INVER GROVE HEIGHTS
Northwest Area

Appendix B

Stormwater BMPs and Plant Material Selection

Northwest Area (NWA)
Inver Grove Heights Stormwater Manual

Stormwater BMPs and Plant Management Selection

Appendix B

Key Topics: stressors evaluation and plant material selection, BMP buffer vegetation, pre-treatment sites for infiltration basins, annual maintenance, references

Contents

I. Evaluating Environmental Stress is a Critical Pre-planning Step to Plant Material Selection

Plant material selection depends on the type of storm water BMP and environmental stressors. Stressors include the levels of various pollutants and moisture and will directly affect vegetation response, health, and effectiveness of the BMP. For these reasons an evaluation of BMP stressors must be considered before selecting plant material. BMP vegetation must be carefully selected and maintained (see subsequent section on Operation and Maintenance) in order for the infiltration function to operate.

The quality of water entering the urban storm water BMP is influenced by the type of runoff surface and expected pollutants. For example, impervious surfaces from major roads will see more vehicle traffic, more potential dirt and grit, more petroleum products, and in northern climates, more sand or salt use for ice management. In contrast, driveways, rooftops, sidewalks and small streets and roads will not typically provide the same amount of pollutant load. The proportion of impervious surface attributed to roads is listed in Table B.1 as one criteria to evaluate and anticipate the stressors for BMP vegetation. The other criteria listed in Table B.1 is the proximity of road runoff to the BMP. For example, the BMP site could be separated by grassed side slopes or buffer strips, be located on minor streets, or be designed to have a pretreatment site. In these cases road runoff is indirect. All buffer strips and pretreatment areas are assumed to have direct road runoff without any filtering. These two criteria combined will determine the anticipated levels of various environmental stressors.

Flooding for more than a couple of days is used as a general cut off point for shifting vegetation from generally intolerant to flood-tolerant. This level of flooding is expected for the infiltration basin and sometimes for vegetated swales. However, the other BMPs are not expected to encounter flooded conditions, if the catchment area is sized appropriately. Salt stress is another burden on the BMP vegetation. Various levels of salt-tolerance must be accommodated based upon the amount of catchment area being treated with salt in the winter. This is distinguished in Table B.1 as 'salt-treated surface as proportion of total impervious' and assumes that not all public road surfaces are equally treated. Salt stress can be buffered to some extent with the appropriate buffer vegetation, except in the design of the parking lot bioretention, in which it is assumed there is no buffer. However, salt and other soluble contaminants are much more difficult for buffers to screen out compared to silt and sand, and so the actual BMP vegetation must still be considered for salt-tolerance (see the last column in Table B.1). Excess nutrient is not listed as a stressor, but may be problematic because several commonly known invasive or undesirable species are more competitive under higher nutrient loads. A healthy buffer should help alleviate this by trapping much silt, which is a carrier for much of the phosphorus in the runoff. The green roof is subject to quite different stressors compared to other BMPs further down the treatment train. Air-borne particulates can be a problem under higher atmospheric pollutant loads, but no information is available in this geographic region to compare green roofs with and without this load. Drought and heat stress are well studied stressors and green roof selections shall need to consider this.

Table B.1 Wetland Management Standards								
BMP	**Road Surface as proportion of total impervious (low, medium, high)**	**Proximity of road runoff (direct, indirect)**	**Environmental stressor (salt, petroleum, flooding, silt, sand, drought shown where applicable)**					**Salt-tolerant requirement (low, medium, high)**
			Silt/ Sand	**Salt**	**Petroleum**	**Flooding**	**Drought**	
Infiltration basin (several days standing water)	Medium	Indirect		Salt	Petroleum	Flooding		Medium
Infiltration trench	High	Direct		Salt	Petroleum			High
Rain Garden	Low	Indirect		Salt	Petroleum			Low
Parking lot bioretention	High	Direct	Silt/sand	Salt	Petroleum			High
Vegetated swale – dry Infiltration and biofiltration		Indirect via grassed buffer		Salt	Petroleum	Flooding		Low to medium
Vegetated swale – wet (several days standing water)		Indirect via grassed buffer		Salt	Petroleum	Flooding		Low to medium
Buffer strip for rain garden, vegetated swale, infiltration trench	Low to high	Direct	Silt/sand	Salt	Petroleum			High
Infiltration basin pretreatment basin	High	Direct	Silt/sand	Salt	Petroleum	Flooding		High
Green roof	n/a	n/a	Air-borne Particulates				Drought and Heat	n/a

II. Healthy BMPs Require Vegetated Buffers

Every BMP that might encounter higher pollutant loads and environmental stress will require a pretreatment buffer area. In the case of infiltration basin, a volume control pretreatment basin can provide the settling capacity for much of the heavier particles to be removed. Still, salts will not be removed in this process. A variety of swale and trench type BMPs might be located so as to accommodate vegetated buffers to filter out some of the products in direct road runoff, particularly in drainage areas with a high proportion of higher traffic roadways.

