11. Drinking Water Source Areas

11.1. Ground Water

This group includes any ground water recharge areas that supply water used for drinking water supply. The management goal is to maintain ground water recharge while preventing the possibility of ground water contamination. Ground water is a critical water resource, as many residents depend on ground water for their drinking water, and the health of many aquatic systems depends on steady recharge to maintain surface water bodies throughout the year. For example, during periods of dry weather, ground water sustains flows in streams and helps to maintain the hydrology of wetlands. Because development creates impervious surfaces that prevent natural recharge,

Table 10.8 Stormwater Design Recommendations to Enhance Phosphorus Removal

BMP Design	Design Criteria
Bioretention	► Bioretention are preferred practices.
Filtration	► Organic filters are a source of soluble phosphorus and should not be used. ► Employ finer-grained media in the filter bed with a small diameter (15 microns), or provide a finer-grained layer at mid-depth in the filter profile. ► The process for pre-treatment and/or filtration should extend from 36 to 48 hours, where possible. ► Filters should be oriented to provide maximum solar exposure. ► Wet swales are not recommended. ► Open channels should be designed to be either self-cleansing or promote maximum sediment retention. ► Open channels should not be relied on as the only BMP to remove phosphorus at a site, with the exception of an engineered dry swale.
Stormwater Ponds	► Design wet ponds with a depth no greater than 10 feet to prevent stratification and potential release of phosphorus from bottom sediments. ► Avoid the use of dry or dry extended detention ponds ► Designers should consider the snowmelt runoff volume and design ponds for seasonal operation ► Use a surface or mid-depth release from the pond. ► Landscape pond to discourage geese. ► Add shallow benches and wetland areas to enhance the plankton community. ► Follow mosquito advisories in Chapter 6.
Constructed Stormwater Wetlands	► Pond/ wetland system is the preferred wetland design. ► Use a surface or mid-depth release from the wetland. ► Maximize surface micro-topography. ► Landscape wetland to discourage geese. ► Follow mosquito advisories in Chapter 6.
Infiltration	► Infiltration BMPs are preferred practices. ► Provide a minimum 3-foot separation from the seasonally-high water table, bedrock or impervious soil layer.

a net decrease in ground water recharge rates can be expected in urban watersheds. Thus, during prolonged periods of dry weather, stream flow sharply diminishes. In smaller headwater streams, the decline in stream flow can cause a perennial stream to become seasonally dry.

Urban land uses and activities can also degrade ground water quality if stormwater runoff is directed into the soil without adequate treatment. Certain land uses and activities are known to produce higher loads of metals and toxic chemicals and are designated as potential stormwater hotspots or "PSHs" (see Chapter 13 for definitions and further discussion). Soluble pollutants, such as chloride, nitrate, copper, dissolved solids and some hydrocarbons can migrate into ground water and potentially contaminate wells. Stormwater runoff should never be infiltrated into the soil from sites designated as a PSH (Table 10.9).

Stormwater hotspots commonly occur as commercial, industrial, institutional, municipal, or transportation-related operations that produce higher levels of stormwater pollutants, and/ or present a higher potential risk for spills, leaks or illicit discharges (Table 10. 9). Runoff from these operations may contain soluble pollutants which cannot be effectively removed by current BMPs and can contaminate ground water quality.

Typical sources of nutrients, metals, hydrocarbons, toxins and other pollutants that can be generated from PSH are summarized in Table 10.10. It should be noted that not all of these operations or activities will actually generate pollution at an individual stormwater hotspot. In fact, many industrial operations are highly regulated under state and federal programs. There are, however, many small or unregulated facilities (such as gas stations or auto salvage yards) that are of concern because of the potential for release of toxic material to stormwater.

