Ada County Highway District

STORMWATER MANAGEMENT BASIN REVEGETATION GUIDANCE MANUAL

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Ada County Highway District

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October 2017

Acknowledgments

We would like to thank Beth Corbin, Bureau of Land Management botanist, Ann Debolt, Natural Communities Specialist at Idaho Botanical Garden, and personnel at Granite Seed Company for seed mix suggestions. Aaron DeJoia, Certified Professional Soil Scientist, and Jeff Klausmann, Intermountain Aquatics, Inc., also provided valuable assistance.

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ACHD	Ada County Highway District
B	Boron
C	Carbon
C:N	Carbon to nitrogen ratio
Ca	Calcium
Ca^{2+}	Calcium ion
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate (or limestone)
$CaSO_4$	Gypsum
CEC	Cation exchange capacity
Cl^-	Chloride ion
cm	Centimeter(s)
CO_2	Carbon dioxide
Cu	Copper
dS	Decisiemens
EC	Electrical conductivity
FAC	Facultative
FACW	Facultative wetland
Fe	Iron
g	Gram(s)
H_2SO_4	Sulfuric acid
HCl	Hydrochloric acid
K	Potassium
K^+	Potassium ion

Mg	Magnesium
Mg^{2+}	Magnesium ion
Mn	Manganese
N	Nitrogen
Na	Sodium
Na^{+}	Sodium ion
NH_4^{+}	Ammonium ion
NO_3^{-}	Nitrate ion
NPDES	National Pollutant Elimination Discharge System
NRCS	Natural Resources Conservation Service
OBL	Obligate wetland
P	Phosphorus
pH	A measure of acidity or basicity
PLS	Pure live seed
PO_4^{3-}	Phosphate
S	Sulfur
SAR	Sodium absorption rate
USDA	U.S. Department of Agriculture
VAM	Vesicular-arbuscular mycorrhizae
Zn	Zinc

1.0 Introduction

The Ada County Highway District (ACHD) maintains more than 70 stormwater management basins throughout Ada County, Idaho. These basins occur in a variety of settings and address a wide range of stormwater conditions. A large quantity of water is directed into and through stormwater management basins in Ada County, and as such, the conditions of these basins are directly related to the quality of water that enters surface waters or infiltrates the soil. Appropriate cover and composition of vegetation is key for the proper functioning of stormwater management basins and optimal water treatment.

The purpose of this document is to present easy-to-implement guidelines for revegetation of side-slopes, banks, and bottoms (except sand invert areas) of new and existing stormwater management basins throughout the jurisdiction of ACHD. The intended audience for the guidance manual is ACHD personnel involved in site selection, engineering, vegetation management, and maintenance of stormwater management basins, as well as consultants and contractors that may provide these services. Guidelines in this document will assist personnel in identifying and prioritizing goals for revegetation of individual basins based on site characteristics. This document also presents specific recommendations for site preparation, planting and seeding to assist in meeting identified goals for both existing and new basins.

2.0 Goals for Revegetation of New and Existing Basins

ACHD has identified five general goals for vegetation of all stormwater management basins, which are:

- ***Aesthetics.*** Many stormwater management basins are highly visible due to their proximity to residential and commercial areas. Maintaining a positive public perception of stormwater management basins is very important to ACHD. The public is more likely to support maintenance and construction of basins if they contribute to, rather than detract from, the appearance of an area. Stormwater management basins that are in proximity of roads, walkways, and residential and commercial development are more visible to the public and, therefore, are subject to greater scrutiny.
- ***Noxious weed and invasive species management.*** The State of Idaho requires the control or containment of several noxious weed species identified as nuisances or dangers to the public (refer to Idaho State Department of Agriculture [ISDA] noxious weed list [ISDA 2014] for a current species designations). Additionally, many plant species not formally designated as noxious can be detrimental to the functioning of a stormwater basin and must therefore be controlled or eliminated. Properly established native or desirable vegetation can exclude or suppress the growth of undesirable species in most situations. The replacement of noxious weeds or other invasive species with native or desirable vegetation may contribute to the attractiveness and ecological function of stormwater basins, thereby increasing the public's perception of these areas.
- ***Fire hazard reduction.*** Fire hazard due to vegetation at stormwater management basins is of high concern for ACHD and the public. Fire hazard of a site often is related to dominance of highly flammable invasive plant

species such as cheatgrass (*Bromus tectorum*). Displacing invasive species with native or desirable species can reduce the flammability of an area. Though grass species generally are not considered fire resistant, certain characteristics of native and desirable non-native grasses decrease their susceptibility to fire when compared to common invasive species. Most native perennial grasses stay green longer in the summer and are therefore less flammable than common invasive species. Bunchgrass species provide a less continuous fuel source than do sod-forming species; fires in areas vegetated with these species are less likely to spread as rapidly. Additionally, warm-season grasses stay green significantly longer in the summer and are less flammable than cool-season grasses or many invasive species. Additionally, shorter grass species may be marginally less likely to facilitate fire spread than taller species.

- ***Water quality.*** Stormwater management basins maintained by ACHD are engineered to serve as either retention or detention basins for stormwater. Detention basins have both inflow and outflow mechanisms and provide temporary storage of runoff. Suspended solids are allowed to settle in detention basins before water is released. Retention basins do not have outflow mechanisms and are intended to serve as basins where received water infiltrates into soil or evaporates. Properly established vegetation in both detention and retention basins can increase the quality of water that infiltrates or exits the basin. Vegetation in detention basins reduces water velocity, allowing suspended solids to settle out before water exits through outflow mechanisms. Vegetation in detention basins also can act as a filter and intercept suspended solids directly. In both detention and retention basins, plant roots also increase soil porosity and, therefore, increase the ability of the soil to filter water through adsorption, sorption, anion exchange, and cation exchange (Environmental Protection Agency 2005).
- ***Erosion control.*** Vegetation decreases water and wind velocity and increases soil infiltration and organic matter content, thereby decreasing soil erosion. Adequately establishing vegetation on the slopes of a stormwater management basin may reduce erosion and minimize the need for importing soil material for slopes, recontouring, or dredging basin infill areas.

Establishment of vegetation at new and existing stormwater management basins also may provide secondary benefits beyond these identified goals. Establishment of native and desirable vegetation is likely to reduce weed control efforts and maintenance costs, as well-established native plants are able to outcompete non-native species under many conditions. Maintaining aesthetically pleasing stormwater management basins vegetated with fire-resistant species also is likely to reduce time and expense associated with addressing public complaints. Native and desirable plant species also can provide habitat for beneficial pollinator insect species (e.g., bees, butterflies) and birds, many of which are at risk due to loss of habitat. These sites also may provide opportunities for community education of the use of native plant materials for stormwater management.

3.0 Preliminary Planning for Revegetation of Existing and New Basins

Conditions at both new and existing basins will inform revegetation activities such as site preparation, plant material and seed mix selection, and ongoing site maintenance. Each site should be assessed individually and revegetation activities should be planned on a site-by-site basis. Assessment of conditions at new and existing basins will help identify any barriers to revegetation that may occur, such as problematic soil or hydrological conditions or high cover of noxious weeds or invasive species.

Conditions at existing basins may only need to be assessed once in the planning process to plan revegetation activities (Section 6.0). Conditions at new stormwater management basin sites may need to be assessed to determine site suitability (Section 5.1) and again following construction activities to determine necessary steps for revegetation (Section 6.0). General flowcharts of revegetation planning and

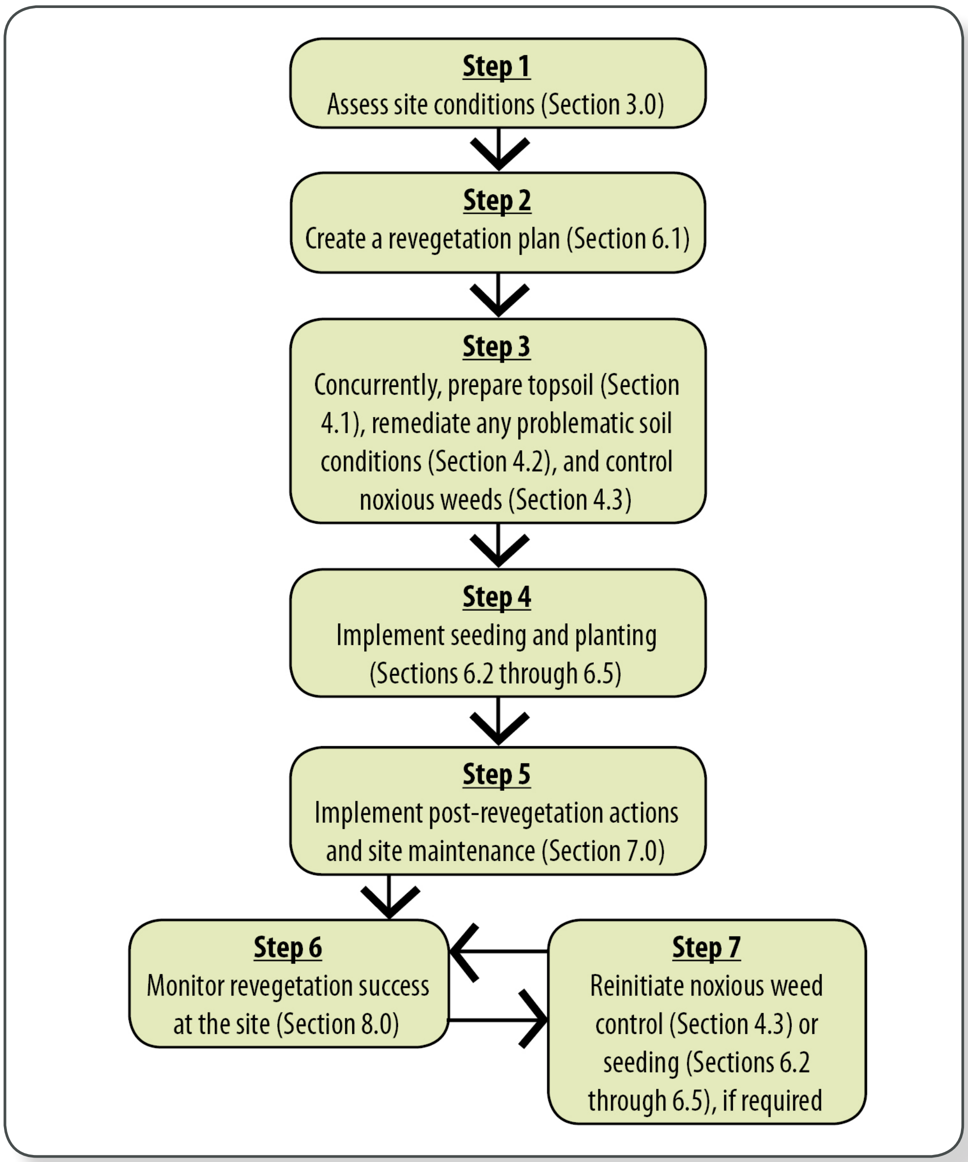

Figure 1
Flowchart for steps involved in revegetation of existing stormwater management basins