BMP buffer vegetation selection as well as the operations and maintenance schedule are different from the other BMPs.

BMP Buffer Vegetation for the Rain Garden, Vegetated Swale, and Infiltration Trench

The BMP buffer is often edges of roads and sidewalks. Salt stress may be a problem. Cultural practices often dictate that the buffer strip also be mowable grass. Trampling and pet waste may be additional stressors. They tend to be shallowly sloped and thus not subject to flooding. From multiple stressors, the lifespan may be short or the health poor for the BMP buffer. The potential for frequent reseeding and mowing dictates that plant selection is best focused on function under high stress and low cost. A simple mix of tolerant grasses is thus recommended.

Summary of Criteria for BMP Buffer Plant Selection

- Inexpensive seed source
- Compatible species (similar growth and colonizing rates)
- Tolerant of the anticipated environmental stress (see table above)
- Short-lived perennial grasses – long life span not needed (long-lived perennials OK where environmental stressors are low)
- Amenable to mowing

Plant selection is not to be limited to native species. Buffer sites are also assumed to be slightly sloping without opportunity for ponding, and with substrate that is well-aerated and porous. Different sites should be tested with different mixes or species to see what works best.

Looking In-Depth at Salt Tolerance for BMP Buffers

Mn/DOT funded the production of a handbook on the principles of integrated roadside vegetation management (IRVM). This handbook provides some guidance on nonnative turf species which are feasible for high salt stress. The internet access for this publication is http://www.lrrb.gen.mn.us/PDF/200019.pdf The full citation is in the Vegetation References. Below is the recommended nonnative turf seed mix for salt-tolerance. The 2005 Mn/DOT technical report that summarizes all of their seed mix numbers now gives the following as seed mix 260.

A report titled *Establishment, Protection, and Reestablishment of Urban Roadside Vegetation Against Salt and Ice* is available through Mn/DOT's Office of Research Services. The report outlines many maintenance and construction activities to use in Minnesota.

Source: 2005 Mn/DOT Technical Report

To alleviate the effects of roadway salt on adjacent soil and vegetation, treat the soil with gypsum, which reverses the effects of salt and sodium accumulation, and plant a salt-resistant or alkali grass. Mn/DOT has developed a new low-maintenance turf seed mix, 60A (Modified 60B), for use in areas with high salt, the composition of which is shown below. This grass reaches a height of about 12 inches. The application rate is 100 pounds per acre.

Common Name	Botanical Name	Percent of Mix
Fescue, creeping-red "Cindy"	Festuca rubra	10.0
Rye-grass, perennial "Elf"	Lolium perene	14.0
Bluegrass, Canada "Reubens"	Poa compressa	12.0
Bluegrass, fowl	Poa palustris	10.0
Bluegrass, common "98/85"	Poa pratensis	12.0
Bluegrass, Kentucky "Park"	Poa pratensis	12.0
Bluegrass, Kentucky "Caliber"	Poa pratensis	10.0
Alkali grass, "Salty"	Puccinella distans	19.0
White clover	Trifolium repens	1.0
	Total	**100.0**

The following natives or wildflowers can also be used with success in areas where salt is an issue:

Native grasses: Canadian wild rye, Indian grass, little bluestem, blue grama, side oats grama
Wildflowers: Black-eyed Susan, purple prairie clover, yarrow, bush clover

A report titled *Establishment, Protection, and Reestablishment of Urban Roadside Vegetation Against Salt and Ice* is available through Mn/DOT's Office of Research Services. The report outlines many maintenance and construction activities to use in Minnesota.

Native plant seed mixes may also be amenable to BMP buffers. This list of seed mixes may be considered.

- BWSR Mixture U10 – native berm
- MNDOT Mixture 350NGR – general purpose roadside (taller stature)
- MNDOT Mixture 30B – urban prairie (shorter stature, ca. 18 inches – no mowing)

Following is a list of individual species considered as salt-tolerant.

