendix identifies, for the purpose of illustration, the percent phosphorous load reduction required to match pre-development conditions for a variety of post-development scenarios; applicants will need to calculate treatment efficiency specific to the soil types, land uses and design features of the site. The District has developed the appendix using the Hydrology Guide for Minnesota to compute runoff volumes for different land uses for the typical water quality event (2.5 inches in 24 hours). In addition, the District relies on the recently published Minnesota Stormwater Manual (2005) for pre- and post-development phosphorous concentrations.

Appendix D to this SONAR offers a sample calculation of the required percent phosphorous load reduction evaluated for a hydrologic soil group B soil.

The rule as proposed will require phosphorus load reductions that vary depending on land use. The required reductions are consistent with the range of phosphorus reductions documented in the National Urban Runoff Program (NURP) documentation. This documentation indicates that phosphorus reductions in stormwater ponds adhering to NURP design guidelines range from about 30 percent to about 90 percent (Schueler, 1992). The lower performance rates were measured in detention ponds that were poorly designed and not maintained. The higher performance rates were measured in well-designed ponds that were actively maintained.

The range reflects the performance of individual ponds, not the higher performance that can be achieved in BMP treatment trains involving ponds and other practices connected in series. If an applicant develops a stormwater management plan that proposes to treat stormwater runoff in a series of BMP's, it should be relatively easy to demonstrate the required phosphorous load reductions. However, if an applicant chooses to comply with the standard by treating stormwater runoff in a single detention pond, it will have to be designed and constructed using strict engineering guidelines and pond maintenance will have to be performed on a routine basis to ensure performance standards will be met.

Under the proposed rule, an applicant may use either a generalized land use-based approach or a plan-specific approach to demonstrate compliance. Under the land use- based approach, an applicant aggregates the site, pre- and post-development, by land use and employs the land use-based CN values stated in the rule to calculate runoff for each land use and aggregate site runoff characteristics. Under the plan-specific approach, an applicant models the actual site and proposed design, and calculates the pre- and post-development annual phosphorous loads accordingly. This approach is more intensive, but allows an applicant to gain all the benefits of proposal-specific design such as Low Impact Design techniques and innovative BMP's.

Finally, it should be noted that the District's proposed standard is consistent with the goal of the St. Croix Inter-Agency Water Resources Planning Team to reduce annual phosphorous loads to the St. Croix River by 20 percent from the defined baseline. According to the MPCA website, the total phosphorous loading reduction goal is based on the 39 percent projected population growth in the St. Croix Basin by the year 2020. The goal is intended to approximate the ecological conditions of Lake St. Croix prior to 1950, before major existing ecological changes occurred.

2. Eliminate explicit standards for water quality parameters other than phosphorus.

The rule revision would delete separate water quality criteria for TSS, TN, and heavy metals, on the reasoning that pursuant to well-investigated relationships, removing phosphorus necessarily will remove at least equivalent percentages of the other named pollutants. After developing the proposed phosphorous load reductions, the District performed an analysis to verify that phosphorous would be the limiting water quality parameter. As detailed in Appendix E to this SONAR, the District, relying on the same method used to determine TP concentrations, calculated TSS and TN concentrations for pre-development and post-development land uses and the treatment efficiency needed to control these pollutants to pre-development conditions. Figure E-1 in Appendix E, illustrating typical wet detention pond performance relative to percent total phosphorous removal, confirms that phosphorous load reductions are the limiting water quality parameter and that if the proposed phosphorus loading standard is met, loadings of TSS and TN will not increase from pre-development levels.

D. Groundwater-Dependent Natural Resources

1. Background.

Groundwater-dependent natural resources (GDNRs) are rare natural communities where soils are saturated from the upwelling of groundwater, creating spring rivulets and wet areas. These sensitive resources are becoming even more rare in the Twin Cities Metropolitan Area through draining, excavating and elimination from the landscape. Because their hydrology is supported by surficial and bedrock aquifers, groundwater appropriation from private/municipal wells, construction dewatering and placement of other public and private infrastructure can short-circuit the flow of groundwater.

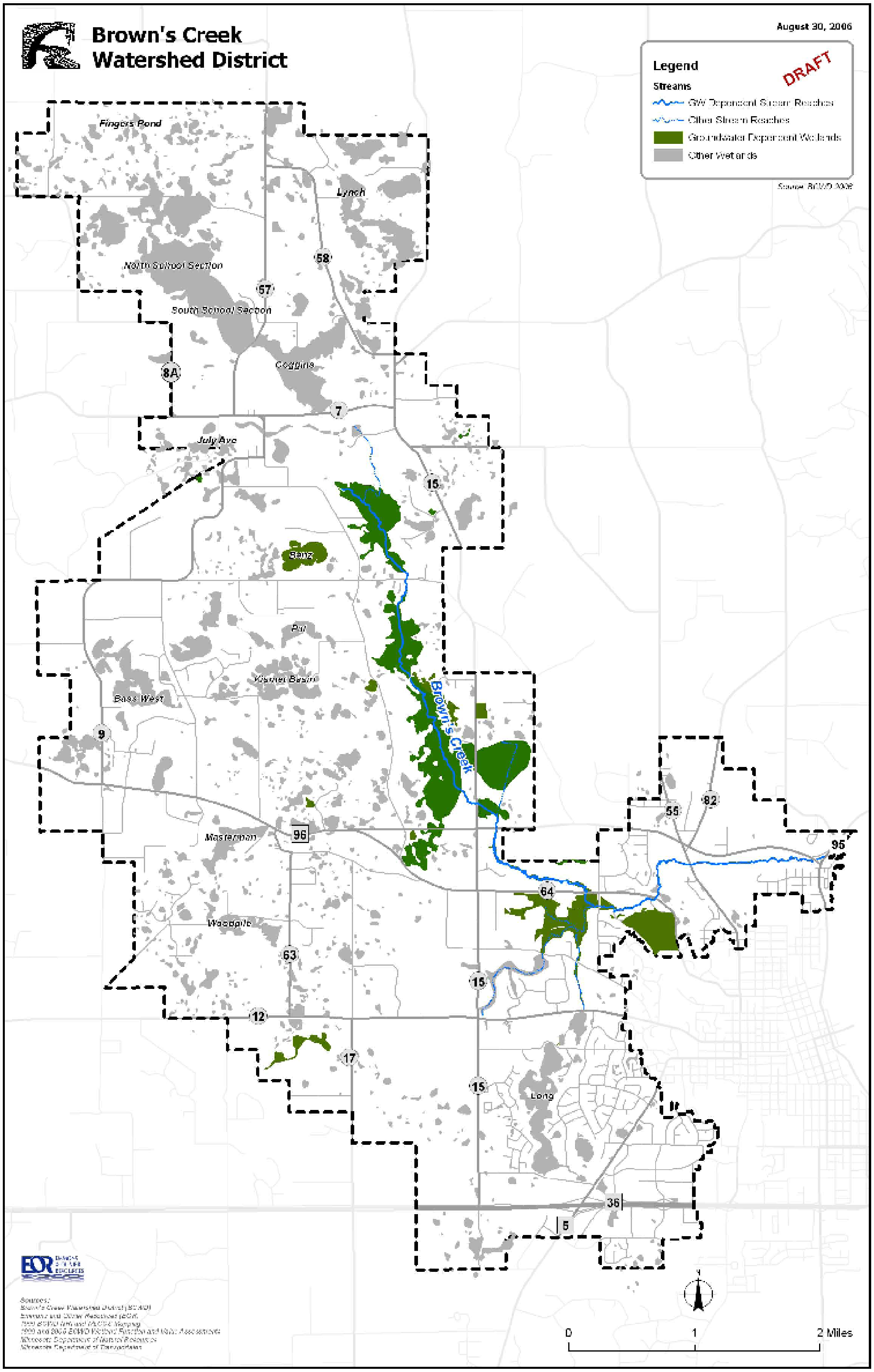
The types of GDNRs found in the Brown's Creek Watershed District include sedge meadow (seepage subtype), rich fen, poor fen, black ash/mixed hardwood seepage swamp, mineraltrophic tamarack swamps, wet cliffs and talus slopes. Poor fens and mineraltrophic tamarack swamps are much more prominent in the more northerly portions of Washington County.

Given the biological importance of GDNRs, the rarity of their unique landscape features, and their susceptibility to degradation from human activities, the District is proposing special protection by incorporating protective standards.

GDNRs are identified in a map developed for the Brown's Creek watershed and reproduced on the following page. To develop this map, the District used the best available information in the following sequence:

1. Using the Minnesota Land Cover Classification System, the District designated definite groundwater-dependent plant community types based on assemblages of sensitive plant species and known hydrology and marked all those areas within the Brown's Creek watershed as "Groundwater Dependent Wetlands."

2. The District incorporated additional information layers of GDNRs, including trout streams and other spring creeks (known spring-fed wetlands), personal observation of groundwater seepage, and known groundwater dependent lakes


Brown's Creek
Watershed District
August 30, 2006
Legend
DRAFT
Streams
GW Dependent Stream Reaches
Other Stream Reaches
Groundwater Dependent Wetlands
Other Wetlands
Fingers Pond
Lynch
North School Section
South School Section
Goggins
July Ave
Benz
Pal
Kismet Basin
Bass West
Masterman
Woodpile
Long
Brown's Creek
58
67
8A
7
15
9
96
55
82
95
64
63
12
17
36
5
Sources:
0
1
2 Miles

identified through the “Lake Data and Groundwater Function” table from the Emmons & Olivier Resources, Inc., study “Integrating Groundwater and Surface Water – North Washington County Groundwater Study.” The study also contributed GPS points of discrete groundwater discharge to enable additional classification of spring-fed wetlands.

3. For Brown’s Creek only, the District evaluated data collected for the 1999 and 2005 Wetland Function and Value Assessments to determine any additional wetlands identified in the field as being definitely groundwater dependent. The 1999 Wetland Function and Value Assessment collected data on wetlands and lakes larger than 2.5 acres, and the 2005 Wetland Function and Value Assessment Update added data collected on wetlands between 1 and 2.5 acres in size.

An appendix to the “Definitions” section of the proposed rule lists the plant communities and aquatic ecosystems that constitute GDNRs. Whether a resource feature is a GDNR should be determined by a vegetation specialist with a hydrology background. Before commencing land development activity, an applicant may need to identify and evaluate wetlands to determine their status as GDNRs.

Because of their rarity, moderate temperatures, stable hydrology and unique water chemistry, GDNRs often contain plants that are rare or endangered in Minnesota, including several considered to be relics from the last glacial period, when ice sheets covered the state. The unique and diverse plants found within the Brown’s Creek watershed include:

<u>Plants</u>
Viola lanceolata (lance-leaved violet)
Platanthera flava var. herbiola (tubercled rein-orchid)
Cephalanthus occidentalis (common buttonbush)
Echinochloa walteri (coast barnyard grass)
Poa paludigena (bog bluegrass)
Lycopus virginicus (Virginia water horehound)

<u>Bryophytes</u>
Bryum muehlenbeckii (Muehlenbeck’s bryum moss)
Conardia compacta (compact conardia moss)
Mnium marginatum (olivegreen calcareous moss)
Philonotis marchica (philonotis moss)
Lophozia badensis
Mannia triandra

A number of Unique and Rare Plant Communities, as mapped by the Natural Heritage Program, Minnesota Department of Natural Resources, are associated with GDNRs. While not necessarily "Threatened and Endangered Species,” they are indeed "rare,” whether measured, locally, regionally, statewide, or beyond. In the Brown's Creek watershed, such communities include:

Moist Cliff
Tamarack Swamp*
Tamarack Swamp Seepage Subtype
Mixed Hardwood Swamp*
Floodplain Forest Silver Maple Subtype
Seepage Meadow
Rich Fen
Poor Fen
Lake Bed
Shrub Swamp*
Emergent Marsh*
Alder Swamp
Cattail Marsh*

GDNRs also serve as a habitat for a diverse and unique assemblage of wildlife and insects, including:

Seiurus motacilla (Louisiana waterthrush)
Buteo lineatus (red shouldered hawk)
Emydoidea blandingii (Blanding's turtle)*
Elaphe vulpina (fox snake)
Alasmidonta marginata (elktoe mussel)
Obovaria olivaria (hickorynut mussel)
Tritogonia verrucosa (pistolgrip mussel)

2. Define GDNRs.

The District proposes the following definition of GDNRs:

"Groundwater-dependent natural resource" (GDNR) means a feature with surface emergence of groundwater at a spring or seepage area, sufficiently mineral rich to support a plant community or aquatic ecosystem [defined as follows:]

