Investigation Purpose

1. Collect stormwater reuse data and current research
2. Compare with Carver County’s existing plans
3. Provide recommendations regarding:
   a. Climate
   b. Soils
   c. Vegetation
   d. Irrigation Systems
Tasks

1. Rainfall and Stormwater Reuse
2. Analyze Existing Soils
3. Evaluate Engineered/Amended Soil
4. Study Suitable Vegetation
5. Irrigation System Design
Rainfall and Stormwater Reuse
Rainfall and Stormwater Reuse

<table>
<thead>
<tr>
<th>Treatment Volume</th>
<th>1.05” over the site impervious area</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Volume Reduction</td>
<td>0.5” from impervious area to be infiltrated on site</td>
</tr>
<tr>
<td>-Water Quality Treatment</td>
<td>0.55” from impervious area to treat TP and TSS</td>
</tr>
<tr>
<td>Irrigation rate</td>
<td>2”/week max. over 20 weeks from May-September</td>
</tr>
<tr>
<td>Pond</td>
<td>4 ft min. depth and 4 weeks of irrigation storage</td>
</tr>
</tbody>
</table>
Rainfall and Stormwater Reuse

Chaska 2NW Gage

- Period of Record: 2003-present
- Average weekly rainfall in the summer is ~1” per week
Rainfall and Stormwater Reuse

Beise Addition/Red Cedar Creek

- Pond ~ 0.7 acres
- Irrigated Area = 1.8 acres
- Impervious Area is varied
Rainfall and Stormwater Reuse

Simple Continuity Model
\[ \Delta \text{Storage} = \text{Inflows} - \text{Outflows} \]

Inflows
- Direct rainfall to pond
- Impervious rainfall runoff

Outflows
- Average evapotranspiration rates
- Varied irrigation rates
Rainfall and Stormwater Reuse
Rainfall and Stormwater Reuse: Results

For Impervious to Irrigated Area ratios:

- **1:1**
  - 2″/week irrigation draws **below minimum pool** an average of **20 days/year**

- **4:1**
  - **Exceeds capacity at least 30 days/year** for all rates

- **2:1**
  - **Most appropriate** for keeping the pond within range

1-2″/week is appropriate for ratio less than 4:1 (if soil and vegetation requirements met)
Existing Soils
Existing Soil Conditions
USDA Web Soil Survey Results

- ~0-10 inches: loam
- ~10-38 inches: clay loam
- ~38-80 inches: loam
- ks: 0.20 to 2.00 in/hr
- Water capacity: 0.17 (measured as 1 cm of water per 1 cm of soil).
MGS Map 178-Surficial Geology

<table>
<thead>
<tr>
<th></th>
<th>wilting point</th>
<th>field capacity</th>
<th>water capacity</th>
<th>hydraulic conductivity (in/hr)</th>
<th>wetting front suction head (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>loam</td>
<td>0.1</td>
<td>0.3</td>
<td>0.2</td>
<td>0.86</td>
<td>3.5</td>
</tr>
<tr>
<td>clay loam</td>
<td>0.15</td>
<td>0.35</td>
<td>0.2</td>
<td>0.04</td>
<td>8.22</td>
</tr>
</tbody>
</table>

Loamy till (low relief)—Chiefly loamy-textured, unsorted sediment (diamict; pebbly, with scattered cobbles and rare boulders. Shale clasts generally compose from 25 to 40 percent of the very coarse-grained (12 millimeters) sand fraction. Lenses of stratified sediment are uncommon in most areas. Overlain in some small, low-lying areas by 3 feet (1 meter) or more of loamy to clayey, organic-bearing colluvium. The till deposits form a low, undulating topography with widely-spaced, circular, flat-topped hills, with an overall relief of about 10 to 30 feet (3 to 9 meters). Commonly water-washed and overlie in places by a few feet (meter) of lacustrine, fluvial, or eolian sand in the vicinity of sand deposits, within the Glacial Lake Anoka basin, and within areas bounded by scarp.
Time of Ponding for Existing Soil

\[ t_p = \frac{k_s \theta \Psi}{i(i-k_s)} \]

- Used average loam values
- Varied Ks from 0.04 to 0.9 ks/hr
- Varied infiltration rate from 0.48 to 1.64 in/hr

<table>
<thead>
<tr>
<th>watering schedule</th>
<th>minimum ks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 in/week</td>
<td>0.8 in/hr</td>
</tr>
<tr>
<td>2.0 in/week</td>
<td>0.88 in/hr</td>
</tr>
</tbody>
</table>
Engineered and Amended Soils
Engineered Soils

• Applicable to boulevards
  ○ Soil compaction issue

• Engineered structural soil

• Benefits
  ○ Plant life
  ○ Structural integrity
  ○ Infiltration
Soil Amendments

- MnDOT Grade 2 compost
- Perlite, Vermiculite or Pumice
- Benefits
  - Increase infiltration rate
  - Increase water retention
  - Support plant life
Vegetative Cover
Vegetation Study

- Desired Traits:
  - Low maintenance
  - Attractive
  - Deep roots (break into clay)

- Locations for this study:
  - Founder’s Ridge Boulevards
  - Red Cedar Creek
Boulevard Turf

