



Community Gravel Beds:

Helping Reforest Minnesota on a Budget

Minnesota Shade Tree Advisory Committee
Monthly Forum – November 16, 2017



Roundtable Presenters

- Jacob Busiahn, City of Eden Prairie; formerly City of Shakopee
- Dustin Ellis, Hennepin County Environment and Energy
- Gary Johnson, University of Minnesota, Dept. of Forest Resources
- Stephan Papiz, City of Robbinsdale

This presentation on community gravel beds was delivered at a Minnesota Shade Tree Advisory Committee monthly forum at Newell Park, Saint Paul, MN. All presenters have extensive experience in cultivating gravel bed trees both at the municipal and research level.



Community Gravel Bed Terminology

- **Gravel.** Washed river gravel ranging in diameter from 3/8” to 3/4”
- **Bare Root Plants.** Woody plants with no soil encasing roots
- **Liners.** Woody plants, usually bare root, less than 3 years old
- **Whips.** Woody plants, usually bare root, unbranched or lightly branched, less than 1” caliper
- **Calipered.** Woody plants, usually bare root, branched, greater than 1” caliper
- **Caliper.** Width of tree stem measured 6” above first main root
- **ANSI Z60.1.** This is the American Standard for Nursery Stock, 2014. Available as an on-line pdf.

These are commonly-used terms for nursery-grown trees.



Discussion Topic One:

- How long have you been using or working with community gravel bed?
- What “style” of gravel bed do you work from?
- What type of gravel do you use? What is the depth in your beds?
- What is the square footage of your bed/s?
- What is the type of irrigation and what is the frequency of daily irrigation?

After a brief introduction to terminology and the concept of community gravel beds by Gary Johnson, each of the guests representing various community gravel bed projects responded to a series of questions that fell under four different topical areas.



Discussion Topic One Responses: Jacob Busiahn –Shakopee Gravel Bed

- ▶ I've been working with community gravel beds for over six years.
 - ▶ I prefer a gravel bed to be constructed with two movable sides – I used concrete traffic barriers – above-ground.
 - ▶ Preference is for 3/8” washed river gravel, 15-18” deep.
 - ▶ The community gravel bed at Shakopee was 2700 square feet.
 - ▶ Irrigation heads were placed on T-posts in the middle of the bed, spraying as low as possible to gravel; frequency was adjusted based on time of year, temperature and wind speed, normally mid morning and night for 30-45 minutes.
- 



Discussion Topic One Responses: Dustin Ellis, Hennepin County

- ▶ I have over six years of experience working with a variety of gravel beds.
 - ▶ We prefer an above-ground system with movable sides.
 - ▶ The preferred gravel is 3/8" to a depth of 18".
 - ▶ Our current gravel bed is approximately 15,000 square feet.
 - ▶ Irrigation is overhead, four times a day for 15-30 minutes depending on weather conditions.
- 



Discussion Topic One Responses: Stephan Papiz, City of Robbinsdale

- ▶ I've been working with gravel beds for over four years.
- ▶ Our community gravel bed is four sided, above-ground at our Public Works shop and is underlain by a concrete surface.
- ▶ Currently, our bed is using 3/8" washed river gravel, ranging from 14-18" deep. However, actual gravel size is closer to 1/8".
- ▶ Our gravel bed is 672 square feet (14' x 48') but expandable to 840 square feet.
- ▶ Irrigation water source includes a Woodford yard hydrant connected to a fire hydrant water main 50' away. The yard hydrant self-drains when shut off and includes a built-in backflow preventer.
- ▶ The irrigation system includes a Hunter brand solenoid unit that controls 6 evenly spaced irrigation pop-up heads with a 180 degree spray field area. Irrigation activates 4 times per day with timing, length and pressure determined by weather conditions.