Cold water trout stream
Spring creek
Groundwater-dependent lake
Tamarack swamp seepage subtype
Tamarack swamp minerotrophic subtype
Tamarack swamp sphagnum subtype

White cedar swamp seepage subtype
Black spruce bog
Black spruce bog intermediate subtype
Black spruce bog raised subtype
Black ash swamp seepage subtype
Mixed hardwood swamp seepage subtype
Scrub tamarack poor fen
Birch bog, spiraea temporarily flooded shrubland
Shrub fen
Poor fen shrub subtype
Rich fen shrub subtype
Wet brush-prairie seepage subtype
Shrub swamp seepage subtype
Alder swamp - saturated soils
Birch bog, spiraea shrubland - saturated soils
Alder swamp
Birch bog, spiraea shrubland - seasonally flooded
Birch bog, spiraea shrubland - semipermanently flooded
Wet prairie seepage subtype - saturated soils
Calcareous seepage fen
Calcareous seepage fen boreal subtype
Calcareous seepage fen prairie subtype
Poor fen
Poor fen sedge subtype
Poor fen patterned fen subtype
Rich fen
Rich fen sedge subtype
Rich fen floating-mat subtype - saturated soils
Rich fen patterned fen subtype
Open bog Open sphagnum bog schlenke subtype
Graminoid bog
Wet meadow floating mat subtype
Rich fen floating-mat subtype - semipermanently flooded
Rich fen floating-mat subtype - intermittently exposed
Rich fen floating-mat subtype - permanently flooded
Talus slope algific subtype
Seepage meadow
Wet cliff
Moderate cliff

Midwest sedimentary dripping cliff
Saline spring mud flats

3. Impose Careful Development Standards on Surface-Water Contributing Areas to GWDNR's.

Because of the sensitivity of GDNRs and the increasing pressure on them, the District has determined that they require additional protection from stormwater impacts. The District therefore proposes to expand the scope of Rule 2.0 applicability to include any activity that would result in at least 5,000 square feet of impervious surface within the surface water contributing area of a GDNR.

The District has assessed whether a more stringent water quality standard is warranted for stormwater discharges to GDNRs. It believes that at this time, the standard proposed for general applicability is adequate to protect GDNRs.

(a) Water Quality Evaluation for GDNRs – Streams

For GDNRs like trout streams and spring creeks, the proposed percent phosphorous load reductions under the revised water quality rule should provide the level of protection required to maintain resources in their current condition.

The District's review of existing water quality standards for GDNRs generated few results. The turbidity standard for trout streams (MPCA, 2006a) is 10 NTU (nephalometric turbidity units). Using this standard and water quality monitoring data from 1999 and 2000 from the Crow Wing River, Mississippi River, Rum River, Crow River and Blue Earth River (MPCA), the District developed a relationship between turbidity and TSS (TSS = [turbidity – 2.1224] / 0.5092, $R^2 = 0.97$). Since TSS is often the prime component of turbidity, the two measurements are highly correlated. This relationship can differ among regions, depending on the composition of the water. The data used here include data from both highly turbid systems (Crow River) and less turbid systems (Rum River), and therefore include a broad range of samples. Using the relationship, a turbidity reading of 10 NTU is equivalent to 15.5 mg/L TSS.

Using the results of the analyses described above, the District has determined that the proposed percent phosphorous load reductions will also meet the 15.5 mg/L TSS requirement for discharges to a trout stream. A comparison of the range of TP treatment efficiency required to meet pre-development conditions (32 to 99%) with the equivalent TSS percent removal using the chart in the appendix (82 to 99%) reveals that for each land-use, the concentration standard is extremely close to being met. The standard of 15.5 mg/L is very close to being met under one land-use condition -- low-density residential -- for HSG's B, C and D only. **Table 4** provides a summary of this analysis.

Table 4: TSS concentrations corresponding to range of TSS percent removals achieved with the proposed percent phosphorous load reductions.

Land-Use	TSS Concentration [mg/L]	Range of TSS Concentration Corresponding to 82 - 99% Removal [mg/L]
low density residential	109	19.62 – 1.09
Residential	125	22.50 – 1.250
Commercial/industrial	200	36.00 – 2.00

Presently there are no established standards for nutrient levels (TP and TN) in trout streams. Since the proposed percent phosphorous load reductions meet (TP) and exceed (TN) pre-development loads, and since the creek is currently supporting a viable trout population, the District's proposed standard should provide adequate resource protection until the MPCA adopts a more restrictive standard.

(b) Water Quality Evaluation for GDNRs – Wetlands.

In contrast to other wetlands, wetlands that are GDNR's are sensitive to phosphorus water quality due to their reliance on lower-phosphorus groundwater inputs.

In general, the water quality analysis for GDNRs indicates the desirability of local data collection. In the absence of such data, however, the District proposes a groundwater-supported wetlands standard based on literature values, as found in a review of over 40 Midwest-region fens (Amon et al, 2002). This group is representative of the groundwater-supported wetlands in the Brown's Creek watershed.

In wetlands from high to lower biological quality, dissolved phosphate concentrations range from <0.04 to 0.2 mg/L. The lower end of the range provides a better standard to manage for higher quality wetlands. Notably, this range for groundwater-supported wetlands across the Midwest is very similar to the range found in five sampling points on Brown's Creek. As such, the recommendation for wetlands will follow that for Brown's Creek until analysis of further monitoring data suggests that the standard should be revised.

The Amon review does not report total phosphorus. A review of water chemistry for typical natural wetlands by Kadlec and Knight provides a comparison of dissolved and total phosphorus that shows small differences between dissolved and total values (far below an order of magnitude difference). Thus it is reasonable to use the Amon value for dissolved phosphorus as a reasonable comparison to total phosphorus when comparing the standard for the wetlands and the creek.

The proposed Minnesota standards for these waters do not include a nitrogen standard. The District proposes a standard based on existing Brown's Creek monitoring data (Emmons & Olivier Resources, Inc., 2003) and Amon et al, 2002. The nitrate nitrogen range for five downstream Brown's Creek sites is <0.005 mg/L. The nitrate nitrogen range for 60 Midwest fens is <0.04 to 15.83. The higher number represents sites with heavy agricultural runoff influence. Based upon these data, the District proposes to set the standard based on a wetland concentration goal of <0.005 mg/L nitrate nitrogen.

For both TP and TN, the proposed load reductions are meeting, if not exceeding, predevelopment loads. And in both cases, the predevelopment loads are within the range measured by Amon et. al. If the load from the surface water contribution is within the measured range, it arguably would be on the lower end of the range taking the "clean" groundwater contribution into consideration. Volumetric average concentration could also be lower if some groundwater contribution were a constant and the surface water contributions occur on an event basis.

4. Thermal control on discharges to GDNRs.

Hard surface runoff and storm water pond outflow typically is water that has been warmed to a higher temperature. When this runoff enters a stream, stream temperature can increase. Cold-water fish such as trout require stream temperatures below about 20°C, and long-term or sudden increases in temperature can harm the fish population. Volume control practices tend to encourage infiltration and transpiration, minimizing runoff of warmed waters to surface water features.

To address the thermal impacts associated with stormwater runoff, the proposed rule would: (a) prohibit hard surface stormwater runoff or stormwater basin discharge directly to a GDNR; and (b) prohibit siting a stormwater basin within either a GDNR buffer or the streamside or middle zone of a stream buffer. Further, under the proposed rule any stormwater management basin in the contributing drainage area to a GDNR would need to meet the following criteria:

- The basin must contain and infiltrate the volume generated by a two-year storm event. If infiltration is not feasible, outflow from the pond must be routed through a subsurface system, flow spreader or other device that discharges water through or across the ground, so that the temperature of stormwater runoff is effectively lowered to that of the ambient soil. The discharge must be managed to be non-erosive.

- The bottom of the basin must be located at least three feet above the seasonally high water table.

E. Miscellaneous Changes

1. Clarify stormwater management requirements for redeveloped sites.

A challenge to achieving a sustainable hydrologic system in a developed area is the development that occurred before sound stormwater management approaches were understood or mandated by regulation. The District believes it is reasonable that when a substantial change occurs on a previously developed site, the property owner may be required to review and address stormwater management for the site.

The proposed rule provides that if a development activity would disturb more than 50 percent of existing impervious surface on a site, then the stormwater management criteria of subsection 2.4 of the District Rules (peak rate and volume control, water quality, bounce and inundation period in downgradient waterbodies) will apply to all impervious surface on the project site. The reasoning underlying this provision is that if a substantial part of the existing development on the site is being disturbed, then the scope of the work and the availability of working space on the property are sufficient to presume that a stormwater management approach capable of handling the impacts of all site development is feasible.

If less than 50 percent of the existing impervious surface is to be disturbed, the criteria would apply only to the net additional impervious surface. In addition, for road and other linear projects, the proposed rule would apply the subsection 2.4 criteria only to net additional surface, regardless of how much of the existing surface was to be disturbed. This treatment is necessary to avoid creating infeasible compliance circumstances triggered by ordinary road maintenance such as mill and overlay, resurfacing, and the like.

***2. Revise Rule 2.0 Statement of Purposes**.*

The District proposes to expand the Rule 2.0 statement of Purpose and Policy to encompass new priorities reflected in the revised Watershed Management Plan and the proposed rule changes for stormwater management. As the proposed new language of subsection 2.1 reflects, one priority of the revised rules is to retain and infiltrate precipitation where it falls, and therefore to minimize connectivity of impervious surfaces to stormwater system. A second priority is to preserve the natural hydrology of landlocked basins to minimize flooding risk to structures within or downstream of such basins.

3. *Definitions*.

To further guide the application of its rules, the District proposes to add the following new definitions:

> "Best Management Practices (BMPs)" means measures taken to control impacts from stormwater runoff on the receiving water or groundwater. BMP specifications for design and construction follow, in order of priority, the Minnesota Stormwater Manual (MPCA, 2005); Protecting Water Quality in Urban Areas (MPCA, 2000); and Minnesota Construction Site Erosion and Sediment Control Planning Handbook (MBWSR, 1988); as such documents may be amended, revised or supplemented.
>
> "Better Site Design practices" means development design oriented to conserve natural areas, limit hard cover, use natural pervious areas and integrate stormwater management features to more effectively manage stormwater runoff.

"Floodplain" means the area adjoining a watercourse, or a natural or constructed water basin, including the area around lakes, wetlands, stormwater ponds, depressions, and intermittent and perennial streams, that is inundated by the 100-year 24-hour rainfall event or, for landlocked basins, the 100-year 10-day rainfall event.

III. RULE 3.0: EROSION CONTROL

1. Refine reference to erosion/sediment control design specifications.

Section 3.2.2 of the rules requires that erosion control plans be consistent with the MPCA manual "Protecting Water Quality in Urban Areas." The District proposes to amend the rule to explicitly identify the MPCA manual's specific recommendations, including:

- Implementation Schedule – list construction sequencing.
- Winter erosion control plan if construction will span winter season
- Critical erosion areas
- Limits of disturbed areas
- Stabilization of exposed and soil stockpile areas
- Stabilizing of waterways and outlets – site conveyance capable of handling the 5-year, 24-hr rainfall event precipitation
- Adjacent properties protected from erosion
- Storm sewer inlet protection if applicable
- Permanent erosion control
- Rip rap at culvert outfalls
- Rock construction entrances
- BMP construction details
- Incorporate horizontal slope grading where applicable

This housekeeping revision does not materially alter the requirements of the rule. The purpose of the revision is twofold. First, it offers applicants a reminder and checklist of basic requirements for erosion and sediment control plans. Second, it clarifies that the specifics of the MPCA manual will constitute the standard set of requirements that the District will apply in evaluating proposed plans.

2. Require site stabilization within 14 days.

The District erosion control rules presently do not contain any standards to establish a time frame for stabilizing disturbed areas of a site. While the District's practice has evolved to look for acceptable restabilization schedules on erosion control plans, the District believes it is desirable to codify a standard in the Rules to provide for consistency and avoid the need for District staff to ensure that erosion control plans contain adequate notations.

The NPDES construction permit issued by the Minnesota Pollution Control Agency stipulates timeframes for stabilization of unworked areas on the basis of slope. The District has reviewed the NPDES language and the standards of other jurisdictions. It finds that the NPDES standards are reasonable and that there is value in consistency with those standards. Accordingly, it is proposing to adopt very similar standards, as follows:

> All exposed soil areas and soil stockpiles within 200 lineal feet of a wetland, a waterbody, a discernable surface drainage feature or a stormwater system inlet, and with a continuous positive slope to that water feature, must be stabilized with erosion control measures, or temporary or permanent cover, within the indicated number of days after active work on the area ceases:

Slope	Time
Steeper than 3:1	7 days
10:1 to 3:1	14 days
Flatter than 10:1	21 days

3. Establish winter erosion control standards.

Melting snow, combined with spring rain, can cause severe erosion problems. If a construction site is being graded late into the fall construction season, there is little or no time for vegetation to establish. Unless erosion control blanket, mulch, or other erosion control measures have been employed, the site may be left unprotected into the spring construction season.