The management goal in ground water drinking water source areas is to prevent possible ground water contamination by preventing infiltration of untreated hotspot runoff. At the same time, recharge of unpolluted stormwater is needed to maintain flow in streams and wells during dry weather. As such, structural BMPs alone should not be relied upon as a sole stormwater management strategy at a PSH. A stormwater pollution prevention plan for a PSH should also incorporate a combination of:

- Good housekeeping
- Preventive maintenance
- Spill prevention and clean-up

Table 10.9 Business Operations at Potential Stormwater Hotspots (adapted from MDE, 2000)

► Vehicle salvage yards and recycling facilities	► Outdoor liquid container storage
► Vehicle service and maintenance facilities	► Outdoor loading/unloading facilities
► Vehicle and equipment cleaning facilities	► Public works storage areas
► Fleet storage areas (bus, truck, etc.)	► Facilities that generate or store hazardous materials
► Industrial sites	► Commercial container nursery
► Marinas (service and maintenance)	► Large parking lots
► Transportation routes* and fueling areas	► Large chemically managed turf areas

* Note that road surfaces are not always considered PSHs unless a history of contaminated water has occurred.

- Employee training
- Inspections
- Record-keeping
- Chemical use restrictions

More information on how to prepare an effective pollution prevention plan for a site can be found in Chapter 12 and Chapter 13.

The following adjustments to the standard stormwater sizing criteria are recommended to protect the quality of ground water drinking water source areas:

Water Quality: Enhanced sizing and pre-treatment

MPCA water quality sizing Rules 2 or 4 should be applied to development sites within ground water drinking water source areas, depending on whether a pond or non-pond BMP option is be-

Table 10.10 Stormwater Pollutants Associated With Common Operations at Potential Stormwater Hotspots (Schueler *et al.*, 2004)

Operation or Activity	Nutrients	Metals	Oil / Hydrocarbons	Toxics	Others
Vehicle Repair	◔	●	●	●	
Vehicle Fueling	◔	●	●	●	(MTBE not used in MN)
Vehicle Washing	●	◐	◐	●	Water Volume
Vehicle Storage	○	◐	●	◔	Trash
Outdoor Loading	◐	◐	◔	◔	Organic Matter
Outdoor Storage	◐	◐	◐	◐	
Liquid Spills	◐	◐	●	●	
Dumpsters	◐	◐	◐	●	Trash
Building Repair	◔	◐	◐	◐	Trash
Building Maintenance	○	●	◔	◐	
Parking Lot Maintenance	◔	◐	●	◐	Chloride
Turf Management	●	○	○	●	Pesticides
Landscaping	●	○	○	●	Pesticides
Swimming Pool Discharges	○	○	○	○	Chlorine
Golf Courses	●	◔	○	●	Pesticides
Hobby Farms/Race Tracks	◐	○	○	○	Bacteria
Construction	◐	◔	◔	◐	Trash, Sanitary Waste, Sediment
Marinas	◐	◐	◐	●	Bacteria
Restaurants	◐	○	●	○	Grease

Key:
● major contributor
◐ moderate contributor
◔ minor contributor
○ not a pollutant source

ing considered. A minimum of 0.2 watershed-inches of effective pre-treatment is recommended for non-pond BMPs to remove pollutants prior to any infiltration or soil filtration.

Recharge: Encouraged in limited situations

Infiltration is encouraged at residential subdivisions to increase ground water recharge through rooftop disconnections and other better site techniques. Commercial and institutional rooftops can also be disconnected as long as they are not a potential stormwater hotspot. No infiltration or recharge of runoff from potential stormwater hotspot operations should be allowed to reduce the risk of ground water contamination. Caution on the source of infiltrating water should be exercised in all cases.

BMP Selection: The following guidance on BMP design and selection is offered to protect ground water drinking water source areas.:

- In general, infiltration of clean runoff from residential and non-residential rooftops is encouraged with acceptable pre-treatment.
- Stormwater ponds, wetlands, bioretention, and filters are effective surface treatment
- No infiltration from PSHs, especially those with potentially high chloride levels and/or vulnerable ground water resources
- Minimum setbacks from wells, septic systems, sinkholes and wellhead protection zones in conformance with state and local regulations (contact Minnesota Department of Health) and plans
- Avoid pooling or infiltrating stormwater in active karst areas (Chapter 13)

Additional BMP design criteria for ground water protection are presented in Table 10.11.