- Blue grama grass (Bouteloua hirsuta)
- Buffalo grass (Buchloe dactyloides)
- Little bluestem (Schizachyrium scoparium)
- Tall wheatgrass (Agropyron elongatum)
- Western wheatgrass (Elytrigia smithii)
- Alkali grass varieties Fults and Salty (Puccinella distans) – sod-forming
- Red fescue varieties Dawson and Cindy
- Park Kentucky bluegrass
- Low Maintenance Kentucky bluegrass

Seed source may play an important role in providing salt tolerance. Producers from northwest Minnesota and eastern North Dakota may likely be carrying local seed with more natural salt tolerance than the same

seed from fields in other areas. This is thought to be the case because of naturally higher salt levels which can be found in certain of the region.

BMP Buffer Vegetation as Pre-treatment for the Infiltration Basin

The pre-treatment basin is subject to environmental stressors shown in Table B.1, but unlike grass buffer strips is usually offset from sidewalk and road surfaces and the additional stressors mentioned above. Cultural requirements for mowing are not a factor in plant selection. They are however subject to flooding and therefore require a distinct selection of vegetation compared to the grass BMP buffer.

The pre-treatment function is to settle out sediment prior to the runoff reaching the infiltration site. As such the vegetation will need to be replaced once the settling function declines. This schedule will be determined by performance evaluated under operation and maintenance plan.

The best recommendation for the pre-treatment basin is a seed mix composed of compatible species. This introduces a range of plant tolerances to various stressors. The species which survive are best suited to the site. Different mixes should be tried at different sites to test what is best suited to the general site conditions.

Pre-treatment basin recommended seed mixes:

- BWSR Mixture W4 – native swale/ditch
- MNDOT Mixture 28B – general purpose native ditch
- MNDOT Mixture 328NEP – economy pond/ditch

It may be of interest to have a list of individual plant species suitable for these sites. A list was derived by screening the MPCA publication “Plants for Storm water Design’, because it provides a guide to flooding tolerance. The list in that manual is too broad and does not address the additional environmental stressors identified above. It is also limited to recommendations for rain gardens and vegetated swales (unspecified type).

The list provided here resulted from first screening the MPCA list according to flooding frequency – medium, depth – 12-24 inches , and duration – up to 4 days (herbaceous vegetation only) and then screening for tolerance to the additional environmental stressors.

- Panicle aster (Aster lanceolatus)
- Swamp aster (aster lucidulus)
- New England aster (Aster nova-angliae)
- Red-stemmed aster (Aster puniceus)
- Boltonia (Boltonia asteroides)
- Fringed brome (Bromus ciliatus)
- Awl-fruited sedge (Carex stipata)
- Fox sedge (Carex vulpinoidea)
- Canada wild rye (Elymus Canadensis)
- Virginia wild rye (Elymus virginicus)
- Joe pye weed (Eupatorium maculatum)
- Boneset (Eupatorium perfoliatum)
- Switchgrass (Panicum virgatum)
- Brown-eyed susan (Rudbeckia subtomentosum)
- Woolgrass (Scirpus cyperinus)
- Mad-dog skullcap (Scutellaria lateriflora)
- Cup plant (Silphium perfoliatum)
- Blue vervain (Verbena hastata)

III. Vegetation Operations and Maintenance

Recognizing Healthy Vegetation

Plant health vigor is integral to BMP function. Public works crews must be trained on the signs of vigor and symptoms of stress, as well as how the vegetation functions as part of the stormwater management system. What does vitality and vigor look like? And how is this related to BMP function?

BMP Vegetation

The following qualitative descriptions are expected for healthy BMP vegetation.

- ► Soil surface is fully covered by living shoots without patches of thatch or sediment
- ► Herbaceous vegetation forms a dense stand
- ► Undesirable species are not present
- ► Herbaceous vegetation forms even-height patches of green shoots – no patches of yellowing, sparse, or stunted vegetation

The above descriptions allow the vegetation to function for storm water management in the following ways:

- ► Provide full surface area of the BMP for storm water contact with the soil surface (surface thatch and sediment deposits act as a barrier)
- ► Provide well-aerated, living root zone for storm water to quickly infiltrate the soil (water transport requires a well-aerated, honeycombed soil matrix; a vigorous root system allows for plant water uptake in between runoff events)
- ► Provide a high roughness coefficient of herbaceous shoots to trap and slow above ground runoff
- ► Last but not least, vigorous vegetation is the basis for a tidy and visually pleasing community amenity

BMP Buffer Vegetation

Staff Training

Operations and maintenance will require the skills of evaluating vegetation health and maintaining vegetation health. The recommendations for developing staff training are provided below.