The District's current rule requires that sites be inspected at least weekly until vegetative cover is established. It does not contain specific standards to ensure that disturbed sites are overwintered in a condition in which they are protected from erosion and sedimentation during spring thaw. The District proposes to specify site overwintering standards and to allow for the weekly inspection to be reduced to monthly for sites that comply with these standards.

The District has examined winter site maintenance requirements of several other jurisdictions. It is proposing to adopt standards similar to those used by the State of New York, which it finds to be reasonable and effective. The requirements of the New York Department of Environmental Protection (http://www.dec.state.ny.us/website/dow/toolbox/winter.html) allow permittees to reduce inspections of properly stabilized sites to as little as once per month, provided that soil disturbance is suspended, vegetation activities are scheduled to allow for germination and establishment; and all stabilization occurs before the ground freezes or snow cover occurs. Property owners must:

- Cover exposed soils;
- Grade ponds and sediment traps to capacity;
- Properly install sediment barriers;
- Stabilize slopes and grades;
- Protect soil stockpiles;

- Stabilize site entrances and exits.
- Ensure that snow management does not destroy or degrade erosion or sediment control practices.

The proposed rule also states that if a site is worked after November 15, all sediment and erosion practices must be installed and in working order at the end of each day.

IV. RULE 4.0: LAKE, STREAM, AND WETLAND BUFFERS

A. Background

The benefits of areas of preserved natural vegetation around wetlands are widely accepted and were discussed in the District's original 1998 SONAR. A more recent study on the benefits of buffers conducted by Emmons & Olivier Resources, Inc. (2001) included a review of 350 technical reports, articles and papers. Among the study's key findings:

- Buffers surrounding wetlands are universally supported not only for the protection of wetlands and wetland benefits, but also for the functions and values that buffers themselves possess as vegetated riparian areas.

- The functions and values of wetland buffers are numerous, and include water quality protection (erosion control; sediment, nutrient, biological and toxics removal; thermal protection), hydrologic event modification, groundwater interaction, aquatic and wildlife habitat protection, minimization of human impact, aesthetics/open space, recreation, and environmental education.

- For a buffer's greatest long-term effectiveness, sheet flow must be maintained, vegetation must be kept healthy, and incursions from urbanization must be kept to a minimum.

- Buffers less than 50 feet in width are marginally effective in protecting wetlands.

- Most recommended minimum widths of buffer zones vary by function, but may be summarized as follows:

Function	Special Features	Recommended Minimum Width (feet)
Sediment reduction	Steep slopes (5-15%) and/or sensitive wetland	100
Sediment reduction	Shallow slopes (<5%) or low quality wetland	50
Sediment reduction	Slopes over 15%	Consider buffer width additions

		with each 1% increase in slope
Phosphorus reduction	Steep slope	100
Phosphorus reduction	Shallow slope	50
Nitrogen (nitrate) reduction	Focus on shallow groundwater flow	100
Biological contaminant and pesticide reduction		50
Wildlife habitat and corridor protection	Unthreatened species	100
Wildlife habitat and corridor protection	Rare, threatened or endangered species	200-300
Wildlife habitat and corridor protection	Maintenance of species diversity	50 in rural area; 100 in urban area
Minimize the negative impact of human pressures		50
Flood control		Variable, depending on elevation of flood waters and potential damages

- The "best" vegetation for buffer areas is a mix of trees, shrubs and ground-cover, although any of these individually will provide some benefit.

- The relationship of buffer width to water quality protection is not linear; that is, at the small end of buffer width, a slight increase in width may yield a large increase in water quality, whereas an increase in width of a wide buffer will yield a comparatively smaller water quality benefit.

- Wetland buffers should be part of an effective watershed-wide surface water management program that includes runoff and pollution prevention, installation of BMPs, and waste management.

From a landscape perspective, buffer zones around individual wetlands can have positive cumulative impacts on the water quality of downstream lakes and rivers. Filtering sediment, nutrients and chemicals before they reach a wetland avoids overtaxing its natural adsorption capacity and improves the quality of the water it discharges, thereby protecting downstream water quality.

The benefits of having buffer zones around GDNRs also is widely accepted, but has not been formally addressed by the District. Buffers protect GDNRs in four key ways:

- Chemical Properties: GDNRs exhibit a range of chemical properties including calcareous seeps and fens, with an alkaline pH that is supported by bedrock aquifers; mineraltrophic or rich fens supported by slightly alkaline groundwater: and poor fens supported by low pH groundwater and usually associated with glacial outwash and/or peatland conditions. Chemical properties are regulated by the source of groundwater, glacial and bedrock geology and surface water hydrology. Buffers, especially encompassing soils with high pH buffering capacity, help to moderate the pH of stormwater entering groundwater dependent wetlands.

- Thermal Protection: A significant benefit of a buffer near standing water and saturated soils is the ability to shade the water and moderate its summer temperature. This best is done by a mature stands of trees, but also can be accomplished on a smaller, local scale by shrubs and tall ground vegetation that shades water as it flows through. Buffer areas also cool warm runoff as it flows through vegetation.

- Physical Impacts: Many GDNRs are associated with steep slopes or are in landscape positions vulnerable to sedimentation. Sediment and other water-borne debris can smother wetland surfaces and fill in water tracks, rivulets and other small scale hydrologic features, resulting in hydrologic changes and direct loss of groundwater dependent wetlands. Buffers, especially if expanded to account for steep slopes, are effective at trapping sediment and other debris and reduce the potential for hill slope erosion.

- Groundwater-Surface Water Interaction: Buffers, while not able to directly reduce stormwater volume and discharge rate, can promote infiltration and groundwater recharge, which indirectly can help to stabilize stormwater bounce and maintain groundwater flow. In the case of groundwater dependent wetlands that occur as hill slope seeps, buffers downgradient of the wetland can limit the potential for surface and groundwater flow interference.

B. Expand Applicability of Buffer Requirement to Wetlands One Acre or Larger and Groundwater-Dependent Natural Resources

The present buffer requirement is applicable to all "public waters" watercourses and wetlands, and to lakes classified as natural environment and recreational development under Department of Natural Resources classification standards. "Public waters wetlands" are defined as:

> [A]ll types 3, 4, and 5 wetlands, as defined in United States Fish and Wildlife Service Circular No. 39 (1971 edition), not included within the definition of public waters, that are ten or more acres in size in unincorporated areas or 2-1/2 or more acres in incorporated areas.

Minn. Stat. §103G.005, subd. 15a.

The proposed rule would extend the applicability of the buffer requirement to all wetlands within the watershed and all surface waters defined as GDNRs under the District Rules. The proposed change significantly expands the number of wetlands to which the buffer requirement applies, from the 53 public waters wetlands in the watershed to some 309 wetlands one acre or larger. However, the buffer rule will continue to apply only when land development is proposed that requires subdivision, rezoning, a special use permit or a variance.

The present restriction to public waters wetlands is not based on scientific considerations, but rather was a pragmatic compromise. As the above discussion makes clear, vegetated buffers are important to protect all wetlands and their riparian habitat. The District's earlier decision to restrict the buffer requirement to just public waters wetlands rested primarily on the notion of phasing in regulation and generally conforming regulation to public expectations, which already recognized the more regulated nature of wetlands meeting the regulatory definition of "public waters."

Now, the District has seven years of experience in applying the present buffer rule. Over this time, recognition within the scientific and development communities of the value and importance of vegetated buffer steadily has increased and buffers continue to be integrated into local development codes and watershed management rules. At this time, the District believes it is appropriate to apply the requirement more generally.

Notwithstanding, the District is not proposing to apply the requirement to wetlands smaller than an acre. Given the scientific view that an effective buffer generally should be at least 50 feet in width, in the District's judgment the area of a buffer on a wetland smaller than an acre would be disproportionate to the area of the buffer itself and could be perceived by too many as unfair. Further, the absence of buffers on smaller, disconnected wetlands is less significant than on larger wetlands with more substantial hydrologic connections.

C. Refine Determination of Buffer Width

1. Revise steep slope definition.

The District proposes to clarify its definition of a "steep slope," as follows:

> "Steep slope" means land with an average slope exceeding 12 percent over a distance of 50 feet or more upgradient of the water resource, calculated using a reasonably precise surface model.

2. ***Revise definition of "mapped natural community."***

Current paragraph 4.3.2 states:

> Where a mapped natural community is associated with a stream, lake or wetland, the upland edge of the middle zone shall be as specified in sub-section 4.3.1 or contiguous with the upland edge of the natural community area, whichever is greater.

The definition of "mapped natural community" references those identified in "Natural Communities and Rare Species Map for Washington County" (Minnesota Department of Natural Resources, Natural Heritage Program, 1990), as amended.

During the 1980's, staff from the Minnesota Department of Natural Resources County Biological Survey (MCBS) conducted a process to identify the best remaining examples of natural communities in Washington County. Although Washington County includes substantial undeveloped land, the MCBS project sought to look at only the highest quality remaining natural communities: those areas that exhibit the least human disturbance and most resemble natural communities that would have been present at the time of Euro-American settlement. Plant community survey work was completed using statewide protocol. Based on these plant community surveys, the resulting data in the DNRs "Rare Features Database" and data analyses, the MDNR published the "Natural Communities and Rare Species Map for Washington County."

In conducting this work, MCBS only examined the highest quality areas. Except for native prairie, the MCBS's minimum mapping size standard for a natural community was 20 to 40 acres, which eliminated some of the high-quality natural areas within northern Washington County. The resulting data in the MCBS "Rare Features Database" is not based on a comprehensive inventory, and likely does not include additional rare or otherwise significant natural features in the state. Moreover, some natural areas that were excluded from the inventory may still retain predominantly native species and/or have the ability to be managed back to a higher quality through ecological restoration. Nonetheless, in discussions with the District, numerous staff members in Ecological Services at the DNR[2] have indicated that the "Natural Communities and Rare Species Map for Washington County" will not be amended by Ecological Services or the Natural Heritage Program.

The natural community surveying performed by EOR in 2000 used the same DNR methodology to complete the District's Natural Resource Inventory (NRI) of all natural communities including and associated with wetland systems, regardless of acreage. Because it is more complete, this NRI is reasonably considered an update of natural community mapping in the BCWD. In discussions with the District, DNR staff have concurred that more recent NRI work (especially with natural community quality data) provide better and more updated information than rare features maps based on data compiled 20 or more years ago. The District therefore proposes to use these updated NRI data in conjunction with data from the "Natural Communities and Rare Species Map for Washington County" to define a "mapped natural community" in the District.

D. Require Establishment of Buffer Vegetation

[2]Notably, Carmen Converse, who is in charge of the MCBS program, and Dan Wovcha, who performed some of the original Washington County plant community surveys with John Almendinger in the 1980's/1990's and co-authored the 1995 book Minnesota's St. Croix River Valley and Anoka Sandplain: A Guide to Native Habitats (by Daniel S. Wovcha, Barbara C. Delaney, and Gerda E. Nordquist).

The District proposes to institute a requirement that if an area to be designated as buffer does not meet minimal standards for vegetative adequacy at the time the buffer is established, then the property owner may be required to submit and implement a planting plan establishing a reasonable level of native vegetation.

The existing rule requires that as a condition of a development permit, a buffer be established and protected from disturbance by a declaration recorded on the deed for the property. The rule does not contain an affirmative obligation for a property owner to establish any minimal level of vegetation within a buffer. Clearly, a stable vegetative community is essential to buffer function. Formerly, however, the District hesitated to institute an affirmative obligation to plant a buffer that could be seen as intrusive and difficult to enforce, particularly on residential land.

However, given that a vegetated buffer simply will not serve its function without adequate vegetative cover, the District now is proposing what it believes is a reasonable requirement to meet that need.

Under the proposed rule, a planting plan would be required as a part of the permit application if area to be declared as buffer fails one of the following criteria:

- Thirty percent or more of its vegetation comprises undesirable plant species (for example, reed canary grass, common buckthorn, purple loosestrife, leafy spurge, bull thistle or other invasive or noxious species);

- Bare or disturbed soil constitutes more than 10 percent of the area; or

- The area is composed at least 10 percent of turf grass (Kentucky bluegrass).