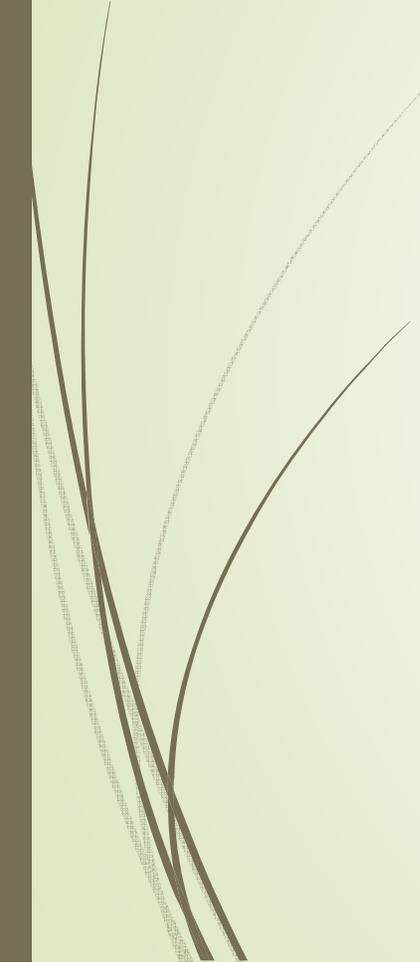
Discussion Topic Two

- What spacing do you use to stock trees? Shrubs?
- When are the beds stocked?
- What types of nursery stock do you use? E.g. liners, whips, calipered, deciduous, evergreens, shrubs.

Spacing refers to the approximate distances between trees/shrubs and between rows in the gravel beds.
Stocking refers to installing those trees and shrubs in the gravel beds.
Shrubs refers to deciduous shrubs only in this context.

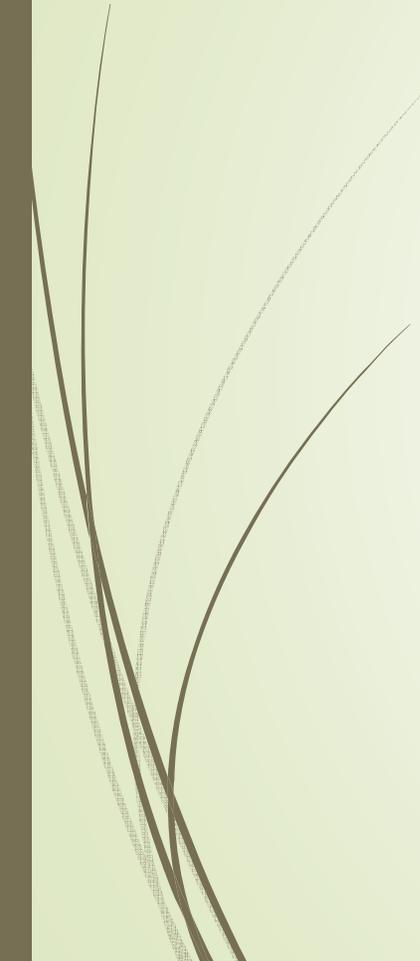


Discussion Topic Two Responses: Jacob Busiahn

- ▶ The spacing for trees and shrubs is approximately 2-3' on center, depending on size.
 - ▶ The beds were usually stocked in late April through early May.
 - ▶ The nursery stock included whips and calipered deciduous trees.
 - ▶ Shakopee's gravel bed measured 90 feet by 30 feet and could easily be stocked with 300-400 trees, depending on sizes.
- 



Discussion Topic Two Responses: Dustin Ellis

- ▶ Trees and shrubs are stocked at 2-3' on center spacing.
 - ▶ Beds are stocked as early as possible. Weather permitting, it will begin in early April and conclude in May.
 - ▶ We stock with whips and calipered deciduous trees and shrubs.
- 



Discussion Topic Two Responses: Stephan Papiz

- ▶ Trees are stocked at 7-10 trees placed in 20 or so total rows; trees ranged in height from 5-9' for larger trees (majority of inventory) and 2-5' for smaller nursery stock.
- ▶ Majority of trees are stocked by the third week of May, heavy irrigation levels are applied for 1-2 weeks after installation to roughly mimic a “sweating technique” to keep the roots very moist. So far by using this technique all tree species generally recommended for sweating (oaks, hawthorns, etc.) have broken dormancy.
- ▶ Robbinsdale uses a variety of nursery stock types, but mostly whips and lightly-branched trees to reduce branch breakage during harvesting operations and to make for easier extraction. Rarely are calipered trees used.
- ▶ Almost all trees are deciduous, but has had success with small black spruce (*Picea mariana*) and dawn redwood. Poor success with *Larix* species if light is inadequate. Good success with shrubs but the only 2 species tried so far are red currants (*Ribes*) and Saskatoon serviceberry (*Amelanchier*).



Discussion Topic Three

- When do you start harvesting plants? When do you finish?
- How do you harvest? By hand, with a tractor and front-end loader?
- How do you keep roots moist between harvest site and plant-out sites?
- How do you prepare planting “holes?” Auger, by hand, stump grinder, backhoe?