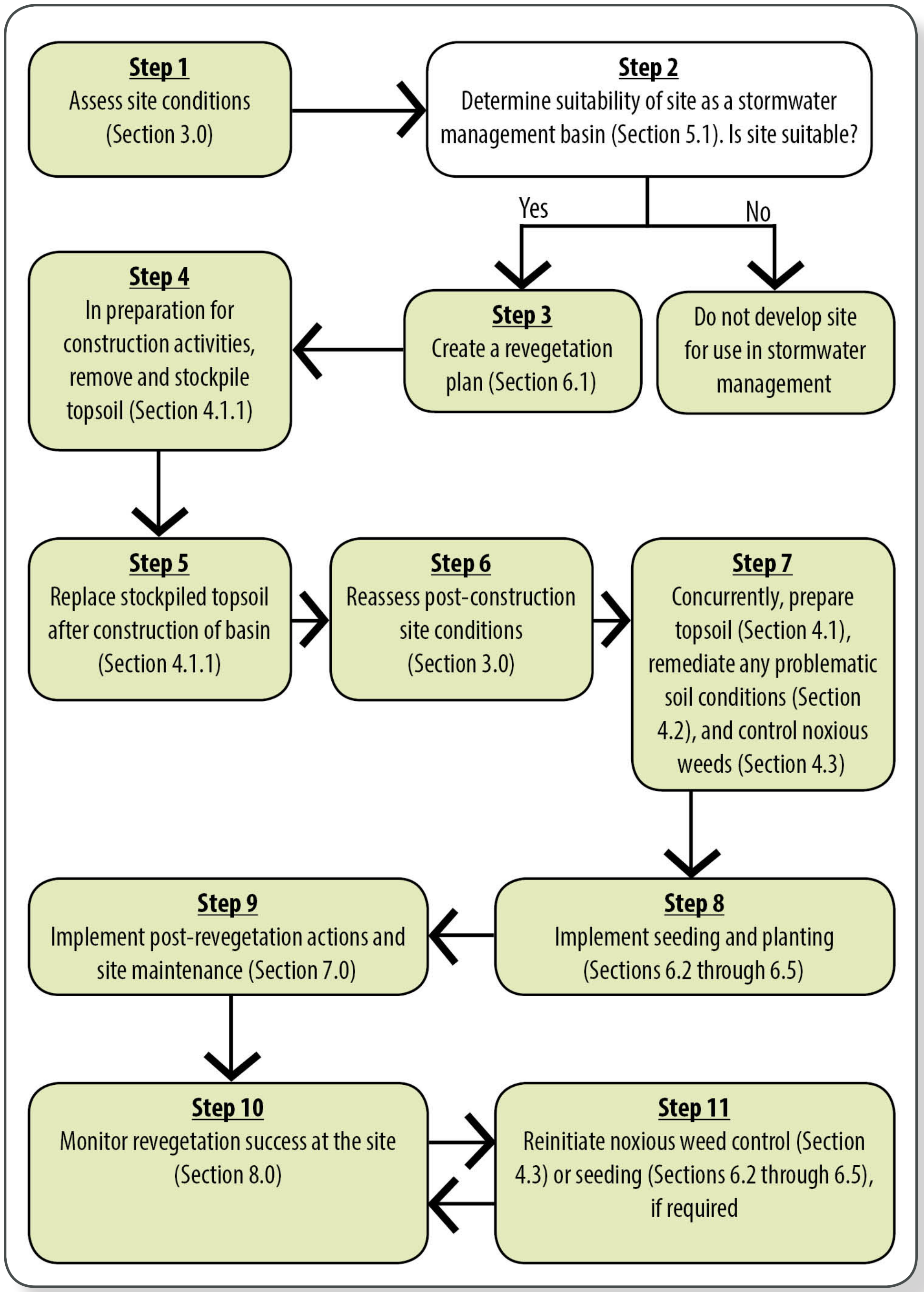

Figure 2
Flowchart for steps involved in revegetation of new stormwater management basins

implementation for new and existing stormwater management basins are presented in Figures 1 and 2.

The following factors should be considered when planning revegetation activities for a site:

- Proximity to public areas
- Existing vegetation conditions
- Existing soil conditions
- Hydrological conditions
- Topography

This section presents general guidelines on how to assess these factors and use this information to plan revegetation activities.

3.1 Assessing Proximity to Public Areas

Proximity of a basin to public areas (and, therefore, its visibility) can be assessed

Figure 3
A highly visible basin site

by examining original site plans, consulting ACHD basin design and maintenance personnel, and drive-by or walk-by observation. Figure 3 shows an example of a highly visible basin site.

The following question will help direct site preparation and revegetation activities.

- **Is the basin or potential basin site highly visible?**
  Highly visible basins should place aesthetics as a high priority for revegetation. Seed mixes for highly visible basins would be more likely to include forb species than less visible basins (Section 6.4). Live plantings of trees and shrubs may also be incorporated at highly visible sites (Section 6.5), especially if a local entity assumes responsibility for maintenance. These basins also would be more likely to use supplemental irrigation to ensure greater establishment of seeded or planted species (Section 7.2)

3.2 Assessing Existing Vegetation Conditions

Vegetation conditions should be assessed both at existing basins and at sites where new basins are planned. As species composition and cover of vegetation at a site is directly related to hydrological and soil conditions, the main objective of vegetation assessment is to identify any barriers to successful establishment of desired species due to conditions at a site. Vegetation at existing stormwater management basin sites also may be useful in selecting appropriate seed and plant mixes for revegetation. Pre-construction vegetation conditions at potential basin sites will help identify suitability for use in stormwater management.

Dominance of noxious weeds and invasive species, especially rapidly growing annual species such as cheatgrass (*Bromus tectorum*), is likely to indicate a situation where excess nutrients are available in the soil. Monocultures of certain species (e.g., cattail [*Typha* sp.]), reed canarygrass [Phalaris arundinaceal]) also may indicate excess availability of nutrients in soils or water as some species are able to easily outcompete others for resources under high-nutrient conditions. Sparse vegetation at a site may indicate deficiencies or excesses of certain nutrients, excess salts, pH imbalances, excess compaction, or contamination by toxic substances. Vegetation composition also indicates the availability of water at a site. The presence of plant species that are adapted to permanently or frequently saturated soils (hydrophytic species) indicates high availability of water, even if water is not apparent at the site at the time of assessment. Figure 4 shows a basin site dominated by *Typha* sp., an invasive, hydrophytic species that requires frequent flooding and thrives in situations with excess nutrient availability.

Figure 4
A basin site dominated by cattail

In most cases, basic visual assessment of vegetation cover and composition by trained personnel will be adequate for addressing the questions below. More rigorous data-collection methods can be employed when quantitative data are required. A basic line-point intercept method is suggested for collecting quantitative data on vegetation cover and composition in these situations (Herrick et al. 2005). Line-point intercept transects are a quick and simple method for determining vegetation cover and composition at a site. This method involves collecting data on the presence of plant species at certain intervals (e.g., every meter, every 5 meters, etc.) along a 50- or 100-meter-long fiberglass-blade measuring tape. A pin-flag or other straight object is dropped to the ground at each predetermined point and the species intercepted by the pin-flag are recorded on a datasheet, indicating a "hit." The number of "hits" of a particular species is used to calculate a percent cover of these species in an area (refer to Herrick et al. 2005 for more specific methods of data collection and analysis). The number and length of transects, as well as the number of data collection points along a transect, should be carefully considered so results are robust enough to make defensible assumptions regarding vegetation cover.

The following questions will help direct site preparation and revegetation activities.

- **Is there a high cover of noxious weeds or invasive species at the site? Alternatively, are only one or two vegetation species dominant?** Dominance of noxious weeds or invasive species or low diversity of species may indicate excess nutrient availability, especially of nitrogen (N) or phosphorus (P). It may be necessary to test the soil for availability of these nutrients (Section 3.3). Excess nutrient availability in the soil may require remediation (Section 4.2.2) before successful seeding of native or other desirable species is possible. Herbicide application (Section 4.3) or higher seeding rates of native or desirable non-native species (Section 6.3) also may be necessary to address dominance of noxious weeds or invasive species.

- **Is overall vegetation cover sparse?**
  Sparse vegetation may indicate problems in the soil. It may be necessary to test the soil for deficiencies of certain soil nutrients, excess salts, pH imbalances or excess compaction that may inhibit vegetation establishment (Section 3.3). Sparse vegetation that results solely from a lack of availability of seeds may be remedied through seeding of desirable species (Section 6.3). Contamination of soil by toxic substances also may result in sparse vegetation or barren soil.
- **Are hydrophytic vegetation species common or dominant at the site?**
  If species are identifiable, refer to the wetland indicator status as listed on the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Plants Database website (http://plants.usda.gov/java/) for all common or dominant species (NRCS 2014) (Note: Ada County is in the Arid West Region). Species with wetland indicator statuses of OBL (obligate wetland, almost always occurring in wetlands), FACW (facultative wetland, usually occurring in wetlands, but may occur in non-wetlands), or FAC (facultative, can occur in wetlands or non-wetlands) can indicate wetland conditions where soils are saturated or inundated for some duration during the growing season. This information can be useful in determining the suitability of a site for use as a stormwater management basin (Section 5.1) or in selecting an appropriate seed or plant mix for a site (Section 6.3).