Table 10.11 BMP Design Considerations for Ground Water Aquifer Protection

BMP Group	Design Consideration
Bioretention	► OK with proper caution for PSH
Filtration	► OK with proper caution for PSH ► Open channels are OK, but polluted runoff must be adequately pre-treated
Infiltration	► Provide a 100-foot horizontal separation distance from wells and three-foot vertical distance from the water table ► No PSH runoff, unless treated by another practice, such as a filtering system ► Needed pre-treatment of all runoff except rooftop
Stormwater Ponds	► Needed liner if A soils or active karst are present ► Pre-treat PSH runoff ► Provide a separation distance from well or water table to BMP
Constructed Stormwater Wetlands	► May needed liner if A soils or active karst are present ► Pre-treat PSH runoff ► Provide a separation distance from well or water table to BMP

11.2. Surface Water

There is a large portion of Minnesota residents served by drinking water obtained from a surface water source. The supplies for the St. Cloud, Minneapolis and St. Paul metropolitan areas are obtained mostly from the Mississippi River; St. Paul's supply is supplemented by both small stream flow and ground water. Several other cities throughout the state are also supplied by smaller rivers such as the Minnesota/Blue Earth, Red Lake and Red Rivers, by Lake Superior or by large abandoned quarries in the Iron Range. In each of the river source areas, protection of the surface water source reaches far beyond the local border to the entire watershed feeding the supply intake. For the quarries, inflow occurs primarily from ground water sources that must be protected as noted in the previous section. Lake Superior itself requires attention, as do the tributary streams that feed it.

Each of the surface water sources is preparing or has prepared a source water protection plan in which they identify potential pollutants of interest and the likely source of those pollutants. They also must put together a plan to protect the source of water. This plan, as is the case for the Mississippi River communities, can stretch far upstream (or up-gradient for ground water) to areas not under the control of the served communities. This severely limits the direct control that the supplied communities have over pollution generating activities. Fortunately, a willingness to help protect these drinking water source areas has led to multi-community cooperative protection efforts.

The pollutants mentioned in the previous ground water section certainly all apply to surface water sources. In addition, surface water suppliers have to be concerned about such things as sediment, phosphorus, nuclear waste (Mississippi River suppliers), any cargo hauled through the watersheds on rail or roads, or on the water in barges, PSHs, fire-fighting runoff and a myriad of other potential surface water contaminants. All of the precautions mentioned in the previous section for ground water source areas should also be applied to surface waters that provide drinking water.

The management goal in surface water drinking water source areas is to prevent possible

Table 10.12 BMP Design Considerations for Surface Water Source Protection (see also Table 10.8)

BMP Group	Design Considerations
Bioretention	► OK with proper caution for PSH
Filtration	► OK with proper caution for PSH ► Open channels are OK, but polluted runoff must be adequately pre-treated
Infiltration	► No PSH runoff, unless treated by another practice, such as a filtering system. ► Need pre-treatment of all runoff except rooftop.
Stormwater Ponds	► Need liner if A soils or active karst are present ► Pre-treat PSH runoff ► Prepare response plan to capture and remove spills in pond
Constructed Stormwater Wetlands	► Pre-treat PSH runoff

source contamination by preventing any potential contaminant from reaching either the stream or river providing the water or any ground water inflow that will eventually feed a surface water source. Pollution prevention and emergency response become primary BMP approaches for source waters. Information on how to prepare an effective pollution prevention plan for a site can be found in Chapter 12 and Chapter 13. The list of focal BMPs remains similar to the ground water list noted previously with the addition of good watershed management to control pollutants associated with nonpoint sources.