“Harvesting” refers to lifting trees or shrubs from the gravel beds. As opposed to field harvesting, the gravel does not adhere to the roots, so the root system is clean from gravel or soil when harvested.



Discussion Topic Three Responses: Jacob Busiahn

- ▶ Harvesting usually starts in late September and finishes by late October but can go into November as long as it isn't freezing up.
- ▶ I've used front end loaders, tractors with pallet forks and front end rock rakers...anything but harvesting by hand.
- ▶ Roots are watered down, dipped in hydrogel and covered by tarps after being loaded on open trailers for transport.
- ▶ Planting holes are prepared by hand, by auger and in some cases, by backhoe scraping. For a good primer on preparing poor planting areas search "*scoop and dump soil remediation*", and for a good overview of starting to plant bare-root trees in a municipal setting, access the video "[Creating the Urban Forest: The bare root Method](#)" from Cornell University.



Discussion Topic Three Responses: Dustin Ellis

- Harvest begins in mid-late September and concludes by late October.
- We harvest by front end loader and some by hand when the loader can't reach them. Harvesting by hand is very time-consuming.
- Roots are kept hydrated by dipping them in a hydrogel, then placing them in a large (#15 or larger) growing container and then filled with mulch. These can then be placed out on site and after planting the mulch is applied to the soil over the roots.
- Holes are prepared by auger or by hand.

See slide 22 for a description of hydrogels.



Discussion Topic Three Responses: Stephan Papiz

- ▶ I begin planting in late September, when the daily high temperatures are no warmer than the 60's. I plant well into November until the ground freezes. In 2017 extended warmth allowed for planting 7 trees on December 4th.
- ▶ If there are trees left, I over-winter them in the gravel bed. All trees are protected by Plantra tree guards after midsummer to prevent rodent damage
- ▶ Most trees are harvested by hand due to the fact that tractor/skid steer access to our bed is impractical and tree stocking is quite dense. A good tool is a railroad ballast fork with a metal handle used to slowly pry the trees out like a hydraulic floor jack. Oaks are generally easy to harvest, Zelkovas, elms, blue beech (*Carpinus*), river birch and Russian olives (*Eleagnus*) are the hardest and sometimes require a machine to extract.
- ▶ Roots are washed and dipped in fine grade Terra-Sorb hydrogel, packed in bundles of 5-6, loaded onto the back of the Toolcat and covered with a water-soaked canvas tarp for transport to planting sites.



Discussion Topic Three Responses: Stephan Papiz - continued

- ▶ Planting holes are prepared with a 36” auger attachment (non-tapered bit) attached to the Toolcat machine.
- ▶ If electric/cable/fiber distribution lines lie directly underground of the planting area holes are dug by hand.
- ▶ Soil in planting hole is evened out and sides scarified prior to tree installation and backfilling.
- ▶ A TreeGator bag is left with each tree to help facilitate watering by residents along with an instruction door hanger about the new tree.
- ▶ The new tree is added to the City’s Tree Inventory using the ArcGIS Collector App directly in the field.



Discussion Topic Four

- ▶ What has been your survival rates as a whole?
- ▶ What are the best species from your experiences? What have been the worst?
- ▶ What has been the establishment rate in landscapes, two to three years after planting out?
- ▶ What types of nursery stock (i.e., liners, whips, etc.) seem to survive and establish the best?
- ▶ Any recommendations for other communities considering gravel beds as an option for reforesting their landscapes on a budget?



Discussion Topic Four Responses: Jacob Busiahn

- ▶ Survival and establishment rates have been about the same for bare-rooted (gravel bed), containerized or balled and burlapped (B&B) trees.
- ▶ The best performing tree species: elm, linden, KY coffeetree, catalpa, honeylocust, serviceberry, cherry, cottonwood and Ohio buckeye.
- ▶ The worst performing tree species: oaks, river birch, hackberry, ginkgo, plane tree and blue beech.

Elm (*Ulmus*), linden (*Tilia*), KY coffeetree (*Gymnocladus*), catalpa (*Catalpa*), honeylocust (*Gleditsia*), serviceberry (*Amelanchier*), cherry (*Prunus*), cottonwood (*Populus*), Ohio buckeye (*Aesculus*), oaks (*Quercus*), river birch (*Betula*), hackberry (*Celtis*), ginkgo (*Ginkgo*), plane tree (*Platanus*), blue beech (*Carpinus*).