3.3 Assessing Existing Soil Conditions

Understanding soil conditions at a site is crucial for determining appropriate site preparation methods, seed and plant mixes, and revegetation methods. As with vegetation assessment, the main objective of soil assessment is to identify any barriers to successful establishment of desired species due to conditions at a site. Soil conditions should be assessed at existing basins where revegetation will occur and at sites where new basins are planned. Assessment of pre-disturbance condition of soils at a new basin site will help identify its suitability for stormwater management and provide information necessary to plan revegetation activities. It also is possible to review soil survey information available from the NRCS (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) to understand soil conditions (including soil type and ecological site descriptions) at undisturbed sites, which may be helpful in determining plant species selection.

Certain qualitative soil characteristics can be assessed visually or with minimal understanding of soil chemical or physical properties. Simple visual or field assessment of soils at a site can include the following:

- ***Check for salt crust on soils.*** Soils with high salinity may have white or light-colored deposits on the surface.
- ***Check for hard, cracking crusts.*** Soil surfaces that are hard and cracking may indicate soil sodicity. Soils can be both saline and sodic. Cracking on soil surfaces also can be an indicator of frequent saturation.
- ***Check texture by feel.*** Rub a small sample of wet soil between fingers. Grittiness indicates high sand content, smoothness indicates high silt content, and stickiness indicates high clay content (Appendix A). Ideally, the sample will be balanced between these three characteristics and no one feeling will predominate.

- ***Check for extreme soil compaction or hard layers.*** Insert a tile probe (long, thin metal or fiberglass pole) or similar device into the soil to determine soil compaction or presence of hardpan or caliche layers.
- ***Check soil color.*** Light soils generally have lower organic matter than darker soils. Red or orange spots in soils, or grey soils, may indicate anaerobic conditions and potential wetland situations.
- ***Check soil smell.*** Sulfitic odor (rotten egg smell) is likely to indicate anaerobic conditions and potential wetland situations. Toxic substances and hydrocarbons also may be detected via smell.
- ***Check for presence of calcium carbonate or limestone (CaCO3).*** Application of a small amount of hydrochloric acid (HCl) will cause soil to effervesce if calcium carbonate is present. The stronger the effervescence, the greater the presence of calcium carbonate.

If the visual assessment of soil indicates any unusual soil conditions, it is recommended that the following soil characteristics be assessed through quantitative laboratory analysis of collected soil samples from existing and pre-construction stormwater management basin sites:

- pH
- Electrical conductivity (EC)
- Cation exchange capacity (CEC)
- Nutrient content:
    - Nitrogen (in the form of nitrate [NO_3^-] and ammonium [NH_4^+] ions)
    - Potassium (K)
    - Phosphorus (P) in the form of phosphate (PO_4^{3-})
    - Calcium (Ca)
    - Magnesium (Mg)
    - Copper (Cu)
    - Zinc (Zn)
    - Manganese (Mn)
    - Iron (Fe)
    - Boron (B)
- Particle size distribution (texture)
- Organic matter content
- Calcium carbonate or limestone content
- Sodium (Na) adsorption ratio (SAR) as a measure of sodicity. Assess only if soil crusting is present.

Though any qualified soil analysis laboratory can be used, the Soil and Plant Laboratory in Anaheim, California (www.soilandplantlaboratory.com) is recommended for analysis of pH, EC, nutrient content (Soil and Plant Laboratory analysis code A17) and soil physical properties (Soil and Plant Laboratory analysis code A06). Specific soil-collection protocols provided by the laboratory should be followed.

Assessment of laboratory results will allow ACHD personnel to determine if any of the chemical or physical soil characteristics at a site are suboptimal for plant establishment and growth. For more information on the optimal ranges of soil physical or chemical components for native plant species, refer to Chapter 7 (Assessing Soil Factors in Wildland Improvement Programs) of the USDA Forest Service General Technical Report RMRS-GTR-136 (USFS 2004).

The following questions can be answered by information gathered from field assessment or laboratory analysis of soil samples and will help direct preparation of the soil for revegetation activities.

- **Is the soil deficient in nutrients?**
  Soils with extremely low availability of nitrogen or phosphorus may need to be augmented with the addition of naturally derived fertilizers following recommendations in Section 4.2.1.
- **Is there an overabundance of soil nutrients?**
  Excess availability of soil nutrients such as nitrate, ammonium, and phosphorus may need to be addressed through manipulations of nutrient cycling using the methods outlined in Section 4.2.2.
- **Is the soil highly saline?**
  Saline soils are highly influenced by an abundance of salts, namely sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), and chloride (Cl^-) ions. The presence of salt crusts or high EC values (Table 1) indicates salinity levels that likely preclude establishment of most species. It is recommended that new stormwater management basins not be located in areas with highly saline soils as these areas are likely to have limited revegetation success.
- **Is the soil sodic?**
  Sodic soils are characterized by a high concentration of sodium and lower concentrations of other salts. Soil crusts that are hard or cracking (SARs of around 13 or greater or pH levels above 8.5) likely indicate sodic soils (Davis et al. 2012) (Table 1 and Figure 5). It is recommended that new stormwater management basins not be located in areas with highly sodic soils as these areas are likely to have poor infiltration and limited revegetation success.

Figure 5
Example of potential saline-sodic soil with surface crusting and salt deposits
Photo Credit: Aaron Dejoia, used with permission

Table 1: General Classification for Sodium Hazard of Soil				
Classification	**Sodium Adsorption Ratio**	**Electrical Conductivity (EC; dS/m)**	**Soil pH**	**Soil physical condition**
Sodic	>13	<4.0	>8.5	Poor; cracking, hard crusts
Saline-Sodic	>13	>4.0	<8.5	Varies; cracking, hard crusts and salt crusts
Slightly saline	<13	2.0 to 4.0	<8.5	Normal
Saline	<13	>4.0	<8.5	Normal, can have salt crusts
High pH	<13	<4.0	>7.8	Varies
NOTE: Adapted from Davis et al. 2012				

- **Is the soil hard or compacted?**
  Soil may be compacted due to construction practices or historical site use. Compacted soils should be remediated following the guidance in Section 4.2.3. Hard soil layers such as caliche may underlie existing stormwater management basin sites. It is not recommended that new stormwater management basins be located in areas with near-surface caliche layers, as infiltration will be greatly impeded in these areas.
- **Is the soil potentially contaminated by toxic substances or hydrocarbons?**
  Contamination of soil by toxic substances also may result in sparse vegetation or barren soil. New stormwater management basins should not be located in areas contaminated by hydrocarbons or other toxic substances or that have a high likelihood of becoming contaminated in the future. Potential locations for new stormwater basins should be investigated to assess the soil for signs of contamination (e.g., discoloration, hydrocarbon odor).

Very little soil is available at some existing stormwater management basins and, therefore, it is not possible or necessary to assess soil characteristics in these areas. In these situations, it is recommended that high-quality topsoil be imported and distributed following the recommendations in Section 4.1.1.

3.4 Assessing Hydrological Conditions

Figure 6
A basin that is saturated or inundated at the lowest elevations for extended periods of time during the growing season

Site preparation, seed and plant mix selection, and revegetation methods will be influenced by hydrological conditions at the site. Sites that are saturated or inundated for long periods of time will require special attention to decrease the potential for soil compaction and invasion by cattail or reed canarygrass. Duration and seasonality of saturation or inundation can be assessed through site examination, review of soil survey information available from the NRCS (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm), review of publicly available hydrology data and aerial photos, review of design drawings, and discussion with personnel familiar with the site. As stated in Section 3.2 and Section 3.3, certain vegetation and soil conditions are likely to be indicators of saturated or inundated hydrological conditions. Figure 6 shows a basin that is saturated or inundated long enough during the growing season to support hydrophytic vegetation. Depth-to-groundwater of a site is determined during basin construction planning; this information may be helpful in determining hydrological conditions.

The following questions will help direct site preparation and revegetation activities.

- **Do dry conditions exist in at least part of the stormwater management basin?**

Areas of basins that receive stormwater only during rare events and that are above the water table should be revegetated with species that withstand dry conditions (Section 6.3.2).

- **Do saturated or inundated conditions exist for all or part of the growing season in at least part of the stormwater management basin?** Areas of basins in proximity to groundwater or are frequently inundated will be seeded or planted with species that can tolerate or thrive in persistently or intermittently wet conditions (Section 6.3.3). Sand invert areas of basins may be seeded, however, it is important to determine how seeding would interfere with site objectives and maintenance activities. Special efforts to reduce compaction during site preparation and seeding may be required in areas of basins that experience frequent inundation or saturation (Section 6.2.2).

3.5 Assessing Topography

Topography of existing stormwater management basins is determined through engineering design and can be assessed through site visits or by referring to design drawings. The general topographic characteristics of existing stormwater management basins to be determined during a site visit or through examination of design drawings are:

- Steepness of basin slopes
- Aspect of site and slopes

Topography of new basin sites can be determined through visual assessment during a site visit or detailed topographic maps. Familiarity with the topography of the site will allow for more precision in planning revegetation activities.

The following question will help direct site preparation and revegetation activities.

- **Do steep slopes occur?** Current ACHD policy states slopes should be 4:1 (14 degrees or 25 percent), but no greater than 3:1 unless approved by ACHD. Basin slopes have been constructed up to a grade of 3:1 (18 degrees or approximately 33 percent) under previous ACHD policy. Steep slopes (greater than 3:1) should be prepared and seeded using considerations outlined in Section 6.2.3.

4.0 Site Preparation for New and Existing Basins

4.1 Topsoil Preparation

Topsoil quality is an important component of revegetation success. Importation of topsoil and the incorporation of organic matter and/or vesicular-arbuscular mycorrhizae (VAM) fungi may be useful in preparing new and existing basin sites for revegetation. Figure 7 shows a basin with sparse side-slope vegetation that may require amelioration with topsoil, compost addition, and/or mycorrhizal inoculation.