Training Programs

- ► Summer staff ½-day workshop – conducted annually to prepare seasonal vegetation specialists
- ► Professional staff kickoff 1-day workshop to prepare professional vegetation specialists
- ► Professional staff annual ½-day update workshop / conference

Training Content (comprehensive; break out according to supervisor or seasonal position)

- ► Selecting vegetation health indicators: the equivalent of blood pressure, height, weight, and health history
- ► Measuring health indicators: knowing what to look for in the field, how to take and record the measurements, field-determined decisions on when to schedule the next check-up
- ► Developing a detailed procedural book
- ► Record keeping of health indicators: storing field sheets, electronic database design and data storage
- ► Evaluating health records: using data to graph, tabulate a meaningful picture of what is going on
- ► Surgery and intervention: what, when and how of removing undesirable vegetation; unhealthy sediment

deposit removal; reclaiming bare areas with seed and seedlings; where to deposit weed flowering heads, stalks, and roots
- Practicing surgical technique: a practicum on de-heading, uprooting, manual seeding and planting, surgery without trampling
- Nursing young vegetation: when watering is needed, hand weeding
- Maintaining health of soils in the BMP buffer
- BMPs amenable to burning: examples of small-scale burns, fire department training practice, when thatch should be burned
- Dogs, cats, snowmobiles, and other visitors: trampling and compaction, ammonia damage, accidental mowing
- Costs and budgeting: labor, materials, administration
- Adopt-a-BMP: when and where this is feasible; who will administrate it?
- Supervisor Resource Library: where to go for contractors and plant materials; assisting City staff to create public information fact sheets
- Professional training: keeping up with technology and advances; networking and sharing experience; in-house training – brown bags for City staff

Annual Maintenance

Monitoring and maintenance is to be divided between supervisors and seasonal staff. Supervisors will have more in-depth initial training/education from which to make decisions, and gain in-depth knowledge from year-to-year experience. Seasonal staff can be quickly trained each season, and perhaps a seasonal, permanent position can be created in lieu to coordinate with the year-round, permanent supervisor. Job descriptions and positions may be somewhat dynamic when the stormwater maintenance program is initially adapting.

Provided below is a generic schedule of monitoring and maintenance activities, with recommended staff assignment given in parentheses. In some cases a contractor is recommended for carrying out a task, which could include other City staff or volunteers as the contractor. In general the supervisors are responsible for measuring the standard health indicators, and documenting miscellaneous observations which suggest the onset of some health decline, whether it be a certain species or the whole site. The seasonal staff can perform the tasks which are clear cut and requiring minimal judgement.

Maintenance, monitoring is a preventive health plan. Falling behind may quickly lead to compounding plant stress and a spiraling of effects on plant health. It is critical not to fall behind on the schedule; skip months, etcetera. Some invasive species are very easy to control IF they are not allowed to reproduce. For example, once weed seed is incorporated into the ground or perennial weed roots have been allowed to expand, then the eradication is escalated many-fold.

The ongoing maintenance is going to be distinctly different for the BMP and BMP buffer, as detailed below.

BMP Vegetation

- April: observe for thatch build up that prevents light penetration to the soil surface; make recommendation to burn or not. (supervisor) and burn (contractor)
- April/May: Observe for sediment deposits after spring snowmelt and flooding (supervisor); scrape or rake all areas with a surface covering to loosen the deposit (seasonal); remove or incorporate into underlying soil (seasonal)
- May/June: Observe for bare spots and lack of new spring growth (seasonal); as needed, determine seed or seedling requirements (supervisor); hand cultivate and sow seed (seasonal), or mechanically prepare and seed areas larger than 100 square feet (supervisor or contractor)
- Early July: Observe for undesirable species - MDA exotic species tables – typically seedlings of common buckthorn, box elder, reed canary grass, purple loosestrife, thistle, burdock, but also cattail

shoots, willow shoots (supervisor); loosen all roots and pull shoots and roots by hand or with weed wrench (seasonal).

- ► September: observe for artificial debris and remove: cigarette butts, bottle caps, plastics, glass shards, bits of paper, etc. - applies to the BMP buffer too (seasonal or contractor)
- ► September/October: Observe for additional bare spots other than areas receiving sediment build up from snowmelt (supervisor); hand cultivate and sow seed (seasonal), or mechanically prepare and seed areas larger than 100 square feet (supervisor or contractor)

Note that fertilizer treatment is not prescribed. Fertilizer provides an advantage to undesirable species which thrive better in more nutrient-rich conditions.