Discussion Topic Four Responses: Jacob Busiahn - continued

- ▶ Most trees are calipered, with an occasional whip
- ▶ Installation costs, including costs of trees/materials - comparisons:
 - ▶ Using City Staff
 - ▶ Gravel Bed Trees @ \$110.00
 - ▶ Containerized Trees @ \$159.00
 - ▶ Using Private Contractors
 - ▶ Containerized Trees @ \$239.00

Cost of trees/materials included the cost of the trees, staking, mulch, stem protection, etc.



Discussion Topic Four Responses: Jacob Busiahn - continued

- ▶ Recommended consulting two on-line resources:
 - ▶ “Creating the Urban Forest: The Bare Root Method,” Cornell University
 - ▶ “The Scoop and Dump Method of Soil Remediation,” Cornell University

Simply type in those titles on any server. Make sure you are looking at the ones with Cornell in the url.



Discussion Topic Four Responses: Dustin Ellis

- ▶ Hennepin County Forestry has experienced excellent survival rates both in the gravel bed holding period as well as the plant-outs in landscapes. Much of the survival rate hinges on best handling practices once the trees are harvested, especially keeping the roots moist.
- ▶ Consistent with most other communities' experience with species performance in gravel beds, oaks have been a struggle to successfully use as gravel bed trees. Most others do quite well.
- ▶ Most installed trees are calipered, with some whips.

The general recommendation for watering newly planted trees is five gallons of water, two to three times a week. Disregard promises of rain unless it really does rain hard. Then a trip or two can be skipped.



Discussion Topic Four Responses: Dustin Ellis - continued

- ▶ Hennepin County Forestry has developed a novel way of transporting trees from the gravel bed to the planting sites. Trees are harvested, dipped in a root-coating hydrogel, placed in a large tree container and filled with mulch. The trees are then transported to the planting sites, staged (placed where they will be planted), planted, watered and mulched with the mulch from the container. It takes a bit more time, but on projects with volunteers planting the trees, they experience a much higher survival rate with this process.

Hydrogel is a generic term for a group of synthetic gels (think of unflavored gelatin) that when mixed in water expands and holds the moisture. Hydrogels are added to water in buckets or small livestock tanks, the tree or shrub roots are dipped in the solution after they are harvested to retain the moisture in the roots. It's essentially coating the roots. The further the trees must be transported, the more beneficial the gels are. Hydrogels are inexpensive and can be purchased from garden centers or on-line.



Discussion Topic Four Responses: Stephan Papiz

- ▶ Survival and establishment rates for trees planted from gravel beds in Robbinsdale has been excellent - equal to containerized or B&B trees. The trick is minimizing the amount of time roots are exposed to open air from extraction to planting and getting residents to regularly water trees, using tree watering bags when possible.
- ▶ With oaks, the best success has been with smaller whips (around 5 feet tall). Calipered oaks do less well. Of the oaks, the best performers have been bicolor, Regal Prince, Majestic Skies, Heritage and northern red, but performance is sometimes variable even within species.
- ▶ River birch often suffers dieback after fall planting, but recovers quickly and grows back fast. Honeylocust also can suffer some dieback but again, recovers quickly with normal care.

Bicolor oak (*Quercus bicolor*), Regal Prince oak (*Quercus robur* x *bicolor* 'Long'), Majestic Skies oak (*Quercus ellipsoidalis* 'Bailskies'), red oak (*Quercus rubra*).



Discussion Topic Four Responses: Stephan Papiz - continued

- ▶ The best tree species have been tuliptree, Japanese tree lilac, hawthorns, crabapples, plane trees (aka, sycamore), Kentucky coffeetrees, elms, aspens, zelkova and Russian olives (not commonly planted but the undisputed king of the gravelbed) have been the best performers.
- ▶ Hackberry does alright in gravel, but often growth seems sluggish the first season after planting. From the second season on, it grows much better.
- ▶ The establishment rate has generally been excellent after the second season in the landscape, but varies according to how well the residents have watered the trees on their boulevards.
- ▶ Robbinsdale prefers to plant lightly-branched whips, generally five to seven feet tall.