4.1.1 Topsoil Salvaging or Importation

Topsoil should be conserved and stockpiled at new stormwater management basin

Figure 7
Basin with sparse side-slope vegetation

sites and redistributed as soon as possible after construction to maintain the greatest biological activity (including that of VAM fungi). Conserving topsoil is one of the most important steps that can be taken to increase revegetation success at a new basin site. Before construction activities begin, the depth of existing topsoil should be identified by qualified personnel. Topsoil initially should be scraped off to this depth and moved from the construction site to a nearby area using appropriate construction machinery. It is important that topsoil be handled in a manner that limits movement; topsoil should be moved with the least amount of heavy equipment traffic across the construction site. Topsoil should be handled so that mixing with unsuitable subsoil is limited. If topsoil quality is degraded by improper handling or mixing with poor-quality subsoil, reclamation success becomes increasingly difficult. Topsoil should not be removed or handled during wet weather or when soils are saturated as this increases the risk of compaction or damage to soil microbial communities. Topsoil should be stockpiled in long rows about 12 to 24 inches high, which minimizes anaerobic conditions and the subsequent loss of microbial biomass and activity. Topsoil stockpiles should be protected from erosion by wind and water as much as possible. Subsoil (especially compacted subsoil, hardpan, or caliche layers) should be scarified before redistribution of topsoil to remove any potential physical barrier to root growth at deeper soil layers.

In existing basin sites with poor quality of topsoil or no topsoil at all, topsoil may need to be imported and distributed. Imported topsoil should be weed-free and not previously treated with herbicides having a long-residual effect. Topsoil should be tested for the same chemical and biological constituents as identified in Section 3.3. If limited options for acquiring topsoil exist, topsoil with deficiencies or other problems may need to be amended using methods and materials described in Section 4.2. Topsoil should be distributed at the site at a depth that is sufficient for the root systems of desired vegetation species. For sites where only grasses and forbs are to be seeded, this depth should be at least 6 to 12 inches. Subsoil should be scarified before distribution of topsoil.

Top soil should not be salvaged from sites dominated by noxious weed species. In these cases it is important to treat weeds with herbicides prior to moving them so that new infestations can be prevented. At least 4-6 inches of topsoil should be removed from weedy areas to ensure that both weedy plant root systems as well as the soil seedbank can be eliminated. In some cases its possible to bury and cap weedy topsoil in berms or at the bottom of deep perennially flooded wetland or basin components.

4.2 Addressing Problematic Soil Conditions

Site investigation and topsoil analysis may indicate the need for remediation of problematic soil conditions such as compaction or nutrient excesses or deficiencies.

Under most circumstances compost addition is not necessary and runs the added risk of introducing noxious weeds to the site. On drastically disturbed sites or when soil quality is very poor or soil properties very challenging the addition of compost may be considered. The following guidelines are recommended for addressing other problematic soil conditions.

4.2.1 Increasing Nutrient Availability

Conventional soil fertilizers are not recommended for use in native plant revegetation, but naturally derived fertilizer and soil conditioning materials may be incorporated into the soil to increase nutrient availability if required. Humate, a soil conditioner, and Biosol, a source of slow-release fertilizer, have been identified by ACHD personnel as being potentially useful for addressing extremely nutrient-poor soils. Humate is derived from mined organic matter deposits and is available in granular form or as a soluble concentrate. The recommended application rates for humate are 750 pounds per acre for granules and 1 pound per acre for soluble concentrate. Humate should be thoroughly mixed into topsoil. Biosol is a commercially available organic fertilizer composed of 90 percent sterile fungal biomass. The nutrient ratio of Biosol is 6 percent nitrogen, 1 percent phosphorus, and 1 percent potassium. According to manufacturer instructions, Biosol should be applied uniformly in very nutrient-poor soils at a rate of 1,500 to 1,800 pounds per acre and thoroughly mixed into topsoil. Manufacturer recommendations should be followed for all commercially available fertilizer and soil conditioning materials.

4.2.2 Reducing Nutrient Availability

Excess nutrient availability can be addressed by altering nutrient cycling either through the addition of organic carbon material or by planting cover crops. Soil addition of organic carbon (C) material (material with a high C:N ratio), such as straw mulch or shredded wood fiber (e.g., arborist mulch), temporarily immobilizes nitrogen in microbial biomass. Reduced nitrogen availability can be a disadvantage to invasive species, thereby allowing native species to become established without heavy competition for soil resources. Straw mulch or shredded wood fiber should be incorporated into the upper six inches of soil. Planting annual cover crops such as common oats (*Avena sativa*) can help reduce excess nitrogen and phosphorus (refer to Clark 2007 for planting guidelines) by temporarily incorporating those nutrients in plant biomass.

4.2.3 Addressing Soil Compaction or Hard Soil Layers

Soil compaction, hardpan, or caliche layers can be addressed through mechanical decompaction practices such as deep ripping or the addition of organic matter to the soil surface. Deep ripping should be done with the use of a tractor-pulled tine ripper at sites where compaction or impermeable layers such as duripan or caliche exists deeper in the soil profile. Disking or tilling alone does not result in decompaction of deeper soil layers. Compost additions to the soil surface prior to deep ripping may increase the benefits of deep ripping or may decrease near-surface soil compaction when used alone.

The use of heavy machinery should be minimized or avoided following deep ripping or other decompaction practices to maintain soil structure and decompaction benefits.

4.3 Noxious Weeds and Invasive Species Control

All noxious weeds should be reported to the Ada County Weed, Pest & Mosquito Abatement Department (wpm@adaweb.net). All noxious weeds detected at a site should be controlled or eliminated as determined by their level of concern as identified in the Idaho Noxious Weed List (refer to ISDA 2014 for a current list). The three levels of concern for Idaho's noxious weed are:

1. ***Early detection, rapid response.*** Species that may not be present in Idaho but that would require immediate eradication if detected.
2. ***Control.*** Species that have a minimal presence in Idaho and may be able to be contained within a few seasons of treatment.
3. ***Containment.*** Common weeds that pose the greatest economic threat to property. It may not be possible to eradicate all occurrences of these species; however, landowners and municipalities are required to manage and contain the spread of these species where detected.

Figure 8 shows a basin site with a high cover of noxious weeds. Noxious weeds and invasive species should be controlled before, during, and after implementation of revegetation activities. Chemical weed control (i.e., the application of selective pre-emergent or post-emergent herbicides) is generally effective and safe when manufacturer recommendations are followed. ACHD maintenance personnel currently use several selective herbicides for maintenance activities throughout the county and are well-instructed on the handling and application of these herbicides. Herbicide selection should be targeted to specific problematic species at a site and manufacturer recommendations should be followed. It is recommended that herbicide application not occur until seedlings of seeded species reach the four- to six-leaf stage. Broadleaf herbicides should be used sparingly and highly selectively in areas where forbs have been incorporated into seed mixes as there is a high likelihood that forb seedlings will be eliminated with broadleaf herbicide application. Aminopyralid herbicide, which effectively controls annual and perennial thistles should be avoided at sites where legume species (e.g. clover, vetch, lupine etc.) are to be planted. Legumes are very sensitive to aminopyralid herbicides for several years following application.

Establishment of robust native or desirable species can exclude noxious weeds and invasive species in many situations. As discussed in Section 4.2.2, it also may be beneficial to reduce soil nutrient availability to facilitate establishment of seeded species in areas where noxious weed or invasive species presence may be problematic.

4.4 Potential for Engineering Redesign

The Boise/Garden City area MS4 National Pollutant Discharge Elimination System (NPDES) Permit, Section II.B.4.g states that:

> (i) Permittees must evaluate the feasibility of retrofitting existing stormwater control devices to provide additional pollutant removal from collected storm water. (ii) No later than the expiration date of this Permit, Permittees must identify and define all locations where such retrofit project opportunities are feasible, identify appropriate funding sources, and outline project timelines or schedule(s) for retrofit projects designed to better

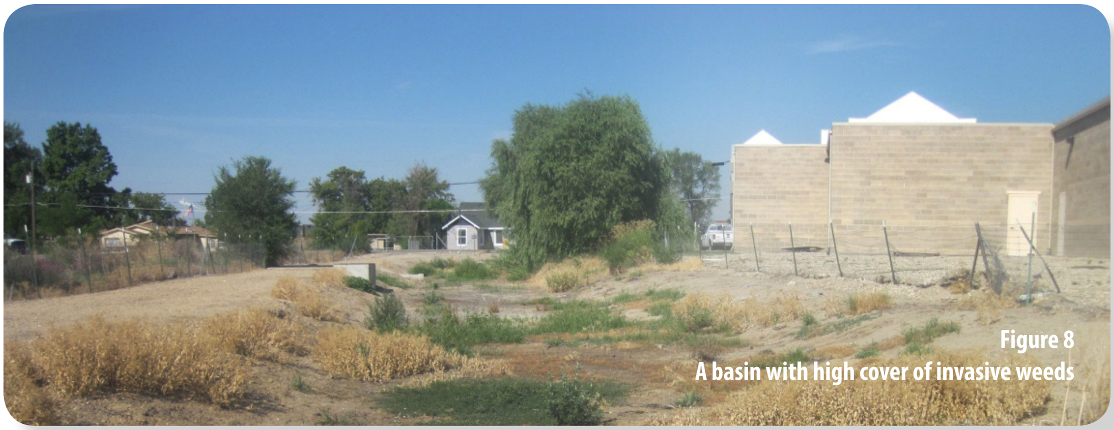

Figure 8
A basin with high cover of invasive weeds

control the discharge of pollutants of concern to the Boise River and its tributaries.

Revegetation of stormwater management basins with species that increase water quality would assist ACHD in meeting these retrofit requirements. It also may be necessary to redesign or recontour a basin that is not adequately addressing stormwater permit requirements to create greater opportunity for treatment of stormwater runoff. ACHD is currently developing criteria for determining the feasibility of and establishing priorities for retrofitting existing basins throughout its jurisdiction.

5.0 Considerations for New Stormwater Management Basins

5.1 Siting

Stormwater retention basins should be located in areas where geologic, hydrologic, and soil conditions support infiltration of runoff and establishment of desirable vegetation. Site investigations and review of available information as described in Sections 3.0 should be conducted at all potential sites considered for retention basin construction.