The District would make a determination of acceptability at the time of permit review. If required, the planting plan would need to provide for the planting and establishment of predominantly native cover of perennial grasses, herbaceous cover, shrubs and/or trees.

The landowner would be required to maintain the vegetative cover for three years, in order to ensure that the cover was successfully established. Disturbance of the vegetative cover would be permanently restricted, consistent with the terms of the buffer declaration, but after three years the landowner would not be under a legal obligation to maintain and replace the cover if it were to cease to prosper.

This approach is consistent, for example, with vegetation maintenance requirements under the Minnesota Wetland Conservation Act and Section 404 of the federal Clean Water Act, both of which obligate a landowner for some five years but are not generally read to impose a permanent maintenance requirement. The District believes it represents a reasonable regulatory outcome that provides for vegetative cover to be established but does not subject a landowner to the possibility of visits from the “vegetation police” forever into the future.

Resistance to establishing native cover has been expressed due to concern that such a planting approach is unsightly or unsafe. To the contrary, the District believes there are many native vegetation approaches and species that fit with all manner of aesthetic preferences. The District intends to develop guidance, including sample plant lists, to assist those subject to buffer requirements in understanding the full range of options they may have.

E. Limit Stormwater Basins in Buffers.

The District proposes to revise the buffer rule to: (a) prohibit a temporary or permanent basin in the buffer of a GDNR unless groundwater separation and infiltration standards are met; and (b) prohibit a temporary sedimentation or permanent stormwater treatment basin in the streamside or middle zone of a stream buffer.

Restricting temporary sedimentation and permanent stormwater basins in the buffer (and direct discharges from basins to GDNRs) provides thermal protection for those resources sensitive to the impacts of heated stormwater runoff. The DNR has conducted or sponsored many studies of Minnesota trout streams over several decades that have established characteristics and conditions for maintaining good habitat. (Bachman, 1991 and Dieterman et. al., 2005).

A recent publication (Dieterman, et. al, 2005) strongly suggests that the mechanism for variation in trout growth is related to stream temperature through the effects of temperature on in-stream macroinvertebrates and other food sources. The results, somewhat surprising to the investigators, suggest that macroinvertebrate habitat impacts are a limiting factor on trout productivity. Thus, within the range of temperatures of trout-supporting streams, sedimentation, water clarity, oxygenation, storm and base flow, aquatic macrophytes and algal growth may be likely factors influencing trout food sources throughout the summer foraging season. Young brown trout feed on aquatic insects and other invertebrates. As browns exceed a foot in length, they seek chubs, dace and other small fish (MDNR, 2006a).

The optimum summer temperature range for brown trout is 12.6-15.4 C (Bachman, 1991). The temperature range for trout streams in southeastern Minnesota studied by Dieterman, et. al. was different for fast-growth (trout grow faster) and slow-growth streams. Fast-growth streams were warmer with a June-September range of about 13.5-16+ degrees Celsius; slow-growth streams had a range of about 12-13 degrees Celsius. Brown’s Creek is an average-producing brown trout stream at the temperature limit, even for brown trout (DNR 2006b and 2006c). By tempering Bachman’s optimal range with recent data on Minnesota brown trout streams, the Brown’s Creek recommended summer limit for temperature is 16.5 degrees Celsius.

Because of the recent Dieterman study and previous studies on other habitat variables, it is fairly clear that a thermal control standard will be effective for Brown’s Creek trout habitat only if it is combined with other elements. This includes a wide variation in overbank cover, periodic deeper pools, large woody debris and habitat conditions for forage.

It is widely accepted that stormwater BMPs increase the temperature of runoff by holding it in a permanent pool to be heated by the sun. A study in Prince Georges County, Maryland, investigated the thermal impacts of a wide range of stormwater management practices (Galli, 1990). Appendix G to the SONAR summarizes the findings of a literature review and notes the potential increase in stormwater runoff temperatures attributable to BMPs.

F. Miscellaneous Proposed Changes.

1. Define "buffer area."

To guide property owners, the District proposes to add the following definition of "buffer":

> "Buffer" means an upland area contiguous to a lake, stream or wetland that is maintained in or restored to primarily native vegetation and protected from invasive management.

2. Define "lake."

The buffer rule distinguishes between lakes and wetlands. For guidance, the District is proposing to define lakes within the watershed by listing those waterbodies as follows:

- Goggins
- Plaisted
- South School Section
- North School Section
- Lynch
- Benz
- Kismet
- Bass
- Masterman
- Wood Pile
- Long

Within the scientific community, lakes are distinguished from wetlands on the basis of factors including the existence of deepwater habitat, deepwater aquatic vegetation and a lesser proportion of water/upland fringe. The universe of lakes as defined above is the result of the District's assessment of these factors, supported by examination of DNR protected waters classifications, lacustrine classifications in the National Wetlands Inventory and field review.

3. Determine buffer width on basis of wetland management class rather than stormwater susceptibility.

Currently, the required width of wetland buffer under Rule 4.0 varies from 25 to 100 feet depending on the wetland's susceptibility to degradation from stormwater inputs. Since adoption of the current rule, the District has conducted a wetland function and value assessment of each wetland in the watershed ¼-acre or larger. This assessment provides a basis for assignment of buffer widths that is scientifically superior than stormwater susceptibility.

Wetland buffer widths would continue to range from 25 to 100 feet. The proposed rule would use the District's function and value assessment to assign a management classification to each wetland, based on the wetland management classification system developed by the MnRAM Working Group for use with the wetland functional assessment method known as MnRAM v. 3.0.

Wetlands within each of the four management categories would require buffers of 100, 75, 50 and 25 feet, respectively, in descending order of wetland function and value. If the District has assessed the wetland in question (i.e., it is ¼-acre or larger), then that assessment will be used to set the management classification and therefore the applicable buffer width. If it has not been assessed, the applicant will need to assess it to determine the applicable buffer width. The District believes that a competent assessment can be obtained from a qualified consultant for $100 to $300.

The results of the function and value assessment of a wetland would be used to determine the wetland's management category. A wetland would be placed in the highest classification in which it meets a specified rating level(s) for any single or joint function or value within that classification. The classifications, from highest to lowest quality condition, are as follows:

Table 5: Preserve Category Wetlands

	Function or Value	**Rating**
1	Vegetative Diversity	Exceptional
2	Wildlife Habitat	Exceptional
3	Fish Habitat	Exceptional
4	Aesthetics/education/recreation/cultural AND Wildlife Habitat	Exceptional High
5	Stormwater Sensitivity AND Vegetative Diversity	Exceptional Medium or greater
6	Vegetative Diversity AND Maintenance of hydrologic regime	High High or greater

Table 6: Manage 1 Category Wetlands

	Function or Value	**Rating**
7	Vegetative Diversity	High

8	Wildlife Habitat	High
9	Fish Habitat	High
10	Aesthetics/education/recreation/cultural AND Wildlife Habitat	High Medium
11	Stormwater Sensitivity AND Vegetative Diversity	High Medium
12	Vegetative Diversity AND Maintenance of Hydrologic Regime	Medium High

Table 7: Manage 2 Category Wetlands

	Function or Value	**Rating**
13	Vegetative Diversity	Medium
14	Wildlife Habitat	Medium
15	Fisheries Habitat	Medium
16	Aesthetics/education/recreation/cultural AND Wildlife Habitat	Medium Low

Manage 3 Category Wetlands

Any wetland not meeting another classification.

The methodology for rating wetland functions and values can be found in the MnRAM Comprehensive Guidance document for the Minnesota Routine Assessment Methodology for Evaluating Wetland Functions. Board of Water and Soil Resources, Version 3.0, April 2004. The existing stormwater susceptibility classifications are explained in "Recommended Wetland Management Classification System to accompany the Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.0" (Board of Water and Soil Resources, 7/15/04).

Using the function and value assessment to assign a management classification allows the District to set required buffer sizes based on a variety of relevant characteristics. The highly variable nature of wetlands necessitates this type of approach. The management categories are based on a priority-setting of functions and values that incorporates, but does not rest entirely on, wetland susceptibility to degradation from land development.

More wetlands in the watershed will qualify as "Preserve" wetlands under the new classification framework than as "highly susceptible" wetlands under the existing framework. Before development and refinement of the MnRAM functional assessment tool, the District was not willing to rest buffer width on the function and value assessment. The past seven years have brought a much greater understanding of how to consistently assess wetland function and value, and the District now has confidence that the proposed management classification system is sound.

4. Revise buffer averaging criteria.

The District understands that the requirement of a buffer of fixed width everywhere can cause hardship for applicants, and that more flexibility can reduce this hardship while maintaining the same or greater protection of the water resource. The present rule contains a provision to allow variation in buffer width if the buffer, on average, meets the required width. The provision is not well worded and several years ago the District, by resolution, adopted a policy to clarify that applicants may use buffer averaging if wider buffers are placed strategically to provide at least as much water resource protection, overall, as strict compliance with the buffer width requirement would produce.

For the purpose of clarity, the District proposes to incorporate improved buffer averaging language into Rule 4.0, as follows:

> Buffer width may vary, provided that the average width at least equals the applicable width of subsection 4.3.1, the buffer is at least half of that width at all points, and the buffer provides water resource and habitat protection at least equivalent to that of a uniform buffer of the required width. Buffer area calculation will exclude any part of the buffer exceeding twice the width specified in subsection 4.3.1.

The District believes that this provision creates substantial flexibility for landowners while creating the opportunity for outcomes that enhance water resource protection. For averaging to be approved, the District Board will need to find, with reliance on the recommendations of District staff and the District engineer, that the proposed buffer provides more overall water resource protection than would strict compliance with the width requirement at all points. An applicant proposing to use buffer averaging is encouraged to advise District staff at an early time so that the best outcome for both the applicant and the District can be collaboratively identified.

V. RULE 5.0: SHORELINE AND STREAMBANK ALTERATIONS

A. Application Submittal Requirements for Bioengineering

Current subsection 5.5 of the District Rules does not specify submittals for bioengineering installations. The District has determined that specific exhibits are necessary because bioengineering stabilization works generally are subject to more exacting design considerations and, if not well designed, more prone to failure than structural techniques such as riprap. Bioengineering techniques also generally require more careful examination of site conditions and site-specific consideration than do structural methods.

The proposed rule change would add specific exhibits that must be included in any application for a shoreline or streambank installation that is to be bioengineered or includes bioengineered elements:

- Complete set of project plans, including project setting in relation to adjacent waterbody.

- Information to permit a determination that the installation will withstand wind- fetch induced waves and currents, including orientation of the proposed installation relative to fetch distance and current.
- Planting plan, planting list (to include species and planting density) and specifications.
- Project timeframe and schedule, including any work restrictions due to high water.
- Inspection and maintenance schedule to ensure project success.

The District currently requires these submittals in conjunction with a bioengineering permit application. This revision would simply codify current District practice, and therefore would impose no new compliance costs.

B. Application Submittal Requirements for Streambank Alterations

Paragraph 5.9.1 of the District's current rule requires that permit applicants submit a site plan prepared by an engineer or surveyor that shows property lines, the ordinary high water and floodplain elevations, and existing streambank and contour elevations. The District proposes to revise this requirement to require that plans be prepared by a registered engineer and meet more detailed specifications. The rule also proposes to allow alternate forms of documentation if approved by District staff. Finally, the District proposes to make explicit the requirement that applicants document the hydraulic capacity of the affected stream channel.

These proposed changes would strengthen the District's current rule to ensure that construction plans are complete and have been prepared by a qualified individual. For most engineering projects, a full set of construction plans includes existing and proposed site conditions as well as supporting cross-sections and construction details. Because these sheets are likely to be prepared as a matter of course, requiring these plans from an applicant places virtually no additional burden on them and provides the District with an additional measure of assurance.

Currently, Rule 5.0 requires that streambank and contour elevations be provided. The District proposes to clarify what is required so that contour data are complete. The Federal Emergency Management Agency (FEMA) requires cross sections at points 50 feet upstream and 50 feet downstream of a proposed stream crossing, on the reasoning that these distances are likely to bound the hydraulic impact of the crossing. The District proposes to adopt a similar requirement, with the ability to require more extensive data in an individual case if hydraulic impact may extend beyond 50 feet in either direction.

Rule 5.0 suggests that a professional surveyor can certify a streambank stabilization plan. The District proposes to modify the rule text to clarify that a professional engineer must certify the plan, because a surveyor is not qualified to perform the hydraulic calculations required to determine flood elevations, or to prepare other analyses required by the rule.