- **Tall Fescue**
  - Moderate salt tolerance
  - Deeper roots
  - 2.5-3 in/wk ET

- **Fine Fescue**
  - Highest available salt tolerance in MN
  - Shallower roots
  - 1.9-2.4 in/wk ET
Maintenance

- For deep roots:
  - Cut grass infrequently
  - Avoid shallow watering
  - ½” or shallower thatch depth

Cut to 2” every week
Cut to 2” every 2 weeks
Cut to 2” every 4 weeks
Open Field Vegetation

- Take rain garden approach
  - Hearty
  - Attractive
  - High water use

- Trees
  - Red Oak / Sugar Maple / Basswood / American Elm

- Table 1 BMP Guidelines
**Table 1. List of Suitable Plants for Infiltration/Filtration Areas**  
(BMP Guidelines)

<table>
<thead>
<tr>
<th>Wet (Basin Base)</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant Bur-reed</td>
<td>Sparganium eurycarpum</td>
<td>Joe-Pye Weed</td>
<td>Eupatorium maculatum</td>
<td></td>
</tr>
<tr>
<td>Wool Grass Sedge</td>
<td>Scirpus cyperinus</td>
<td>New England Aster</td>
<td>Aster novae-angliae</td>
<td></td>
</tr>
<tr>
<td>Cord Grass</td>
<td>Spartina pectinata</td>
<td>Prairie Blazingstar</td>
<td>Liatris pycnostachya</td>
<td></td>
</tr>
<tr>
<td>Blue Flag Iris</td>
<td>Iris versicolor</td>
<td>Boneset</td>
<td>Eupatorium perfoliatum</td>
<td></td>
</tr>
<tr>
<td>Swamp Milkweed</td>
<td>Asclepias incarnata</td>
<td>Black Willow</td>
<td>Salix nigra</td>
<td></td>
</tr>
<tr>
<td>Tamarack</td>
<td>Larix laricina</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wet Edge (Lower Side Slopes)</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Bluestem</td>
<td>Andropogon gerardii</td>
<td>New England Aster</td>
<td>Aster novae-angliae</td>
<td></td>
</tr>
<tr>
<td>Blue Joint Grass</td>
<td>Calamagrostis canadensis</td>
<td>Red-osier Dogwood</td>
<td>Cornus sericea</td>
<td></td>
</tr>
<tr>
<td>Switch Grass</td>
<td>Panicum virgatum</td>
<td>Sandbar Willow</td>
<td>Salix exigua</td>
<td></td>
</tr>
<tr>
<td>Blue Vervain</td>
<td>Verbena hastata</td>
<td>Black Chokeberry</td>
<td>Aronia melanocarpa</td>
<td></td>
</tr>
<tr>
<td>Prairie Blazingstar</td>
<td>Liatris pycnostachya</td>
<td>Black Willow</td>
<td>Salix nigra</td>
<td></td>
</tr>
<tr>
<td>Tamarack</td>
<td>Larix laricina</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meso Upland (Upper Side Slopes &amp; Edge)</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Bluestem</td>
<td>Andropogon gerardii</td>
<td>Yellow Coneflower</td>
<td>Ratibida pinnata</td>
<td></td>
</tr>
<tr>
<td>Switch Grass</td>
<td>Panicum virgatum</td>
<td>Purple Prairie Clover</td>
<td>Petalostemum purpureum</td>
<td></td>
</tr>
<tr>
<td>Indian Grass</td>
<td>Sorghastrum nutans</td>
<td>Gray Dogwood</td>
<td>Cornus racemosa</td>
<td></td>
</tr>
<tr>
<td>Golden Alexander’s</td>
<td>Zizea aurea</td>
<td>Nannyberry</td>
<td>Viburnum lentago</td>
<td></td>
</tr>
<tr>
<td>Black Eyed Susan</td>
<td>Rudbeckia hirta</td>
<td>Quaking Aspen</td>
<td>Populus tremuloides</td>
<td></td>
</tr>
<tr>
<td>Swamp White Oak</td>
<td>Quercus bicolor</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Irrigation Systems
Irrigation System Design

- Soil and climate info needed
- Calculate water zone
- Calculate application rate
- Specify layout
- Draft maintenance plan

http://www.fao.org/
Drip Irrigation Advantages

- Higher water efficiency
  - Uniform application
  - Reduced runoff and evaporation
- Reduced fungal growth
- Longer lifespan
- Lower pumping needs
- Lower maintenance cost
Sprinkler Irrigation Advantages

- Easier to monitor
- Ideal in uneven areas
- Better for trees
- Easier to repair
- Higher volumes used

http://www.homeadvisorhomesource.com/
Final Recommendations
Final Recommendations

• Irrigation appropriate at 2 in/week for K=0.88 in/hr
  o Soil cores to determine soil characteristics
  o Use time of ponding table for irrigation rates
• Subsurface irrigation for open area with <2% slope
• Sprinkler irrigation for trees and uneven areas

• Amended soils and vegetation
  o Compacted areas
  o Clay areas
• Field: Trees & rain garden plants
• Boulevard:
  o Tall Fescue (moderate salt)
  o Fine Fescue (high salt)