The following recommendations pertain to siting of new stormwater management basins (adapted from Watershed Management Institute 1997):

- Soils at new stormwater retention basins should be porous (i.e., coarse textured soils such as sands and gravels). Soils with 30 percent or greater clay content or 40 percent or greater clay and silt content generally are not suitable for retention basins.
- It is not recommended that stormwater management basins be located in areas with highly sodic soils as these soils are poorly structured and can inhibit infiltration of water.
- Sites also should not be located in areas with high water tables or in proximity to groundwater, as stormwater may not be adequately filtered by soils and plant roots before entering groundwater. High water tables or groundwater proximity may be indicated by the presence of wetland vegetation.
- Basins should not be located in areas where there is a shallow depth to impermeable soil layers.

- It is not recommended that new stormwater management basins be located where soils are contaminated by hydrocarbons or other toxic substances.
- It is also not recommended that new stormwater management basins be located on steep hillsides.

5.2 Potential for "Ecological Design"

Stormwater management basins constructed throughout the country historically have been engineered primarily to meet specifications relating to storage capacity. Less attention has been paid to designing basins with the primary intent of stormwater treatment or to provide other ecological services. Many municipalities are now designing stormwater management facilities to mimic natural features in ways that provide for more thorough and ecologically based treatment of stormwater. Ecologically designed stormwater management basins can incorporate elements of wetland creation and may require highly technical expertise. At a minimum, however, ecologically sound stormwater management involves using native plant material, more natural topography, and native soils. For example, basins that manage larger volumes of flow-through stormwater are often designed to mimic highly sinuous stream channels, thereby providing greater opportunity for sediment filtration and settling. Specialized expertise should be consulted on a site-by-site basis if ecological design of stormwater management basins or the construction of wetlands for stormwater treatment becomes a priority for ACHD.

6.0 Revegetation Actions for New and Existing Basins

6.1 Revegetation Plan Creation

All revegetation efforts should begin by creating a revegetation plan. The revegetation plan should outline steps that will be taken to prepare the site for revegetation (Section 4.0), implement seeding and planting, maintain the site after seeding and planting (Section 7.0), and monitor the success of revegetation actions (Section 8.0). The revegetation plan should also indicate the seed mixes, species of live plant materials (as well as sizes) and planting formats to be used at a site, as well as identifying planting methods to be used. The plan should also include a schedule for the completion of all revegetation activities and post-revegetation maintenance and monitoring.

This plan should include a simple design drawing that indicates zones where the various seed mixes and revegetation methods should be incorporated. For example, site assessment may have revealed that a basin has dry, sandy soils on the banks and slopes and intermittently flooded, poorly drained soils at the bottom of the basin. A revegetation plan and design drawing would indicate that the seed mix in Table 2 should be seeded on the banks and slopes and the seed mix in Table 3 should be seeded at the bottom of the basin. It may also indicate where seeding is likely to fail and where plants should be utilized.

6.2 Recommended Seeding Methods and Equipment

Recommended seeding methods and equipment needed for conditions likely to be encountered in revegetation of ACHD-administered stormwater management basins are described in the following sections. Topsoil preparation, addressing of problematic soil conditions, and weed control (Section 4.0) should be completed before seeding activities. Seeding should be completed in the fall, which allows seeds to make use of increased soil moisture during the winter. Cold, wet conditions over an extended period of time are also required by many native plant species to break dormancy.

6.2.1 Seeding in Upland Areas

Drill seeding is recommended in upland areas with slopes less than 3:1. Seeding rates for upland seed mixes in Section 6.3.2 have been calculated to follow recommendations for drill seeding. Seed deposition should be calibrated to a depth of 0.25 to 0.5 inch. Full-size or compact rangeland drills are recommended to be used for drill seeding. Depending on their size, rangeland drills can be pulled by tractor or all-terrain vehicle. Drill seeding should follow contours in topography to minimize erosion potential. Drill seeding can be done over bare soil or into existing vegetation.

6.2.2 Seeding in Wetland Areas

Heavy machinery should not be used in areas with saturated or moist soils to minimize soil compaction or disturbance to sensitive wetland areas. Seeding of wetland species should be accomplished using a push-type or hand broadcaster. Seeding rates for wetland species seed mixes in Section 6.3.3 have been calculated to follow recommendations for broadcast seeding.

6.2.3 Seeding on Slopes

For slopes between 3:1 (18 degrees or approximately 33 percent) and 2:1 (26.6 degrees, or 50 percent), seeds may be broadcast using a push-type or hand broadcaster. Seeding rates for upland seeding mixes in Section 6.3.2 should be multiplied by at least 1.5 if broadcasting is used. Broadcast areas should be hand raked where possible to increase contact of seeds with the soil. Erosion-control blankets or hydromulch may be used to stabilize soils on seeded slopes after broadcast seeding. The hydromulch mixture should include tackifier to increase cohesion and stability of seeded areas.

Figure 9
A basin with steep side-slopes that may require broadcast seeding or hydroseeding

Hydroseeding, a method where seeds are incorporated into hydromulch and hydraulically sprayed onto a site, may also be used on steeper slopes (3:1 or greater). This method allows for easy coverage of large areas that may otherwise be difficult to seed using broadcast or drill seeding.

However, seeds in the slurry mix may germinate without direct contact with the soil and fail to become established, thereby reducing seedling establishment. Supplemental irrigation may be useful for increasing seedling establishment in areas where hydroseeding is used. Recommendations for hydromulch mixtures, application rates, and tackifier additions can be obtained by consulting with representatives from hydroseeding companies. It is recommended that hydroseeding occur only in areas with bare soil, as standing vegetation will interfere with the distribution of hydromulch application. Figure 9 shows a basin with steep side-slopes that may require broadcast seeding or hydroseeding.

6.3 Recommended Seed Mixes

6.3.1 Important Seed Mix Considerations

6.3.1.1 Native versus Non-native Species

To minimize the chance of non-native species spreading into adjacent wildland areas, vegetation species native to the Intermountain West and southwestern Idaho should be favored for revegetation activities. It may be useful to seed with non-native species that are able to outcompete noxious weeds or invasive species in certain situations; however, with the availability of robust, locally available native species, the use of non-native species is not necessary. All species in seed mixes or containerized planting lists presented in Section 6.3 through Section 6.5 are native to southwestern Idaho or the Intermountain West.

If new stormwater management basins are to be constructed in relatively natural areas, it may be beneficial to salvage existing plants or seeds for use in revegetation efforts. This may increase revegetation success and decrease costs associated with acquiring plant material.

6.3.1.2 Salinity Tolerance

Salts are likely to build up in soils of stormwater management basins, especially those that serve as retention basins. Tolerance of seeded species to saline conditions is likely to be important in these situations. The species in seed mixes presented in Section 6.3 exhibit varying salinity tolerances. It is not necessary that all species in a mix be highly tolerant of salinity as long as a range of tolerances is represented. Characteristics of all recommended species, including relative salinity tolerances, are indicated in Appendix B.

6.3.1.3 Species Diversity and Seral Stages

The seed mixes presented in Section 6.3 are formulated to be diverse in terms of growth habits, heights, growth periods, and seral stages. The existence of a diversity of plant species at a basin increases its ability to adapt to changing environmental conditions and to provide a range of environmental and aesthetic benefits. Diversity of seeded species also increases the likelihood that at least some seeded species establish successfully at a site.

The likelihood of revegetation success over time and under a variety of conditions may be further increased by including species in seed mixes adapted to a diversity of seral stages. A seral stage is an abstract concept indicating the progression of an ecological community from a newly disturbed site characterized by high resource availability and low intraspecific and interspecific competition ("early-successional" or "early-seral" community) to an established, stable ecosystem with low resource availability and high intraspecific and interspecific competition ("late-successional," "late seral," or "climax" community). Species adapted to early-successional conditions alter a site in ways that allow for the eventual establishment of late-successional species, which may remain dormant in the soil until conditions are appropriate. Incorporating species into seed mixes that are adapted to various seral stages allows dynamic revegetation to occur in response to changing site conditions over time.

Characteristics of all recommended species, including growth habits, size, growth period, and seral stages are indicated in Appendix B.

6.3.1.4 Increase in Seeding Rates in Difficult Conditions

Seeding rates presented in Section 6.3 may need to be increased in difficult situations, such as when saline or sodic soils are present, on hill slopes, in the presence of dense undesirable species, or when poor soil conditions exist that are not able to be remedied. These conditions may require increasing seeding rates of desired species or altering composition of seed mixes. Seed producers may need to be consulted to determine exactly how much recommended seeding rates should be increased or altered in these situations, but generally, seeding rates may need to be increased 1.5 to 2 times in difficult conditions.

6.3.1.5 Cultivated Varieties of Seed

Sections 6.3.2 and 6.3.3 present seed mixes for upland and wetland areas, and Section 6.3.4 presents a list of recommended forb species for inclusion in upland seed mixes if desired. Several cultivated varieties of some of these species may be available from seed producers. It is recommended that ACHD consult with the producer of the seed material to determine which variety is best suited for the intended location. It is recommended that certified seed be used for all cultivated, named seed varieties. Seed certification means the genetic material of the variety has been inspected and found to be true to form and free from contamination by other species. Land in which certified seed is grown also cannot be contaminated by noxious weeds or invasive species, which minimizes the likelihood that seeds of problematic species will be imported to a site.

6.3.2 Upland Seed Mixes

6.3.2.1 Upland Areas with Sandy Soils

The seed mix in Table 2 is suggested for use in upland areas with well-drained soils. This seed mix is based on a rate of 60 Pure Live Seeds (PLS) per square foot.

Table 2: Recommended Seed Mix for Upland Areas with Sandy Soils

Common Name	Scientific Name	Pounds Pure Live Seed per Acre	Percent of Pure Live Seed in Mix
Bluebunch wheatgrass	*Pseudoroegneria spicata* (*P. spicata* ssp. *spicata*)	3.7	20
Idaho fescue	*Festuca idahoensis*	0.9	15
Indian ricegrass	*Achnatherum hymenoides*	2.8	15
Needle-and-thread	*Hesperostipa comata* (*H. comata* ssp. *comata*)	0.2	1

Table 2: Recommended Seed Mix for Upland Areas with Sandy Soils			
Common Name	**Scientific Name**	**Pounds Pure Live Seed per Acre**	**Percent of Pure Live Seed in Mix**
Prairie junegrass	*Koeleria macrantha*	0.1	10
Thiskspike wheatgrass	*Elymus lanceolatus*	2.5	15
Sand dropseed	*Sporobolus cryptandrus*	0.07	14
Sandberg bluegrass	*Poa secunda* (*P. secunda* ssp. *sandbergii*)	0.2	10
Total		10.6	100

6.3.2.2 Upland Areas with Clay or Silt-Clay Soils

The seed mix in Table 3 is suggested for use in upland areas with poorly drained soils. This seed mix is based on a rate of 60 PLS per square foot.