C. Criteria for Retaining Walls

The District's current rule sets forth criteria for bioengineering, riprap, sandblankets, and streambank stabilization, but not for retaining walls. The current rule recommends that under normal conditions, riprap not be placed at a finished slope greater that 3H:1V. Further, any finished slope steeper than 2H:1V must be evaluated in accordance with the conditions for a retaining wall. At present, however, there is no requirement to justify a retaining wall.

The purpose of the proposed rule change is to define what is a retaining wall, restrict the circumstances under which a retaining wall will be permitted, and describe the method to evaluate a proposed design.

Under proposed subsection 5.5, any new retaining wall would be permitted only pursuant to a variance under Rule 10.0. Retaining walls damage the near shore environment and lead to artificial shoreline straightening and hardening. This straightening may result in loss of valuable fish habitat and natural shoreline contours and landscapes.

Retaining walls also do not disperse wave energy or currents well. Most of the waves' energy is reflected back out into the stream or lake, while some energy is dissipated on the bed of the water body, undermining the retaining wall. In comparison to properly installed riprap, vertical or near-vertical walls are more susceptible to damage from frost heaving and failure over time, especially if not properly engineered. Finally, retaining walls risk violating the Rule 5.0 policy to preserve the ecological integrity and natural appearance of shoreline and streambank areas.

Under the proposed rule, a new or expanded retaining wall would not be permitted unless the applicant demonstrates that there is a need for bank stabilization and that a retaining wall is the only feasible design. The District does not expect to receive many applications for retaining walls.

D. Refine Definition of Retaining Wall.

The proposed rule explicitly excludes a single course of riprap from the definition of a retaining wall, unless it exceeds 18 inches in height. Riprap armoring is subject to different forces than a retaining wall. Riprap design is evaluated for its level of protection against wave and current induced erosion, while retaining walls need to consider the additional force of lateral earth pressure. Further, a single course of riprap readily can be designed in conjunction with emergent or riparian vegetation to avoid damage to the natural appearance of a shoreline.

VI. RULE 6.0: STREAM AND LAKE CROSSINGS

Presently, the District's Rules require that when a permit is approved for installation of permanent stormwater management facilities or wetland buffer, a declaration for permanent maintenance of that feature is recorded on the deed for the property. Rule 6.0, however, fails to contain a similar provision for the maintenance of stream or lake culverts and other crossing structures against hydraulic and navigational blockage. This is an oversight and the District proposes to correct it in this rule revision.

VII. RULE 7.0: FLOODPLAIN AND DRAINAGE ALTERATIONS

A. Landlocked Basins

The District proposes to amend Rule 7.0 in several respects to explicitly address concerns in landlocked basins:

- First, the rule would define "landlocked basin" and add a new statement of policy to its floodplain rule to underscore that it specifically addresses floodplain issues in landlocked basins.

- Secondly, the District proposes to require a permit for any placement of fill within a landlocked basin, essentially defining the entirety of a landlocked basin as "floodplain" for the purpose of Rule 7.0. Commentors are invited to speak to this proposed change and whether certain minor exceptions can be articulated and incorporated into the rule.

- Finally, the District proposes to establish a separate, more demanding freeboard requirement within landlocked basins. As proposed, the rule would require that the lowest basement floor be three feet above the 100 year flood elevation, rather than two feet, unless the floor elevation is at least one foot above the natural, operating basin overflow.

B. Extend Application of Freeboard Requirement to Manmade Basins

The District's current rule 7.2 does not explicitly apply the freeboard requirement to manmade basins. The District proposes to revise the rule to state that these basins must be designed for adequate freeboard to adjacent development.

C. Clarify Requirement for District Approval of Surface Runoff Alterations

Present paragraph 7.2 of the District Rules requires a District permit for changes to surface hydrology. In recent years, several instances have come to the District's attention involving land changes or surface runoff diversions creating impacts contrary to the intent of paragraph 7.2 but, as a result of the way paragraph 7.2 is worded, straining the apparent applicability of that paragraph. The District proposes to redraft the provision in a more general manner to clarify that the District will review any change to land contour or surface flow that may create landowner or ecological impacts. The proposed text also would state more clearly the criteria the District will apply in evaluating a proposed alteration.

APPENDICES A through E

Statement of Need and Reasonableness
April 9, 2007

Brown’s Creek Watershed District

APPENDIX A

Technical Documents: Modeling Methods and Curve Number Approach

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File #	Reference	Summary
1	Busman, L., and Sands, G., 2002. Agricultural Drainage: Publication Series. University of Minnesota Extension Service, MI-07740, http://www.extension.umn.edu/distribution/cropsystems/DC7740.html .	Subsurface drainage reduces surface runoff by 29 to 45%, reduces peak flow by 15 to 30%, but has little impact in the total annual flow.
2	Center for Watershed Protection. 2000. *Technical Note 107: The Compaction of Urban Soils.* Watershed Protection Techniques 3 (2), January 2000.	• Urban soils bulk density range from 1.5 to 2.1 g/cc. Approach bulk density of concrete (2.2 g/cc) . Generally, root growth inhibited above 1.6 g/cc (even lower for clay at 1.4 g/cc). • Implications are increased runoff, decreased infiltration, decreased plant health, coverage, and decreased evapotranspiration. • recommends adjusting runoff coefficients up 0.1 to 0.5 or for SCS method, jumping to next lower soil hydrologic group (no suggestion for D soil).

File #	Reference	Summary
3	Center for Watershed Protection. 2000. *Technical Note 108: Can Urban Soil Compaction be Reversed?* Watershed Protection Techniques 3 (2), January 2000.	Restoration through compost amendments appears promising (reducing bulk density up to 0.17 gms/cc). Time and reforestation (decades) also decreases bulk density.
4	Fennessey, L., and Hawkins, R. 2001. The *NRCS curve number, a new look at an old tool.* Proceedings of the 2001 Pennsylvania Stormwater Management Symposium, October 17-18, 2001.	• NRCS (formerly SCS) CN method often misused. • Minimum 24-hr design depth often ignored (inappropriately used for small storm hydrology) • For large ungaged watersheds model +/- 30% accurate. Less so for smaller watersheds • CN not constant from event to event • Paper suggests ways to improve CN assignment
5	Garen, D.C., and Moore, D.S., 2005. Curve number hydrology in water quality modeling: uses, abuses, and future directions. Journal of American Water Resources Association 41 (2), 377-388.	CN method does not adequately account for full range of streamflow generating processes and results in a large uncertainty with sediment yield and pollutant loading predictions (small storm hydrology). Use of CN method for flood hydrograph engineering still appropriate.

File #	Reference	Summary
6	Golding, B.L., Smith, R.E., Willeke, G.E. 1997. *Runoff curve number: has it reached maturity?* Journal of Hydrologic Eng., 1(1), 145-148.	• Using single composite CN can lead to underestimating runoff. • Advocate of changing initial abstraction coefficient. • Guidance on how to vary the AMC would be helpful. • Overriding reason for acceptance and popularity of CN method is, in part, that it is a supported method and publication of the U.S. government. • The method is convenient and simple, but outdated and obsolete.
7	Gregory, Justin H. 2004. *Stormwater infiltration at the scale of an individual residential lot in north central Florida.* University of Florida MS Thesis.	Test substantiated research findings that soil compaction significantly increased runoff/decreases infiltration.
8	Grove, M., Harbor, J., and Engel B.A.. 1998. *Composite versus distributed curve numbers: effects on estimates of storm runoff depths.* Journal of American Water Resources Association 34(5), 1015-1023.	Compositing CN results in underestimation of runoff. Errors are most significant for wide CN ranges, low CN values, and low precipitation depths. Use is distributed CN recommended and important for analysis is urbanizing watersheds, long-term studies using daily rainfall, and small-scale design projects
9	Legg, A.D., Bannerman, R.T., and Panuska, J., 1996. *Variation in the relation of rainfall to runoff from residential lawns in Madison, Wisconsin, July and August 1995*. U.S. Geological Survey Water-Resources Investigations Report 96-4194, 11 p.	• Soil runoff coefficient increase as much as 0.5 on compacted lawns • Age of lawn important in predicting runoff - new lawn more compacted. • Soil type may not be important. • Rainfall intensity may not be important.

File #	Reference	Summary
10	Mandel, R., Caraco, D., and Schwartz, S.S. 1997. *An evaluation of the use of runoff models to predict average annual runoff from urban areas.* Interstate Commission on the Potomac River Basin (ICPRB) Report No 97-7, November 1, 1997.	• notes that (as explained in Urban Hydrology for Small Watersheds) urban CN's are averages of pasture and impervious surface CN's • Notes that watering of lawns – potentially increasing runoff – is not accounted for • Notes lack of consideration for disturbance and compaction typical of urban soils. • Takes issue with common lumping of CN parameter.
11	McCuen, R.H. 2002. *Approach to Confidence Interval Estimation for Curve Numbers.* J. Hydrologic Eng., 7 (1), 43-48.	Derived confidence intervals for CNs showing that CN is not a constant value, rather a variable. Variations attributed to multiple factors including antecedent soil moisture and temporal variability of watershed and channel storage.
12	McCutcheon, S.C., 2006. *Hydrology of Eastern U.S. Forested Mountain Watersheds: Rigorous Testing of the Curve Number Method for Flood Analysis.* Testimony to the West Virginia Forest Management Review Commission, January 8, 2006.	Curve numbers calibrated for large flood events would under predict small frequent event runoff volumes by an order of magnitude. When calibrated to median runoff (2-yr), large events were over predicted, and small event volumes significantly under-predicted.
13	North Carolina Sedimentation Control Commission. 2000. *Urban soils: A new focus in watershed protection.* Sediments Vol 7, No 3, July – September 2000.	• Compacted soils shown to have runoff coefficients as high as 0.5 • Because of compaction lawns produce more runoff • Compaction increases need for irrigation • Vegetation tends to be less healthy and requires extra fertilization

File #	Reference	Summary
14	Pitt, R., 1999. Small storm hydrology and why is it important for the design of stormwater control practices. Advances in Modeling the Management of Stormwater Impacts, Volume 7.	Re-examines fundamental urban hydrology modeling assumptions using historical runoff data from 24 locations across the US. • Computed observed CN's varied by storm magnitude
15	Pitt, R., Lantrip, J., Harrison, R., Henry, C., and Hue, D. 1999. *Infiltration through disturbed urban soils and compost-amended soil effects on runoff quality and quantity.* US EPA, Water Supply and Water Resources Division, National Risk Management Research Laboratory. EPA-600/R-00/016. Cincinnati, Ohio. December 1999, 231 p.	It was found that sandy soils were mostly affected by compaction with moisture levels having little affect on infiltration rates, while clayey soils showed a strong correlation between the effect of soil moisture and soil compaction. The mean final infiltration rates measured after 2 hours of testing were found to be 414 mm/h for noncompacted sandy soils, 64 mm/h for compacted sandy soils, 220 mm/h for noncompacted and dry clayey soils and 20 mm/h for all other clayey soils (Pitt et al., 1999).
16	Pitt, R., Chen, S., Clark, S. 2001. *Infiltration through compacted urban soils and effects on biofiltration designs.* Low Impact Development Roundtable Conference, Baltimore, MD, July 2001.	• Emphasizes findings that the effect of urbanization on soil structure can be extensive (infiltration is reduced, stormwater runoff increased) • Soil amendments improve infiltration capacity and better capture pollutants • Presents Horton parameters for compacted and non-compacted soils

File #	Reference	Summary
17	Pitt, R., Chen, S., Clark, S. 2002. *Compacted urban soils effects on infiltration and Bioretention stormwater control designs.* 9th International Conference on Urban Drainage. IAHR, IWA, EWRI, and ASCE. Portland, Oregon, September 8-13, 2002.	• Emphasizes findings that the effect of urbanization on soil structure can be extensive (infiltration is reduced, stormwater runoff increased) • Soil amendments improve infiltration capacity and better capture pollutants • Laboratory and field gathered infiltration rates for an array of soil types that are compacted and non-compacted are presented in tables.
18	Ponce, V.M. 1996. *Note of my conversation with Vic Mockus.* http://mockus.sdsu.edu/	Vic Mockus was a developer of the SCS method. He disagreed with the set 0.2 = Ia/S ratio and saw no problem with changing the adopted 0.2 to 0.1 or 0.3 or any other value if the data warranted it.
19	Schneider, L.E., and McCuen, R.H. 2005. *Statistical Guidelines for Curve Number Generation.* Journal of Irrigation and Drainage Engineering, 131 (3), 282-290.	• □□can be quite variable, ranging from 0.01 to 0.18. • CN and □ parameters are highly correlated and should be calibrated simultaneously. • If data is available, CN and □ should be calibrated.
20	Stormwater Center. 2006. Recommended agricultural CN for Environmentally Sensitive Development Credit. http://www.stormwatercenter.net/Manual_Builder/Credits/SITE/environmentally%20sensitive.htm	For agriculture, existing conditions should be defined by the average curve number for a five-year crop rotation and should be no larger than the curve number for small grains.