The following adjustments to the standard stormwater sizing criteria are recommended to protect the quality of surface water drinking water source areas:

Water Quality: Enhanced sizing and pre-treatment

MPCA water quality sizing Rules 2 or 4 should be applied to development sites within surface water drinking water source areas that are determined in a source water protection plan to be critical to maintaining the quality of the source water. A minimum of 0.2 watershed-inches of effective pre-treatment is recommended for non-pond BMPs to remove pollutants prior to any

Table 10.13 Susceptibility of Wetland Types to Degradation by Stormwater Input (Source: State of Minnesota Storm-Water Advisory Group, 1997)

Susceptible		Non-Susceptible	
Highly Susceptible Wetland Types[1]	**Moderately Susceptible Wetland Types[2]**	**Slightly Susceptible Wetland Types[3]**	**Least Susceptible Wetland Types[4]**
► Sedge Meadows ► Open Bogs ► Coniferous Bogs ► Calcareous Fens ► Low Prairies ► Coniferous Swamps ► Lowland Hardwood Swamps ► Seasonally Flooded Basins	► Shrub-carrs[a] ► Alder Thickets[b] ► Fresh (Wet) Meadows[c,e] ► Shallow Marshes[d,e] ► Deep Marshes[d,e]	► Floodplain Forests[a] ► Fresh (Wet) Meadows[b] ► Shallow Marshes[c] ► Deep Marshes[c]	► Gravel Pits ► Cultivated Hydric Soils ► Dredged Material / Fill Material Disposal Sites

1. Special consideration must be given to avoid altering these wetland types. Inundation must be avoided. Water chemistry changes due to alteration by stormwater impacts can also cause adverse impacts. Note: All scientific and natural areas and pristine wetlands should be considered in this category regardless of wetland type.
2a, 2b, 2c. Can tolerate inundation from 6 inches to 12 inches for short periods of time. May be completely dry in drought or late summer conditions.
2d. Can tolerate +12" inundation, but adversely impacted by sediment and/or nutrient loading and pro- longed high water levels.
2e. Some exceptions.
3a. Can tolerate annual inundation of 1 to 6 feet or more, possibly more than once/year.
3b. Fresh meadows which are dominated by reed-canary grass.
3c. Shallow marshes dominated by reed-canary grass, cattail, giant reed or purple loosestrife.
4. These wetlands are usually so degraded that input of urban stormwater may not have adverse impacts.

Notes:
There will always be exceptions to the general categories listed above. Use best professional judgment.
Pristine wetlands are those that show little disturbance from human activity.

infiltration or soil filtration.

Recharge: Encouraged for watersheds, with caution for ground waters feeding a surface water source

Infiltration is encouraged within watersheds upstream of drinking water intakes from surface water. Protective measures consistent with the previous ground water supply section are encouraged for ground waters feeding surface water sources.

BMP Selection: Supplemental BMPs should follow those suggested for Sensitive Lakes. The following guidance on BMP design and selection is offered to protect surface water source areas:

- A pollution prevention plan is essential for the entire area draining to the surface water intake;
- Stormwater ponds, wetlands, bioretention, and filters are effective surface treatment;
- No infiltration or direct runoff in the vicinity of the intake from PSHs, especially those with potentially high chloride levels and/or vulnerable ground water resources; and
- An emergency response plan should be prepared for spill response in areas critical to supply protection.

Additional BMP design criteria for ground water protection are presented in Table 10.12.

Table 10.14 Recommended Hydroperiod Standards for Wetlands (Source: State of Minnesota Storm-Water Advisory Group, 1997)

	Susceptible		Non-Susceptible	
Hydroperiod Standard	Highly Susceptible Wetlands	Moderately Susceptible Wetlands	Slightly Susceptible Wetland	Least Susceptible Wetlands
Storm Bounce	Existing	Existing plus 0.5 ft	Existing plus 1.0 ft	No limit
Discharge Rate from Wetland	Existing	Existing	Existing or less	Existing or less
Inundation Period* for 1- & 2-Year Precipitation Event	Existing	Existing plus 1 day	Existing plus 2 days	Existing plus 7 days
Inundation Period for 10-Year Precipitation Event & Greater	Existing	Existing plus 7 days	Existing plus 14 days	Existing plus 21 days
Run-Out Control Elevation (Free Flowing)	No change	No change	0 to 1.0 feet above existing run out	0 to 4.0 feet above existing run out
Run-out Control Elevation (Landlocked)	Above delineated wetland	Above delineated wetland	Above delineated wetland	Above delineated wetland

* Inundation period is the time above the normal water level (NWL)