Table 3: Recommended Seed Mix for Upland Areas with Clay or Silt-Clay Soils			
Common Name	**Scientific Name**	**Pounds Pure Live Seed per Acre**	**Percent of Pure Live Seed in Mix**
Alkali sacaton	*Sporobolus airoides*	0.1	9
Blue wildrye	*Elymus glaucus*	2.9	15
Great Basin wildrye	*Leymus cinereus*	2.0	10
Idaho fescue	*Festuca idahoensis*	0.6	10
Needle-and-thread	*Hesperostipa comata* (*H. comata* ssp. *comata*)	0.2	1
Slender wheatgrass	*Elymus trachycaulus* (*E. trachycaulus* ssp. *trachycaulus*)	3.3	20
Squirreltail	*Elymus elymoides*	2.7	20
Western wheatgrass	*Pascopyrum smithii*	3.6	15
Total		15.4	100

6.3.3 Wetland Revegetation

6.3.3.1 Perennially, Intermittently and Seasonally Flooded Wetland Areas

Revegetating wetland zones within existing or new stormwater projects can be challenging in areas of prolonged soil inundation or saturation. Most native, obligate wetland graminoids (sedges, rushes, spikerushes, bulrushes) in our region cannot be reliably established from seed. In fact, even in nature colonization and spread of these species occurs clonally from plant fragments, usually rhizomes or tubers and not from seed. The characteristic “banding” of plants observed within natural wetlands reflects hydroperiod. Hydroperiod relates to the depth and duration of soil inundation or saturation within a wetland. Each species has adapted to living and competing within specific zones of hydrology defined by the hydroperiod. With an understanding of hydroperiod its possible to successfully revegetate saturated or inundated areas by planting the correct species in the correct zones. Planting at reasonable densities will facilitate clonal expansion and in-fill of these zones while at the same time inhibiting the invasion of weeds or other undesirable plants (e.g. cattail, reed canarygrass).

Plant material type, size, planting density and species composition are all important revegetation considerations. Generally, wetland plants can be collected in the wild and transplanted to the site or obtained from regional native plant nurseries. Wild collections have the advantage of being locally adapted but also run the risk of introducing unintended species from the soil seedbank. Care should be taken when harvesting from the wild so that donor plant communities are not permanently degraded. The ideal scenario occurs when plants are salvaged from a wild site ahead of a planned alteration or destruction of that site, as in the case of road construction or other permitted activities.

Nursery grown wetland plant material is generally available as containerized seedlings or bareroot stock. These materials are generally easier to plant due to uniformity. Lead time is a consideration when planning to use nursery material so that the correct species in the correct quantities and sizes are available when you need them.

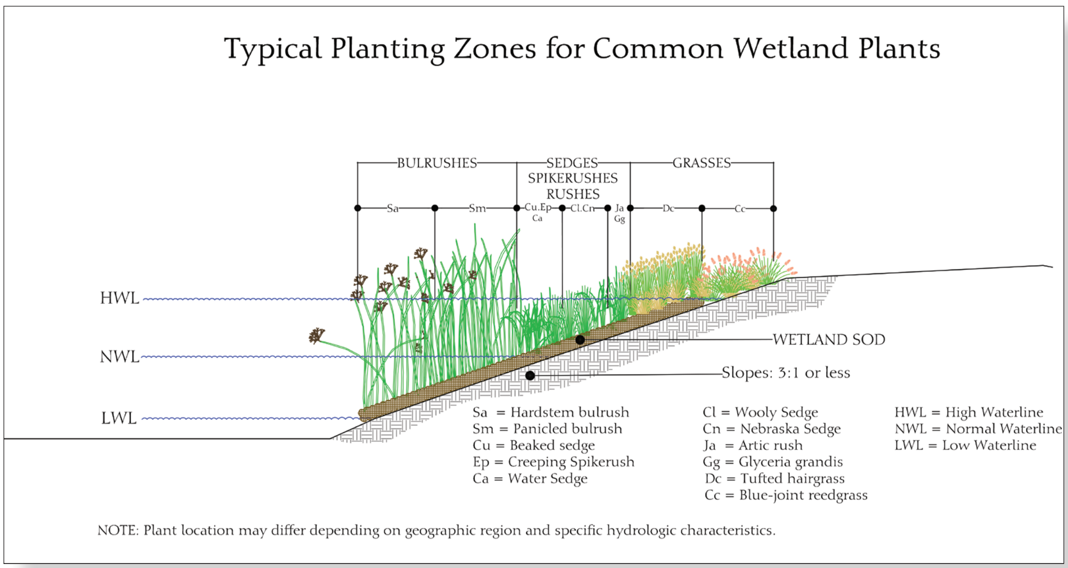

Figure 10
Wetland Revegetation Zones (courtesy of North Fork Native Plants)

Plant sizing is often limited to what's available. Typically, container plants should be sized from 3 – 10 in^3 in tube formats. Smaller plants can be used when hydrology is well understood and confidence is high that plants will not be placed too deep in the water or too high on dry soils; larger plants, with their deeper root profile and taller shoot system can hedge against uncertainties in hydrology. Because planting costs include both plant material and installation, tube formats are easier and faster to plant and thus most efficient from an installation perspective. Bareroot material is generally less expensive than containers but extra care must be taken to keep plants fresh during delivery and until they are planted. Planting installation rates for bareroot material in most soils are comparable to containers. If correctly handled, bareroot survival and growth are also similar to container formats.

Planting density is the number of plants in a given area. For restoration plantings density is usually specified as a distance between plants. For example, planting 1 ft. on center, a common specified density, means that plants are spaced 1 ft. apart or that there is 1 plant per square foot of planted area. The higher the plant density the more plants required to revegetate a given area. A good rule of thumb is to plant at the highest density your budget allows. Low density looks good for the budget but usually involves failure or future headaches associated with greater weed maintenance. Higher densities provide greater initial weed resistance and will fill in more quickly which can cut down on long term monitoring effort. Effective planting densities usually range from 0.75 – 2 ft. on center spacing depending on weed pressure.

Species composition is the mix and abundance of species occurring at a site. As previously mentioned wetland plants sort themselves out according to hydroperiod. Figure 10 is a conceptual cross section show where regionally common wetland species occur on a wetland gradient.

6.3.3.2 Intermittently Flooded or Saturated Wetland Areas

The seed mix in Table 5 is suggested for use in intermittently flooded or saturated sites. Existing vegetation in these areas, if present, is likely to have wetland indicator statuses of FACW (usually occurring in wetlands, but may occur in non-wetlands) and FAC (occurring in wetlands and non-wetlands) (NRCS 2014).

Table 4. Recommended Seed Mix for Intermittently Flooded or Saturated Sites

Common Name	Scientific Name	Pounds Pure Live Seed per Acre
Rough bentgrass	*Agrostis scabra*	.02
American sloghgrass	*Beckmannia syzigachne*	0.27
Canada wildrye	*Elymus canadensis*	3.03
Slender wheatgrass	*Elymus trachycaulus*	1.92
Western mannagrass	*Glyceria occidentalis*	1.11
Meadow barley	*Hordeum brachyanterum*	.77
Western wheatgrass	*Pascopyrum smithii*	2.77
Tufted hairgrass	*Deschampsia caespitosa*	.35
Fowl bluegrass	*Poa palustris*	.11
Artic rush	*Juncus arcticus*	.04
Small-fruited bulrush	*Scirpus microcarpus*	.06
Total		10.42

6.3.4 Incorporating Forbs in Upland Seed Mixes

The aesthetic qualities of highly visible areas may be increased by including forb species into seeding mixes in upland areas (refer to Section 6.3.2 for seed mixes). Incorporation of forbs into seed mixes may also increase the attractiveness of an area to beneficial pollinator species. Table 6 presents a list of suggested forb species adapted to upland conditions and native to Ada County or the surrounding area.

These species are readily available from commercial seed growers, and any of these species could be selected for inclusion in the upland seed mixes presented in Tables 2 and 3. Forb seeds can be included in addition to grasses in these mixes; the compositions and rates of application for grasses in these mixes would not need to be adjusted. Specific application rates for forb species are not presented in this table as rates will depend heavily on site conditions, seed cost, and the seed mix into which the forb seeds are incorporated. A representative from the seed producer should be consulted to determine exact rates for forb inclusion into the upland grass mixes in Tables 2 and 3. It may be advantageous to wait until seeded grasses are established at a site and weeds are controlled before seeding forbs in an area, as broadleaf herbicides typically will eliminate desired forb species in addition to targeted weed species.

Table 5: Recommended Forb Species to Incorporate into Upland Seed Mixes

Common Name	Scientific Name	Native to Boise Area[1]	Occurs in Idaho[2]	Pure Live Seed per Pound[3]
Arrowleaf balsamroot	*Balsamorhiza sagittata*	✓	✓	55,000
Aspen fleabane	*Erigeron speciosus*	✓	✓	1,600,000
Common wooly sunflower[4]	*Eriophyllum lantanum*		✓	1,400,000
Common yarrow	*Achillea millefolium*	✓	✓	2,770,000
Fernleaf biscuitroot	*Lomatium dissectum*	✓	✓	45,000
Firecracker penstemon	*Penstemon eatonii*		✓	400,000
Gooseberryleaf globemallow	*Sphaeralcea grossularifolia*		✓	500,000
Hooker's evening primrose	*Oenothera elata*	✓	✓	1,300,000
Lewis flax	*Linum lewisii*	✓	✓	170,000
Mule's ears	*Wyethia amplexicaulis*		✓	28,000
Munro's globemallow	*Sphaeralcea munroana*	✓	✓	500,000
Pacific aster	*Aster chilensis (Symphyotrichum chilense* var. *chilense)*		✓	2,668,000
Parsnipflower buckwheat	*Eriogonum heracleoides*		✓	135,700
Royal penstemon[4]	*Penstemon speciosus*		✓	400,000
Rydberg's penstemon	*Penstemon rydbergii*		✓	850,000
Scarlet gilia	*Ipomopsis aggregata*	✓	✓	357,000
Silvery lupine	*Lupinus argenteus*	✓	✓	18,300
Sticky purple geranium	*Geranium viscosissimum*	✓	✓	52,000
Sulphur-flower buckwheat	*Eriogonum umbellatum*	✓	✓	209,000

Table 5: Recommended Forb Species to Incorporate into Upland Seed Mixes				
Common Name	**Scientific Name**	**Native to Boise Area[1]**	**Occurs in Idaho[2]**	**Pure Live Seed per Pound[3]**
Western coneflower	*Rudbeckia occidentalis*		✓	345,000

NOTES:
[1]Idaho Conservation Data Center 2005
[2]Natural Resources Conservation Service (NRCS) 2014
[3]Granite Seed Company catalog, Lehi, Utah.
[4]This species not available from Granite Seed Company. Information from NRCS 2014.