File #	Reference	Summary
21	United States Department of Agriculture, Soil Conservation Service, Engineering Division. 1984. *Computer program for Project Formulation.* Technical Release 20. Washington, D.C. Department of Agriculture.	SCS method development and presentation.
22	United States Department of Agriculture, Soil Conservation Service, Engineering Division. 1986. *Urban Hydrology for Small Watersheds.* Technical Release 55. Second Edition. Washington, D.C. Department of Agriculture.	Runoff for urban watersheds. Open space (lawns, parks, golf courses, cemeteries, etc) CN are equivalent to those of pasture.
23	Walker, S.E., Banasik, K., Jiang, N.N., Yuan, Y., and Mitchell, J.K. 2006. *Application of the SCS Curve Number Method to Mildly-Sloped Watersheds.* Southern Cooperative Series Bulletin, SAAESD, http://www3.bae.ncsu.edu/Regional-Bulletins/Modeling-Bulletin/paper98-draft1.html .	Main difficulty applying SCS CN method to mildly sloped, tile-drained watersheds is the assessment of AMC prior to an event. Study investigated the use of baseflow, rather than AMC, to quantify watershed wetness.
24	Washington Department of Transportation. 2005. *Chapter 4: Hydrologic Analysis and Appendix 4B: TR55 Curve Number Tables.* Highway Runoff Manual (Draft). http://www.wsdot.wa.gov/environment/wqec/docs/HRMapp4bPendingDraft.pdf.	Better estimates of runoff from pervious areas such as lawns, parks, and open space from CN's developed for western Washington (typically higher than standard CN values)
25	Williams, K.K., 1980. *Calibration of Federal Agency Storm Water Runoff Quantity Models for Oklahoma City.* Proc. Okla. Acad. Sci. 60, 75-81.	Notes lawn watering as possible cause for poor calibration.

File #	Reference	Summary
26	Woodward, D.E., Hawkins, R.H., Jiang, R., Hjelmfelt, Jr., A. T., Van Mullem, J.A., and Quan, Q.D. 2003. *Runoff curve number method: Examination of the initial abstraction ratio.* World Water & Environmental Resources Congress 2003 and Related Symposia	□ = 0.05 (affecting mainly smaller event) provided a better fit to runoff data from 307 watersheds or plots, each with 20+ criteria passing storm events.
27	Zarriello, P.J. 1998. *Comparison of nine uncalibrated runoff models to observed flows in two small urban watersheds*. Proceedings of the First Federal Interagency Hydrologic Modeling Conference, April 19-23, 1998, Las Vegas, NV: Subcommittee on Hydrology of the Interagency Advisory Committee on Water Data, p. 7-163 to 7-170.	Nine un-calibrated runoff model results were compared to observed flows. Models based on the SCS curve number method for generating runoff generally had the poorest fit.
28	Zucker, L.A., and Brown, L.C., 1998. Agricultural Drainage: Water Quality Impacts and Subsurface Drainage Studies in the Midwest. Ohio State University Extension, Bulletin 871-98. http://ohioline.osu.edu/b871/index.html .	The reduction in the total runoff that leaves the site as overland flow ranges from 29% to 65%. However, the total discharge is similar to land without subsurface tiles.

APPENDIX B

Brown's Creek Watershed District
Recommendations on Landlocked Basin Policy
Memorandum of Emmons & Olivier Resources, Inc.
January 18, 2006

<u>Background</u>

Landlocked basins are a special concern because changed conditions such as alterations in land use or a changing climate can drastically alter water surface elevations. Altered conditions can cause water levels to rise to the level where there is a natural outlet. In some cases, a natural outlet exists a few feet above the currently expected high water elevation. In other cases, the natural outlet may be much higher. Structures and property below the natural outlet elevation may be at risk for flooding. On the other hand, if outlets were systematically provided for landlocked basins, the downstream hydrological conditions of the system would be altered and flooding problems would occur elsewhere. Landlocked basin management is always a sensitive issue that could become problematic if appropriate foresight is not used. Balancing flooding, property rights and environmental issues, while preserving natural hydrology, can be difficult endeavor.

The Brown's Creek Watershed District (BCWD) identified in the February 2004 Hydraulic and Hydrologic Study that 28% of the District's basins are landlocked for a 100-year, 24-hour rainfall event. In other words, these basins do not currently have a natural or manmade overflow at or below the water surface elevation expected for the 100-year, 24-hour rainfall event.

To start addressing the landlocked basin management issue, the BCWD must first determine the **definition of a landlocked basin** and develop a **methodology for determining high water levels** (HWL's) in these systems.

This memorandum provides recommendations to the BCWD for these components of what could either become a landlocked basin policy or an addition to the District's Rules and Regulations.

Definition of a Landlocked Basin and Methodology for Determining HWL's

The BCWD defined a landlocked basin in the 2004 H/H Study as a basin that does not have a natural outlet at or below the 100-year, 24-hour rainfall event (5.9 inches). A semi-landlocked basin was defined as a basin that does not have a natural outlet at or below the 10-year, 24-hour rainfall event (4.2 inches) but discharges once the 10-year event is exceeded. The starting water levels used to model these events and identify landlocked and semi-landlocked basins were taken from the following sources: Washington County 2000 aerial photography or DNR Lakes Database.

The Prior Lake – Spring Lake Watershed District defines a landlocked basin as "a basin other than Prior Lake that is one acre or more in size and does not have a natural outlet at or below the 100-year flood elevation as determined by the 100-year, 10-day runoff event"

A report prepared for Washington County, *DRAFT Guidelines for Establishing Floodplain Elevations in Landlocked Basins, June 21, 2001* states that no standardized methods are available for determining flood elevations in landlocked basins. Models used by others to determine elevations include:

- An annual water budget model used by the DNR
- Modeling of the 100 yr 10 day event used by SWWD
- A 100 yr total annual runoff analysis used by LSCVWD
- Modeling of the 100 yr 30 day snowmelt event used by RWMWD

Additionally, the Washington County report notes that the cumulative effect of many years of rainfall has the largest effect on landlocked basins, not single events. The report emphasizes that the basin's water surface starting elevation is a key consideration in modeling basins to determine which are landlocked and to determine the high water elevation. This study decided to use the 100 yr 10 day event with a starting water level established at the highest known water level of the basins. Other modeling options tested to determine elevations were: back-to-back 100-yr, 24-hr event and the LSCWD annual runoff method.

The subsequent report of the *Washington County Landlocked Basin Study: Summary of Hydrologic Modeling Computations*, July 13, 2001 compares back-to-back 100-yr 24-hr events, 100-yr 10-day event, and the LSCVWD annual runoff method. The study found that the annual runoff method resulted in flood elevations that were about 1ft higher than back to back 100-year 24-hour events or the 100-yr 10-day event.

The Scott County WMO, as indicated in their *Rules Guidance, May 10, 2005,* used the Simplified Hydrologic Yield Method which is a simple method using the 100-yr annual rainfall and subtracting off the estimated seepage from the basin to determine elevations for landlocked basins.

A document from Carver County compares methods that can be used to determine flood elevations of landlocked basins:

- Full watershed simulation – Method is time and cost intensive but warranted when potential property loss is high or the analysis is conducted for a large basin.
- Back to back 100-yr 24-hr events – Method is simple but "not a statistically valid way to analyze the problem since the probability of this event occurring is much less than 1 percent."
- 10-day and 30-day runoff event – Method is good because it recognizes that longer time spans affect landlocked basins, but available data is often poor and the critical event could be even longer.
- Runout elevation – This method simply sets the runout elevation as the regulatory elevation for defining lowest floor elevations, it is simple but could consume much land in certain basins.
- Simplified Hydrologic Yield Method – This method is simple but is not good for dry depressions because seepage difficult to estimate and the critical event could be of duration longer than one year.

The Washington County November 2002 Landlocked Basins Pilot Study *included a literature search that identified the following methods that could be used to determine flood elevations when little data is known:*

- Develop model based on a regression on collected data.
- Conduct a historic water balance based on collected data then develop a time series model to determine probabilities of future water levels.
- Determine a basic water budget using collected data.

The goal of their study was to use relationships from in-depth analysis models to develop simple relationships between easily observable characteristics and the high water level. The models used were a monthly water budget model, a daily time step model, and the Valley Branch Watershed Model. The study determined regression relationships between basin flood water levels and the watershed area and lake area.

The Carnelian Marine Watershed District *Washington County Flood Mapping Study: Summary of Hydrologic Modeling Computations, June 2004* estimated flood elevations for landlocked basins using a SWMM model. The model evaluated water surface elevations under a 50 year continuous simulation, a 100 yr 10 day rainfall event, and a 100 yr 10 day snowmelt event. The study used the 1995 water surface elevations as a starting water elevation because the data from this year represented a wetter than normal year and therefore presented a conservative estimate. For most basins, the 50-year continuous water surface elevation was between the water surface elevation predicted for the two 100 year events. The 50-year continuous analysis was thought to be the most accurate analysis, but is data intensive.

The following table summarizes the various events used to determine the landlocked nature of subwatersheds:

Table 1: Summary of Precipitation Events Evaluated for Determining Landlocked Basins

Modeling Event	Rainfall Depth [inches]	Recommended for the BCWD [y/n/why]
100-year 24-hour rainfall event	5.9	No. This is the rainfall event used to define LLB's for the 2004 H/H Study. This rainfall event does not account for longer duration events and is not conservative enough for establishing HWL's in LLB's.

Back-to-back 100-year 24-hour rainfall events	11.8	No. This event is too conservative and simulates a recurrence interval that is much lower than 1 percent.
100-year 10-day runoff/snowmelt event	7.2 (runoff)	Yes. This is a good event because it simulates longer rainfall duration and is more conservative in estimating HWL's. However, the 7.2 inch runoff depth is a theoretical event that was demonstrated once in a landscape that is much different that the BCWD.
100-year 30-day runoff event	9.0 (runoff)	No. While this is a longer duration event, this event is less conservative than the 7.2 inch runoff event and would not be appropriate for establishing HWL's for a LLB.
100-year 10-day rainfall event	10.8	Yes. Again, this is a good event because it simulates longer rainfall duration and is more conservative in estimating HWL's. The 10.8 inch runoff depth was established using a statistical analysis of a large rainfall record for the area (source: Minnesota Hydrologic Guide).
50-year continuous simulation	N/A	No. This method is not suitable for a first cut evaluation of HWL's because it is too time and data intensive.

Recommendation for Landlocked Basin Policy/Rule

Based on the above review of available reports, the 100-year 10-day rainfall event (10.8 inches) was used to determine which basins in BCWD are landlocked. The starting water level used was for this evaluation was determined form the point file for the Washington County 2000 topographic survey. The survey was completed in April of 2000 and provides a consistent baseline for analysis of the District's basins. Table 2 identifies the basins that are landlocked for the 100-year 10-day rainfall event and compares these basins to those identified in the 2004 H/H Study.

Table 2: Landlocked Basins for the 100-year, 10-day Rainfall Event

Basin	Peak Elevation [feet]	Runout Elevation [feet]
CBC-1	965.12	972.8
CBC-3	961.47	961.0
CBC-5	978.66	981.0
CBC-6	973.33	975.0
GSL-1	988.24	991.5
GSL-13	1019.14	1019.0
GSL-14	1008.19	1008.6
GSL-15	1014.03	1014.0
GSL-16	1007.02	1007.5
GSL-2	990.82	999.0
GSL-3	985.04	985.0
H36-5	939.11	939.0
KPL-1	987.90	--
KPL-2	958.03	--
KPL-3	988.39	--
KPL-4	966.88	966.5
KPL-5	961.90	--
KPL-7	947.73	950.5
OPH-10	942.38	943.5
SCT-1	947.91	947.5
SCT-2	929.21	935.0
SCT-3	933.26	935.0
UBC-1	982.73	--

Basin	Peak Elevation [feet]	Runout Elevation [feet]
UBC-3	976.73	--
UBC-4	963.87	--
WKL-1	981.29	982.4
WKL-2	1002.53	1003.5
WKL-3	971.02	971.5

Under this analysis, 28 basins are defined as landlocked. In the 2004 H & H Study, 33 basins were identified as landlocked.