Each BMP site will vary on the kind and amount of pollutant load and factors such as soil, moisture, solar exposure, winter cold snaps, summer droughts, and compaction by foot traffic and snowmobiles. These factors will affect the year to year vigor of the BMP vegetation. Supervisors will quickly learn which stressors are most affecting a particular site.

BMP Buffer Vegetation

Rain gardens and vegetated swales require a buffer between the pavement runoff and the BMP. Conceptual BMP designs display this as a uniform mowed grass buffer. The buffer strip must receive the same level of monitoring and maintenance as the BMP vegetation. A vigorous buffer strip will prolong the life of the BMP by providing a pre-treatment phase and taking the brunt of the stress from sediment load and salt runoff. Even with good maintenance, periodic replacement may be needed. Salt can build up in the soil to intolerant levels over time. Scraping the vegetation, treating the soil with gypsum, and then replanting may be necessary.

BMP Buffer turf monitoring and maintenance may follow turf management practices. Depending on location and surrounding use, the mowing can be set high. This will provide additional roughness to trap runoff, but this will have to be decided according to whether the roughness backs up water in places where it is not wanted, like adjacent curbs and sidewalks.

Preventive maintenance activities for turf:

- ► Sediment scraping and removal
- ► Plug Aeration
- ► De-thatching
- ► Re-seeding, especially bare and stressed points where weeds begin
- ► Mulch Mowing
- ► Fertilizing

If the BMP buffer is a native clump grass, then monitoring and maintenance is more akin to short grass prairie management.

- ► Burning
- ► Scraping and hand seeding
- ► No fertilizing – native grasses are good nutrient scavengers
- ► Sediment scraping and removal
- ► Plug Aeration

IV. Web References for Stormwater BMP Plant Material

The following agency websites provide information on plant material selection for vegetated storm water BMPs.

From the Minnesota Pollution Control Agency:

http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html Appendix E

From the Minnesota Pollution Control Agency:
http://www.pca.state.mn.us/publications/manuals/stormwaterplants.html

From the Rice Creek Watershed District:
http://www.ricecreek.org and click on the Best Management Practices browser

From the Minnesota Department of Transportation:
http://www.dot.state.mn.us/environment/pdf_files/SeedingManual2003.pdf

From the Minnesota Board of Water and Soil Resources:
http://www.bwsr.state.mn.us/wetlands/publications/nativewetveg.pdf Seed Mix: BWSR W4 for ditches and wet swales

These site are for reference only. Actual site design must be discussed with and performed by professionals with expertise in design and maintenance of storm water BMPs.

V. Additional References on Plant Material Selection and Maintenance

The following references will provide background for designing both plant selection and maintenance programs.

Daubenmire, Rexford. 1968. Plant Communities: A Textbook of Plant Synecology. Harper & Row. New York, NY.

Methods of measuring plant vigor and stand characteristics

Jacobson, Robert L. 2005. Guidelines for Restoring and Managing Native Wetland Vegetation. MN/BWSR and MN/DOT. March 2005.

Although focused on wetlands, provides seed mixes that can be appropriate, in particular mixtures W4, U11.

Johnson, Ann M. 2000. Best Practices Handbook on Roadside Vegetation Management. Mn/DOT Report No. 2000-19. September 2000.

There is excellent information depicting the noxious weeds and use of herbicides; a salt-tolerant turf mix is provided also. Appendix C provides a good summary of nonnative grass species and their use.

MNDOT. 2005. Standardization of Seed Mixes from Previous Standard Specifications for Construction Editions Prior to and Including 2000. Tech Mem. No. 05-03-ENV-01. Jan 18, 2005.

Recommended uses provided and all feasible seed mixes listed; gives BMP buffer (use sod-like turf mixes) and BMP mixes (use native mix for wetter as and ditch/infiltration ponds)

NRCS. 1986. Engineering Field Handbook Chapter 7. Grassed Waterways. March 1, 1986.

In Exhibit 7-2 is nice coverage on the vegetation condition associated with different Mannings N values for degree of retardance of water velocity. This is useful for demonstrating the effect of mowing height and vegetation density on retarding water flow. Best for use in BMP buffer management.

USDA. Veg Spec: Creating Vegetative Designs. USDA, USACE, USGS

http://ironwood.itc.nrcs.usda.gov/Netdynamics/Vegspec/pages/HomeVegspec.htm

This is a design module based upon the soil physical characteristics at the site; provides you a full list of plant species that fit the soil type and climate of your location; choice of introduced, native, or both species