6.4 Incorporating Trees and Shrubs

The use of trees and shrubs may be desired in certain situations, such as for visual barriers or to increase the aesthetic quality of a site. Trees and shrubs should be planted in upland areas and only in locations where they will not inhibit site access or maintenance activities. It is recommended that trees and shrubs be planted from containerized stock, though some shrub species may also be available as seeds for incorporation in upland seed mixes. Seed producers can be consulted to determine rates for inclusion of shrub seeds into mixes if this method is desired.

Live plant material can be planted in either the spring or the fall. Fall planting may be more successful as plants will have more time to establish a root system before near-surface soils dry out in the summer. The species presented in Table 7 are native to southwestern Idaho and are likely to be available as containerized stock from commercial growers. This table includes information on the mature size of species, soil conditions to which species are adapted, and relative drought tolerances to inform selection and placement of plants. Local commercial growers or nurseries may be able to recommend other suitable native species. Non-native trees and shrubs recommended for use in the Boise metropolitan area can be determined by consulting the Boise City Community Forestry Department (http://parks.cityofboise.org/community-forestry/).

It may be advantageous to wait until seeded grasses are established at a site and weeds are controlled before planting or seeding trees and shrubs in an area as broadleaf herbicides typically will eliminate desired shrub and tree species in addition to targeted weed species.

Table 6: Recommended Tree and Shrub Species for Visual Barrier Plantings					
Common Name	**Scientific Name**	**Growth form**	**Mature Height (feet)[1]**	**Soils[1]**	**Drought Tolerance[1]**
Rocky Mountain maple	*Acer glabrum*	Tree	30	Medium and coarse	Medium
Antelope bitterbrush	*Purshia tridentata*	Shrub	6	Medium and coarse	High
Big sagebrush	*Artemisia tridentata (A. t.* ssp. *tridentata, vaseyana, and wyomingensis)*	Shrub	Varies	Fine, medium, and coarse	High

Table 6: Recommended Tree and Shrub Species for Visual Barrier Plantings					
Common Name	**Scientific Name**	**Growth form**	**Mature Height (feet)[1]**	**Soils[1]**	**Drought Tolerance[1]**
Blue elderberry	*Sambucus cerulea (S. nigra* ssp. *cerulea)*	Tree/tall shrub	23	Medium and coarse	High
Chokecherry	*Prunus virginiana*	Tree/tall shrub	25	Fine, medium, and coarse	Medium
Creeping barberry	*Berberis repens (Mahonia repens)*	Shrub	2	Medium	High
Fourwing saltbush	*Atriplex canescens*	Shrub	4	Fine, medium, and coarse	High
Golden currant	*Ribes aureum*	Shrub	10	Medium	Medium
Mountain snowberry	*Symphoricarpos oreophilus*	Shrub	5	Fine and medium	High
Netleaf hackberry	*Celtis laevigata* var. *reticulata*	Tree/tall shrub	20	Medium and coarse	High
Rocky Mountain juniper	*Juniperus scopulorum*	Evergreen tree	50	Medium and coarse	High
Rubber rabbitbrush	*Ericameria nauseosa*	Shrub	1 to 8	Medium and coarse	High
Saskatoon serviceberry	*Amelanchier alnifolia*	Tall shrub	15	Fine, medium, and coarse	Low
Skunkbush sumac	*Rhus trilobata*	Tall shrub	4	Medium and coarse	Medium
Snowbrush ceanothus	*Ceanothus velutinus*	Shrub	10	Medium and coarse	Low
Utah serviceberry	*Amelanchier utahensis*	Tall shrub	15	Fine, medium, and coarse	High
Wax currant	*Ribes cereum*	Shrub	3	Medium and coarse	High
Western juniper	*Juniperus occidentalis*	Evergreen tree	33	Medium and coarse	High
Woods' rose	*Rosa woodsii*	Shrub	3	Medium and coarse	Medium
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*	Shrub	3	Fine, medium, and coarse	High
Yellow rabbitbrush	*Chrysothamnus viscidiflorus*	Shrub	3	Medium and coarse	High
NOTE: [1]Natural Resources Conservation Service (NRCS) 2014					

7.0 Post-revegetation Actions and Site Maintenance

7.1 Use of Mulch

The incorporation of shredded wood fiber (e.g., arborist mulch) into the soil surface was recommended in Section 4.2.2 to increase carbon content of the soil. Shredded wood fiber mulch also can be a useful addition to the soil surface after planting or seeding as mulch reduces soil erosion, increases moisture retention in near-surface soil, buffers plants from temperature extremes, and suppresses weeds (Figure 11). Surface application of mulch is highly recommended in areas with live tree and shrub plantings. Finely ground mulch also may be useful in areas seeded with native species; however, thick application of mulch may suppress the germination of seeded species. Arborist mulch can be purchased from the Boise City Parks and Recreation Department.

7.2 Use of Temporary Supplemental Irrigation

Temporary supplemental irrigation may be used in situations where more immediate vegetation establishment is desired, such as in highly visible sites or erosion-prone areas, or where it may be necessary for seedling establishment (e.g., hydroseeded areas). Seeded areas should be irrigated using a sprinkler irrigation system. Trees and shrubs planted from containerized stock should be irrigated regularly using a drip irrigation system. It is recommended that, if used, supplemental irrigation be continued for at least two seasons after planting or seeding.

Figure 11
Shredded wood mulch around shrub plantings adjacent to a stormwater management basin site maintained by the City of Meridian, Idaho

Wetland plants should not be planted in standing water, so wetland zones should be planted during dry or low water conditions. Temporary irrigation is required until natural hydrology returns. Water can be supplied from water trucks, sprinkler systems, high-volume flood pumps or irrigation diversions, as appropriate.

Irrigation water can be supplied through the use of mobile irrigation trucks or the installation of either pressure-flow or gravity-flow water tanks. Mobile irrigation trucks can be scheduled to provide water to a site on a regular basis to feed either a drip-irrigation system or a sprinkler system. Pressure-flow tank systems are controlled electronically and allow for a consistent flow of pressurized water to an irrigation system. Gravity-flow systems do not require electricity to operate and may, therefore, be more economical; however, water pressure in a gravity-flow system is generally lower than from a pressure-flow system. Pressure in gravity-flow systems is based on the amount of water available in the tank, size of the pipe, and elevation of the water supply above the irrigated area. Gravity-flow irrigation may not be adequate for use with drip or sprinkler irrigation systems due to insufficient pressure.

Deep pipe irrigation, a system where a plastic pipe with a series of holes drilled in the side is buried in the soil, also may be useful for watering containerized trees and shrubs. Irrigation water is fed into the pipe through an irrigation system or through hand-watering and water is allowed to penetrate more deeply into the ground than with surface irrigation alone (Bainbridge 2006).

7.3 Dredging

It is recommended that the area in perennially flooded stormwater basins containing ponded water be deep enough (usually greater than 1.5 to 2.0 feet deep) to exclude cattail from interior areas of the basin. If this is not possible, a program of dredging and aggressive seeding with native species may be required to successfully exclude cattail. After dredging, the site should be seeded with species appropriate for site conditions; the seeding rate of this mix may need to be increased where heavy competition from cattail is anticipated. Successful establishment of native or desirable species may be sufficient to exclude cattail (Sharp 2002) and repeated dredging to remove cattail may not be necessary after native vegetation becomes established.

Figure 12
A hillslope where planting of live shrub materials has been completed

7.4 General Maintenance

Sites should be maintained following revegetation activities. This may involve removal of volunteer trees, litter control, weed control, and mowing of tall grasses at the discretion of ACHD stormwater management basin maintenance staff. Mowing of tall grasses should only be performed where forbs, shrubs, and trees are not seeded or planted.

8.0 Post-revegetation Monitoring

Recently revegetated sites should be visited frequently (every 2 weeks is recommended) and assessed to gauge the success of seeding efforts. Metrics for gauging revegetation success should be flexible and based on desired goals identified during site planning; however, a vegetative cover of at least 70 percent of seeded species is generally considered desirable. Figure 12 shows a revegetated hillslope where planting of live shrub materials has been completed and where monitoring should occur. A simple visual assessment by trained personnel should occur several times over the growing season for at least 3 years following revegetation activities. The progress of the site towards meeting revegetation goals (i.e., aesthetics, management of noxious weeds and invasive species, reduction of fire hazard, water quality, and erosion control) should be assessed during each visit. Visual assessment should include estimations of vegetative cover and establishment, vegetation species composition (if detectable), soil conditions, and hydrological conditions. Visual assessment may help personnel identify problem areas where revegetation efforts or site preparation activities were insufficient, and where reinitiation of certain activities may be required.

Visual assessment of revegetated areas should be coupled with stringent, repeatable data collection methods such as line-point intercept transects (Herrick et al. 2005) that can be used to quantify revegetation progress over time. Permanent, relocatable line-point intercept transects should be established at revegetated sites. The number of transects and length of each individual transect should be determined through consideration of size of site and number of different seeding zones established.