Basins identified as landlocked in the 2004 H & H Study (for a 100-year 24-hour event) that are not defined as landlocked under this analysis are: GSL-6, UBC-2, CBC-9, and CBC-12.

A map illustrating the locations of these basins and a discussion of the significance of these differences will be presented at the January 18th Board Meeting.

The proposed regulation is summarized by the following bullets:

- Establish landlocked basins and HWL's using the 100-year 10-day rainfall event (10.8 inches) and the starting water levels identified in the point file for the Washington County 2000 topographic survey. These HWL's are identified in Table 2. It is proposed that the BCWD manage the basins at these HWL's.

- Establish a 3-foot freeboard between the lowest floor elevation and the 100-year 10-day HWL for any new development. If the high water level is within 3 feet of the runout elevation, lowest floor elevations would be required to be one foot above the runout elevation.

- Proposed development will maintain pre-development rate and volume of stormwater for the 2-, 10- and 100-year 24-hour rainfall events.

- If the applicant demonstrates that it is not possible to maintain pre-development rates and volumes for the 2-, 10- and 100-year events they will be required to further demonstrate that the development will have minimal impact on the HWL's of the receiving waterbody/depression under fully developed conditions for the subwatershed/landlocked basin.

- If the applicant demonstrates that stormwater discharges from the development site under fully developed conditions results in a bounce equal to or greater than the 3-foot freeboard OR if conditions start to change due to natural groundwater flow patterns, the District will perform a subwatershed analysis and evaluate the impact (to the receiving waterbody and downstream resources) of constructing an outlet at the 100-year 10-day HWL.

- The subwatershed analysis will require running a continuous 50-year rainfall record to determine what the impact of ultimate development conditions will be to the basin itself using the same starting water level assumed under existing conditions.

- This standard may require future construction of outlet structures on some basins to protect buildings constructed below the runout elevation. Although the goal will be to manage these basins and their waterbodies in a way that such an outlet will be used only as an emergency overflow once the 100-year 10-day rainfall event is exceeded. The regulation would also state that any outlets proposed for landlocked basins must not aggravate or cause downstream flooding and the resultant flows must meet the standards for water quality and duration of inundation for downstream water bodies.

- Include a provision for non-landlocked basins draining to (upstream of) landlocked basins (e.g. GSL-15). Future applicants should be required to demonstrate that stormwater discharges from the development site under fully developed conditions will have a negligible impact on the 100-year 10-day HWL of the landlocked basin(s).

APPENDIX C

Calculating Phosphorous Reduction

Guidance on Use of PONDNET and P8 Models

Background

The District's current rules do not specify how a permit applicant should demonstrate compliance with the water quality portion of the stormwater management rule.

Proposed Amendment

To demonstrate compliance with Rule 2.4.1 (c), the following models, or an equivalent type, shall be used:

(a) PondNET.WK1 - The PONDNET model (Walker 1987) is an empirical model developed to evaluate flow and phosphorous routing in Pond Networks. The following input parameters are defined by the user in evaluating the water quality performance of a pond: watershed area (acres), runoff coefficient, pond surface area (acres), pond mean depth (feet), period length (years), period precipitation (inches) and phosphorous concentrations (ppb). The spreadsheet is designed so that the phosphorous removal of multiple ponds in series can be evaluated.

A copy of PONDNET may be requested from William W. Walker at the following web-site: http://wwwalker.net/.

MODEL LIMITATIONS:

If water quality ponds are too small, the empirical equation used to calculate phosphorous removal will not generate accurate results. As a rule of thumb, a permit applicant shall not use PONDNET to simulate the phosphorous removal efficiency of any pond that has an average depth that is less than 2.5 feet or a surface area less than 0.5 of the watershed area (NURP criteria). That being said, the PONDNET results are more accurate when the pond exceeds the above mentioned sizes.

For ponds smaller with an average depth that is less than 2.5 feet or a surface area less than 0.5 of the watershed area, the permit applicant will be required to submit other calculations demonstrating the phosphorous removal capability of the stormwater Best Management Practice (BMP) in question.

GUIDANCE ON USING PONDNET:

The following input parameters shall be used to assess post-development phosphorous export:

1. Runoff Total Phosphorous (ppb) – When using this program to demonstrate phosphorous reductions, the following phosphorous concentrations shall be used:

   APPENDIX 2._ Phosphorous Concentrations for Variety of Land Uses

Land Use	Phosphorous Concentration (µg/l)
Agricultural	320
Industrial/Commercial	260
Single Family Residential	300
Multi-Family Residential	320
Open/Undeveloped	310

   Source: 2005 Minnesota Stormwater Manual.

2. Season Precipitation (inches) = 19.02

3. Season Length (years) = 0.41917

4. Volumetric Runoff Coefficient (R_v) = The following runoff coefficients should be used to model phosphorous export.

Land Use	Runoff Coefficient
Developed areas	$R_v = 0.05 + 0.009xI^*$ where I = 0-100% of watershed imperviousness
Forest/Woodland	0.08
Golf Course	0.15
Park	0.07
Pasture	0.11
Row Crop	0.14

* Clayton and Schueler (1996).

Source: Runoff coefficients for undeveloped areas were developed using average CN values from the Minnesota Hydrology Guide for the different land uses and converting them into volumetric runoff coefficients for developed area with the same CN value.

5. Watershed Area (acres) = Portion of the site that drains to the modeled waterbody.

6. Pond Area (acres) = Water surface area at the normal water level (NWL) or outlet elevation of the existing or proposed pond. If none are present then use 0.0001 acres.

7. Pond Volume (acre-feet) = Total wet volume (below the NWL or outlet elevation) of the existing or proposed pond. If none are present, then use 0.0001 acre-feet.

   If one pond is routed to another (ponds in series) then the total phosphorous loads (lbs/yr) from the upstream pond need to be routed to the downstream pond.

8. Mean Depth - to determine the mean depth of the pond, divide the volume of dead storage (storage below the outlet elevation) by the surface area at the normal water level (outlet elevation).

(b) P8 - Urban Catchment Model (Program for Predicting Polluting Particle Passage thru Pits, Puddles and Ponds) (Walker), is a physically-based model developed to predict the generation and transport of stormwater runoff pollutants in urban watersheds. The model simulates runoff and pollutant transport for a maximum of 24 watersheds, 24 stormwater best management practices (BMPs), 5 particle size classes, and 10 water quality components. The model simulates pollutant transport and removal in a variety of BMPs including swales, buffer strips, detention ponds (dry, wet and extended), flow splitters, and infiltration basins (offline and online). Model simulations are driven by a continuous hourly rainfall time series. P8 has been designed to require a minimum of site-specific data, which are expressed in terminology familiar to most engineers and planners. An extensive user interface providing interactive operation, spreadsheet-like menus, help screens and high resolution graphics facilitate model use.

A copy of P8 may be obtained from William W. Walker at the following web-site: http://wwwalker.net/.

GUIDANCE ON USING P8:

When using this program to demonstrate phosphorous reductions, the following particle size distribution file shall be used: NURP50.par.

Justification

The water quality models being recommended for use in demonstrating compliance with the BCWD's are widely used in Minnesota and throughout the United States. They are easy to use, easy to obtain and appropriate for a wide range of development sites (application and size).

References

Clayton, R.A. and Schueler, T.R. 1996. Design of Stormwater Filtering Systems. Center for Watershed Protection, Silver Spring, MD.

Weiss, P.T., Gulliver, J.S., Erickson, A.J. 2005. The Cost and Effectiveness of Stormwater Practices. Center for Transportation Studies, Minneapolis, MN.

APPENDIX D

Phosphorus Load Reduction: Sample Calculation

General Assumptions:

- 10 acre development site
- HSG B
- Water quality event = 2.5 inches (Walker, 1987)
- Curve Numbers (CN) selected from the Hydrology Guide for Minnesota (U.S. Department of Agriculture, Soil Conservation Service, St. Paul, MN)
- Total Phosphorous concentrations are as follows:

Land-Use	Total Phosphorous Concentration [ppb]
Predevelopment Background Condition[1]	200
Low Density Residential (LDR)[2]	265
Residential	320
Commercial/Industrial (C/I)	260

Source: 2005 Minnesota Stormwater Manual

[1] Based on 30% crop land, 30% forest/shrub/grassland, 10% wetlands and 30% open space

[2] Based on 10% forest/shrub/grassland, 5% wetlands and 70% open space, 15% residential

Step 1: Determine phosphorous load coefficients

Divide the post-development phosphorous concentration by the pre-development (natural background condition) phosphorous concentration.

$L_0 = 265/200 = 1.33$ [low density residential land-use]

$L_1 = 320/200 = 1.60$ [residential land-use]

$L_2 = 260/200 = 1.30$ [commercial/industrial land-use]

Step 2: Determine the volume of stormwater runoff generated for the 2.5-inch rainfall event

The following equations were used to determine the volume of stormwater runoff generated for the water quality event (2.5-inches):

$$\text{Runoff (inches)} = (P - 0.2S)^2/(P + 0.8S)$$

Where:

$S = (1000/CN) - 10$

P = Storm Depth (inches)

Volume (acre-feet, AF) = Runoff (inches) x 10 acres x 1 foot/12 inches

For pre-development conditions (CN=67):

$S = (1000/67) - 10 = 4.925$

Runoff = $(2.5 \text{ inches} - 0.2(4.925))^2/(2.5 + 0.8(4.925)) = 0.36$ inches

Volume = 0.36 inches x 10 acres x 1 foot/12 inches = 0.3 AF

For low-density residential development conditions (CN=69):

$S = (1000/69) - 10 = 4.493$

Runoff = $(2.5 \text{ inches} - 0.2(4.493))^2/(2.5 + 0.8(4.493)) = 0.42$ inches

Volume = 0.42 inches x 10 acres x 1 foot/12 inches = 0.35 AF

Step 3: Use the information generated in step 2 to develop volume coefficients

V_x = post-development volume [AF]/pre-development volume [AF]

Where:

V_x = the volume coefficient

For the low-density residential development the volume coefficient,

$$V_1 = 0.35 \text{ AF}/0.30 \text{ AF} = 1.16$$

Step 4: Determine the treatment efficiency (percent) required to match predevelopment phosphorous conditions

The following equation can be used to determine the percent phosphorous load reduction required to match pre-development conditions:

$$F_x = L_x \times V_x$$

Where:

F_x = treatment coefficient per land-use

L_x = phosphorous load coefficients per land-use (determined in Step 1)

V_x = volume coefficients per land-use (determined in Step 3)

$$\text{Treatment Efficiency, } E = (100\% - 1/F_x \times 100)$$

For the low-density residential development the treatment coefficient is,

$$F_1 = 1.33 \times 1.16 = 1.54$$

Therefore the treatment efficiency for low-density residential development is:

$$E = (100\% - 1/ 1.54 \times 100) = 36\%$$

A table summarizing the results of performing these calculations for each land-use category and soil type is provided in Appendix ___ of this SONAR. The calculations used to determine the required percent phosphorous load reductions have been performed by the District and will be provided to permit applicants in the rule (see proposed rule language in next section).

APPENDIX E

Analysis to Verify Phosphorus as Limiting Water Quality Parameter

Following the development of these percent phosphorous load reductions, an analysis was performed to verify that phosphorous would be the limiting water quality parameter. The proposed standard as written only provides the level of protection needed if by meeting the required percent phosphorous load reductions, the pre-development total suspended solids (TSS) and total nitrogen (TN) loads would also be met. To perform this evaluation, TSS and TN concentrations for pre-development and post-development land uses were determined using the same methodology for determining TP concentrations. See Table E-1. Upon determination of the pre- and post-development TSS and TN concentrations, the treatment efficiency necessary to match pre-development conditions was calculated using the same methodology described above for TP. The results of this calculation are provided in Table E-2. The nomogram illustrating typical wet detention pond performance relative to percent total phosphorous removal, see Figure E-1, shows that the percent total phosphorous reductions load reductions are the limiting water quality parameter and that the pre-development loads of TSS and TN will be met.