Revegetated sites should be frequently monitored for the presence of noxious weeds and invasive species. Visual site assessment may be sufficient for detection of certain species. The presence of invasive species may require reapplication of herbicide following manufacturer guidelines and maintenance personnel expertise (Section 4.3). If establishment of seeded species has been inhibited by noxious weed and invasive species, it may be necessary to reseed the area following recommendations in Section 6.0 after weeds have been adequately controlled or eliminated. All noxious weeds should be reported to the Ada County Weed, Pest and Mosquito Abatement Department (wpm@adaweb.net).

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APPENDIX A

A Flow Diagram for Determining Soil Texture by Feel

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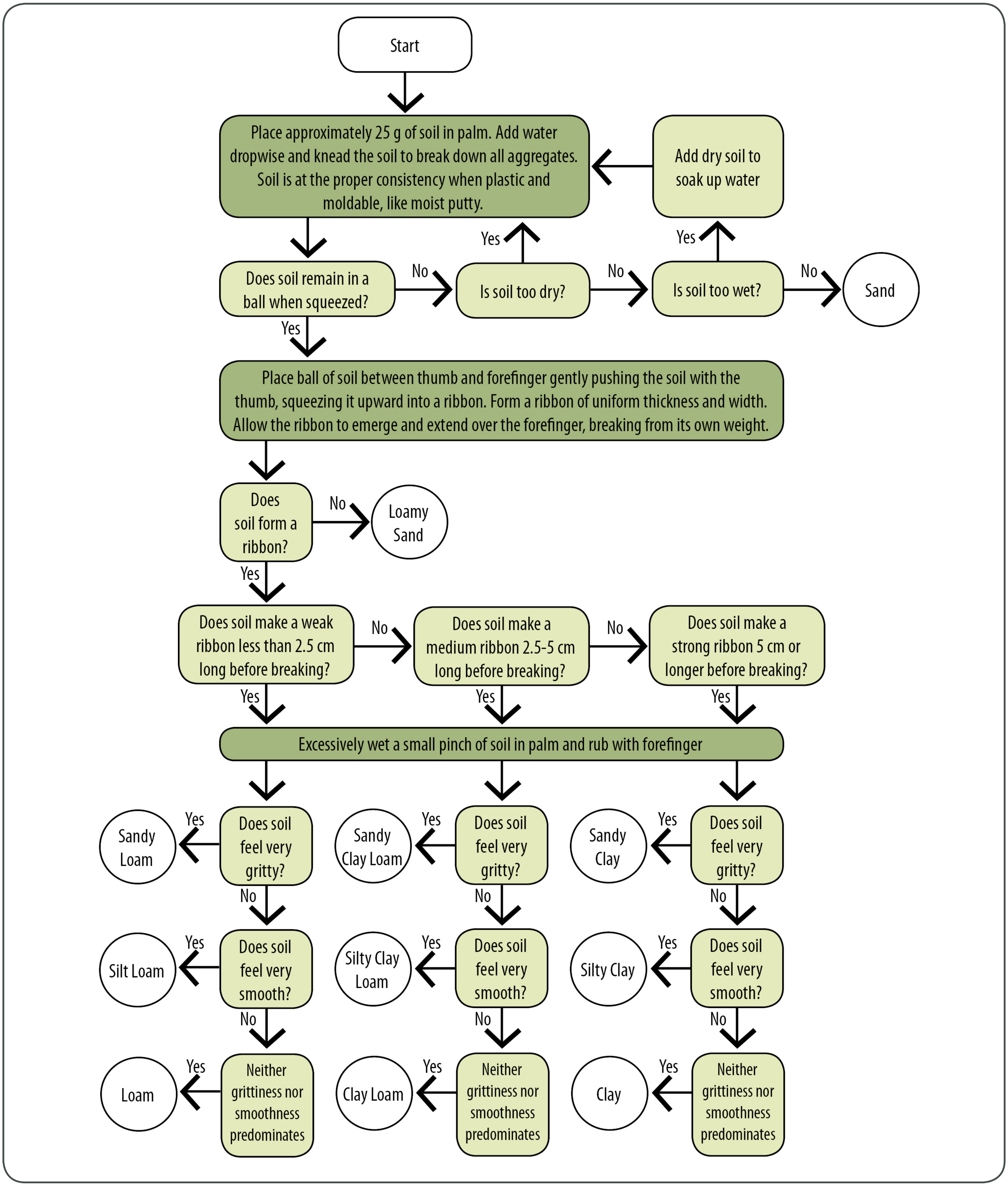

A Flow Diagram for Determining Soil Texture by Feel (modified from Thien 1979)

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APPENDIX B

Characteristics of Upland Grasses Recommended for Use in Revegetation of Stormwater Management Basins

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Table B-1. Characteristics of Upland Grasses Recommended for Use in Revegetation of Stormwater Management Basins

Common Name	Scientific Name	Grown Season[1]	Growth Form[1]	Seral Stage[2]	Maximum Height (feet)[3]	Adapted to Soil Textures[3]	Salinity Tolerance[3]	Calcium Carbonate Tolerance[3]	Pure Live Seed per Pound[1]
Alkali sacaton	*Sporobolus airoides*	Warm season	Perennial bunchgrass	Early	3.0	Fine, medium, and coarse	High	High	1,758,000
Blue wildrye	*Elymus glaucus*	Cool season	Perennial bunchgrass	Early	3.3	Fine, medium, and coarse	Medium	High	134,500
Bluebunch wheatgrass	*Pseudoroegneria spicata*	Cool season	Perennial bunchgrass	Early to late	5.0	Medium and coarse	None	Information not available	140,000
Great Basin wildrye	*Leymus cinereus*	Cool season	Perennial bunchgrass	Early to late	5.0	Fine, medium, and coarse	High	High	130,000
Idaho fescue	*Festuca idahoensis*	Cool season	Perennial bunchgrass	Late	2.0	Fine, medium, and coarse	None	High	450,000
Indian ricegrass	*Achnatherum hymenoides*	Cool season	Perennial bunchgrass	Early to mid	2.0	Medium and coarse	Low	High	141,000
Little bluestem	*Schizachyrium scoparium*	Warm season	Perennial bunchgrass	Early to mid	3.0	Fine, medium, and coarse	None	High	260,000
Needle-and-threadgrass	*Hesperostipa comata*	Cool season	Perennial bunchgrass	Mid	4.0	Fine and medium	Information not available	Information not available	115,000
Prairie junegrass	*Koeleria macrantha*	Cool season	Perennial bunchgrass	Mid	1.5	Medium and coarse	None	High	2,315,400
Sand dropseed	*Sporobolus cryptandrus*	Warm season	Perennial bunchgrass	Early	3.0	Medium and coarse	Medium	Medium	5,298,000
Sandberg bluegrass	*Poa secunda*	Cool season	Perennial bunchgrass	Early to mid	1.4	Medium and coarse	Low	Medium	1,047,000
Slender wheatgrass	*Elymus trachycaulus*	Cool season	Perennial bunchgrass	Early to mid	3.0	Fine and medium	Medium	High	159,000
Squirreltail	*Elymus elymoides*	Cool season	Perennial bunchgrass	Early to late	1.5	Fine and medium	Low	High	192,000
Thickspike wheatgrass	*Elymus lanceolatus* ssp. *lanceolatus*	Cool season	Perennial sod-forming	Early to late	2.3	Fine, medium, and coarse	Medium	Medium	154,000
Western wheatgrass	*Pascopyrum smithii*	Cool season	Perennial sod-forming	Early to late	2.0	Fine and medium	High	High	110,000

NOTES:
[1]Granite Seed Company 2009
[2]U.S. Forest Service (USFS) 2014
[3]Natural Resources Conservation Service (NRCS) 2014

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Table B-2. Characteristics of Wetland Graminoid Species Recommended for Use in Revegetation of Stormwater Management Basins

Common Name	Scientific Name	Wetland Indicator Status[1]	Growth Season[2]	Growth Form[2]	Maximum Height (feet)[2,3]	Adapted to Soil Textures[2,3]	Salinity Tolerance[2,3]	Calcium Carbonate Tolerance[3]	Pure Live Seed per Pound[1]
Alkali bulrush	*Bolboschoenus maritimus*	OBL	Cool season	Perennial sod-forming	3.0	Fine, medium, and coarse	High	Medium	162,600
Baltic rush	*Juncus balticus*	OBL	Cool season	Perennial sod-forming	2.0	Fine and medium	Medium	High	10,900,000
Hardstem bulrush	*Schoenoplectus acutus* var. *acutus*	OBL	Cool season	Perennial sod-forming	10.0	Fine and medium	Low to Medium	High	377,600
Inland saltgrass	*Distichlis spicata*	FAC	Warm season	Perennial sod-forming	1.1	Fine and medium	High	High	520,000
Meadow barley	*Hordeum brachyatherum*	FACW	Cool season	Perennial bunchgrass	2.0	Fine, medium, and coarse	Medium	Medium	85,000
Meadow sedge	*Carex praegracilis*	FACW	Cool season	Perennial sod-forming	2.0	Fine, medium, and coarse	None	Medium	664,900
Nebraska sedge	*Carex nebrascensis*	OBL	Cool season	Perennial sod-forming	3.0	Fine, medium, and coarse	Low	Medium	534,100
Olney threesquare	*Schoenoplectus americanus*	OBL	Cool season	Perennial sod-forming	5.0	Fine, medium, and coarse	Low to Medium	High	179,800
Rough bentgrass	*Agrostis scabra*	FAC	Cool season	Perennial bunchgrass	2.5	Fine and medium	Low	Low	5,000,000
Softstem bulrush	*Schoenoplectus tabernaemontani*	OBL	Cool season	Perennial sod-forming	9.0	Fine, medium, and coarse	Low	Medium	550,000
Tufted hairgrass	*Deschampsia caespitosa*	FACW	Cool season	Perennial bunchgrass	5.0	Fine, medium, and coarse	Low	Information not available	1,500,000

NOTES:

[1]OBL = obligate wetland, plants almost always occur in wetlands; FACW = facultative wetland, plants usually occur in wetlands, but may occur in non-wetlands; FAC = facultative, plants occur in wetlands and non-wetlands

[2]Granite Seed Company 2009

[3]Natural Resources Conservation Service (NRCS) 2014