Table E-1. Summary of Water Quality Concentrations (TP, TSS and TN) based on Land-Use

	Total Phosphorous (mg/L)				TSS (mg/L)				TN (mg/L)			
	2005 Minnesota Stormwater Manual	2003 MCWD H/H	NSQD	NURP	BCWD Rule Review Process	2003 MCWD H/H	NSQD	NURP	BCWD Rule Review Process	2003 MCWD H/H***	NSQD	NURP
Land Cover												
Cropland	0.32	0.32	--	--	170	170	--	--	5.50	5.50	--	--
Forest/Shrub/Grassland	0.04	0.04	--	--	10	10	--	--	0.75	0.75	--	--
Open Water	0.01	0.01	--	--	1	1	--	--	0.60	0.60	--	--
Wetlands	0.01-0.04*	0.01-0.04*	--	--	25	25	--	--	1.30	1.30	--	--
Land Use												
Airports	--	0.28	--	--	130	130	--	--	2.30	2.30	--	--
Freeways	0.25	--	0.25	--	200	--	--	--	2.50	--	--	--
Commercial	0.22	0.28	0.22	0.20	140	140	43	69	1.8	2.00	1.60	1.18
Farmsteads	0.46	0.46	--	--	100	100	--	--	3.00	3.00	--	--
Industrial	0.26	0.28	0.26	--	200	130	--	--	2.30	2.30	--	--
Multi-Family Residential	0.27-0.32	0.32	--	--	125	125**	--	--	2.80	2.80	--	--
Park and Recreation	0.04	0.04	--	--	50	50	--	--	1.20	1.20	--	--
Public Industrial	--	0.28	--	--	--	75	--	--	--	1.50	--	--
Public/Semi Public	0.18	0.28	--	--	75	75	--	--	1.50	1.50	--	--
Public/Semi Public Not Developed	--	0.28	--	--	--	75	--	--	--	1.50	--	--
Single Family Residential	0.30	0.46	0.30	0.38	150	100**	48	101	2.5	3.00	1.40	1.90
Vacant/Agricultural	0.31	0.32	0.25	0.12	125	125	51	70	1.5	2.00	0.60	0.97

* Average for large wetlands and wetland complexes. Individual wetlands could operate as sources or sinks for phosphorous (i.e. Painter Creek Watershed)

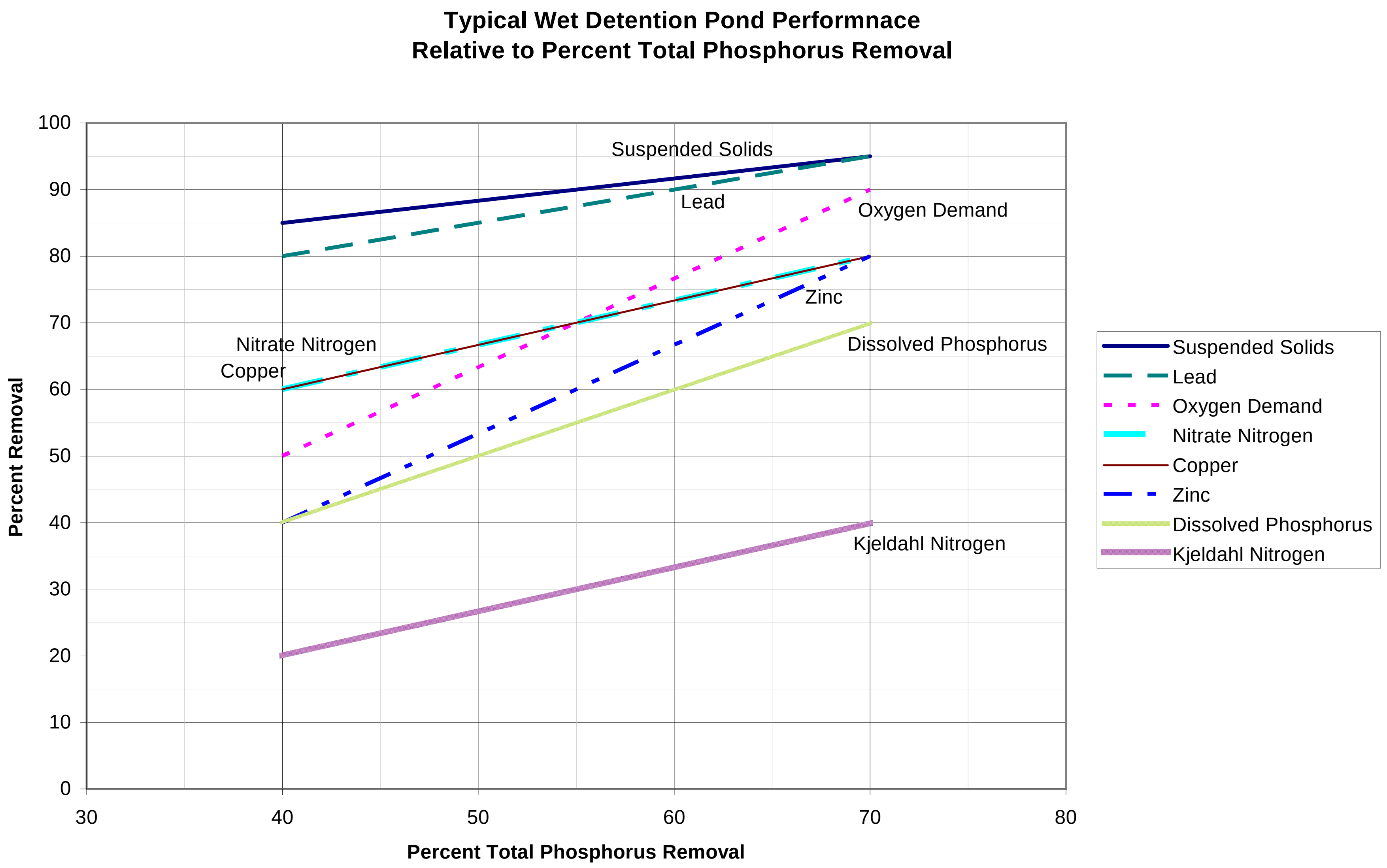
** EMCs for residential land uses in the lower watershed were decreased by 15% (multi-family residential 106 mg/L, single family residential 85 mg/L)

*** Values based on EMCs for Upper Watershed

Table E-2. Summary of treatment efficiency for TP, TSS and TN necessary to match pre-development conditions.

Land Use	TP Treatment Efficiency necessary to match pre-development conditions				TSS Treatment Efficiency necessary to match pre-development conditions				TN Treatment Efficiency necessary to match pre-development conditions			
	A	B	C	D	A	B	C	D	A	B	C	D
Pre-development	–	–	–	–	–	–	–	–	–	–	–	–
LDR	67%	36%	33%	32%	62%	27%	23%	22%	60%	22%	18%	17%
L/MDR	85%	55%	51%	47%	82%	45%	41%	36%	79%	36%	31%	26%
MDR	90%	63%	54%	50%	88%	56%	44%	39%	86%	49%	35%	29%
HDR	96%	73%	63%	55%	95%	68%	55%	45%	94%	63%	48%	36%
HDR	98%	81%	70%	61%	98%	77%	64%	53%	97%	73%	58%	45%
I	98%	80%	65%	54%	99%	88%	78%	72%	97%	72%	51%	37%
CI	99%	84%	70%	59%	99%	90%	81%	75%	98%	78%	58%	43%

Figure E-1. Wet Detention Pond Performance Relative to Percent Total Phosphorous Removal.



The proposed load reductions are achievable and consistent with the range of phosphorus reductions presented in the National Urban Runoff Program (NURP) documentation. This documentation indicates that phosphorus reductions in stormwater ponds, adhering to NURP design guidelines, ranged from approximately 30% to 90% (Schueler, 1992). The lower performance rates were measured in detention ponds that were poorly designed and were not maintained. The higher performance rates were measured in well-designed ponds that were actively maintained. Also, this range does not account for more than one pond connected in series. If an applicant develops a stormwater management plan that proposes to treat stormwater runoff in a series of Best Management Practices BMPs) it will be relatively easy to comply with the required percent phosphorous load reductions. However, if an applicant chooses to comply with the standard by treating stormwater runoff in a single detention pond, it will have to be designed and constructed using strict engineering guidelines and pond maintenance will have to be performed on a routine basis to ensure performance standards are being met.

An additional analysis of the proposed percent phosphorous load reductions was performed to evaluate the need to develop water quality standards specific to groundwater dependent natural resources.

Water Quality Evaluation for Groundwater Dependent Natural Resources – Streams

For groundwater dependent natural resources like trout streams and spring creeks, the proposed percent phosphorous load reductions provide the level of protection required to maintain the resource in its current condition. In the case of Brown's Creek, it is well-documented that this groundwater dependent natural resource is a viable, naturally reproducing trout stream. Preserving or improving the pre-development of TSS, TP and TN to this resource would maintain, if not improve, the condition of the resource.

A review of water quality standards for groundwater dependent natural resources generated few results. According to the standards adopted by the State of Minnesota (MPCA, 2006a), the turbidity standard for trout streams is 10 NTU (nephalometric turbidity units). Using this standard and water quality monitoring data from 1999 and 2000 from the Crow Wing River, Mississippi River, Rum River, Crow River, and Blue Earth River (MPCA), a relationship between turbidity and TSS was developed (TSS = [turbidity – 2.1224] / 0.5092, R^2 = 0.97). Since TSS is often the prime component of turbidity, the two measurements are highly correlated. This relationship can differ among regions, depending on the composition of the water. The data used here include data from both highly turbid systems (Crow River) and less turbid systems (Rum River), and therefore include a broad range of samples. Using the relationship, a turbidity reading of 10 NTU is equivalent to 15.5 mg/L TSS.

Using the results of the analyses described above, and Tables E-1 through E-2, it is possible to determine that the proposed percent phosphorous load reductions will also meet the 15.5 mg/L TSS requirement for discharges to a trout stream. If the range of TP treatment efficiency required to meet pre-development conditions (32 to 99%) is compared to the equivalent TSS percent removal using Figure E-1 (82 to 99%), one can determine that for each land-use, the concentration standard is extremely close to being met. The standard of 15.5 mg/L is very close to being met under one land-use condition, low-density residential, for HSG's B, C and D only. The results of this analysis are summarized in the following table:

Table E-3. TSS concentrations corresponding to range of TSS percent removals achieved with the proposed percent phosphorous load reductions.

Land-Use	TSS Concentration [mg/L]	Range of TSS Concentration Corresponding to 82 – 99% Removal [mg/L]
low density residential	109	19.62 – 1.09
Residential	125	22.50 – 1.250
commercial/industrial	200	36.00 – 2.00

At this point in time, there are no standards established for nutrient levels (TP and TN) in trout streams. Since the proposed percent phosphorous load reductions meet (TP) and exceed (TN) pre-development loads and since the creek is currently supporting a viable trout population, the standards as written should provide the resource protection required until the MPCA adopts standards or the TMDL for the creek indicates otherwise.

Water Quality Evaluation for Groundwater Dependent Natural Resources – Wetlands

The groundwater-supported wetlands standard shall be based upon literature values in a review of over 40 midwest region fens (Amon et al, 2002). This group is representative of the groundwater-supported wetlands in the watersheds (BCWD and CMWD). The dissolved phosphate concentrations ranged from <0.04 to 0.2 mg/L. This includes wetlands from high to lower biological quality. The lower end of the range is more important to set as a standard to manage for higher quality wetlands. It is noteworthy that this range for groundwater-supported wetlands across the Midwest is very similar to the range found in five sampling points on Brown's Creek. As such, the recommendation for the wetlands will follow that of Brown's Creek until analysis of monitoring data suggest that the standard should be revised. The Amon review does not report total phosphorus. A review of water chemistry for typical natural wetlands by Kadlec and Knight provides a comparison of dissolved and total phosphorus that shows small differences between dissolved and total values (far under an order magnitude difference). Thus it is reasonable to use the Amon value for dissolved phosphorus as a reasonable comparison to total phosphorus when comparing the standard for the wetlands and the creek.

No nitrogen standard is given in the proposed State standards for these waters. The standard for BCWD and CMWD shall be based upon existing Brown's Creek monitoring data (Emmons & Olivier Resources, Inc., 2003) and Amon et al, 2002. The nitrate nitrogen range for five downstream Brown's Creek sites is <0.005 mg/L. The nitrate nitrogen range for 60 midwest fens is <0.04 to 15.83. The higher number represents sites with heavy agricultural runoff influence. Based upon these data, the standard shall be set at <0.005 mg/L nitrate nitrogen.

In both of these cases, TP and TN, the proposed load reductions are meeting, if not exceeding, predevelopment loads. And in both cases, the predevelopment loads are within the range measured by Amon et. al. If the load from the surface water contribution is within the measured range, one could argue that it would be on the lower end of the range taking the "clean" groundwater contribution into consideration. One could also argue that the volumetric average concentration would be lower if some groundwater contribution were a constant and the surface water contributions occur on an event basis.

In general, the water quality analysis for groundwater dependent natural resources clearly demonstrates the need for local data collection.