Tuliptree (*Liriodendron*), Japanese tree lilac (*Syringa reticulata*), hawthorn (*Crataegus* species), crabapple (*Malus*), plane tree/sycamore (*Platanus*), Kentucky coffeetree (*Gymnocladus*), elm (*Ulmus*), aspen (*Populus*), zelkova (*Zelkova*), Russian olive (*Eleagnus*).



Discussion Topic Four Responses: Stephan Papiz - continued

- Robbinsdale highly recommends planting from a community gravel bed and can't imagine community reforestation any other way.
- For oaks, stick with smaller sizes for better root growth in the gravel.
- Coordinating delivery and installation of bare root trees in the spring can be a challenge. Robbinsdale keeps it simple and sticks with one or two nurseries for the bulk of the tree stock.
- Lightweight traffic barriers can substitute for custom-made wooden or concrete-framed gravel beds.
- The ease of handling, transportation and planting makes gravel bed trees very attractive to communities with limited labor forces.



Discussion Topic Four Responses: Stephan Papiz - continued

- ▶ Between 2015-2016, Robbinsdale spent ~\$7,000 for just over 300 bareroot trees. Tree costs were approximately \$23 per tree. In-house labor and equipment were used to install all the trees.
- ▶ On a few occasions a County-based work crew (Sentence to Serve) was used to help plant trees. This can be a great resource (if available) for mass plantings or for sites where utilities require hand digging
- ▶ The first season after planting in most cases is a reestablishment year for the trees. The second season is when their growth takes off.

Stocking Beds



Stocking, or installing bare root trees in gravel beds, is variable in terms of spacing (depends on the size of trees) or timing (depends on when you get the shipments in the spring). Most of the time, since gravel beds are holding areas not growing areas, trees are packed in pretty tight to take advantage of space and to shade the gravel.

City of Shakopee



Bare root trees are delivered in the spring between early April and June. They come from cold storage units in wholesale nurseries. Those trees were field-harvested during the preceding autumn and stored for several months in refrigerated and moist storage facilities during the winter. The longer they are stored, the lower the survival rate and the longer the “sweating period” for some tree species. To learn more about “sweating trees,” access this on-line primer: <http://www.mnstac.org/sweating.html>.

City of Shakopee



Even in the cool, moist spring, roots dry out fast, so they must be kept moist and covered until they are staged in the gravel beds. Tarps, wet burlap, anything to keep them from drying.

City of Shakopee



Shakopee's two-sided gravel bed allows for maximum use of a front-end loader to access and drop the gravel as lines of trees are staged across. Note the two walls are left-over concrete traffic barriers. Trees in this bed are staged 2-3 feet apart within and between rows. Gravel is piled over the root systems to a depth of 4-6 inches to keep the roots uniformly moist.

City of Shakopee



An almost fully-stocked gravel bed. Note the trees being held in the 150 gallon livestock tank in the foreground to make sure the roots don't dry out. Like this site, ideally gravel beds are set up on otherwise useless ground such as a parking lot, old gravel pad...anything but good, productive soil.

City of Robbinsdale



Photo by Stephan Papiz

As stated earlier, Robbinsdale gets their trees primarily from one nursery for convenience of delivery. With one nursery, they know all trees will be coming in at the same time. Trees in bundles are of the same species and sizes.

City of Robbinsdale



Photo by Stephan Papiz

In the background, the gravel bed is set up with one side completely open at this point. After the bed is stocked, a bed such as this can either be closed off with timbers or traffic barriers, or left open. The more that can be done with a tractor and front end loader, the better.

City of Robbinsdale



Pea gravel is dumped onto bareroot trees one row at a time when installing bareroot trees using an articulated skid steer with a bucket attachment. Once all the trees are in the gravel, the wooden borders are reinstalled for the summer and then removed when it comes time to begin harvesting.

City of Robbinsdale



Photo by Stephan Papiz

The fully stocked community gravel bed in Robbinsdale, conveniently constructed adjacent to existing pavement with wide enough access for trucks and utility vehicles at the Public Works facility. Note the plastic trunk protectors to prevent animal damage such as from rabbits, mice, voles. There is one kind of tree that rabbits, mice and voles like in particular...store-bought trees.

Cloquet Forestry Center



A much simpler gravel bed, constructed below ground at the Cloquet Forestry Center. This bed was primarily set up for research. Below ground beds are much more moisture-moderated, but that comes at a price. If the soil is poorly-drained, the trees can flood and die. Also, when it comes to harvesting them, it involves a lot of hand digging.



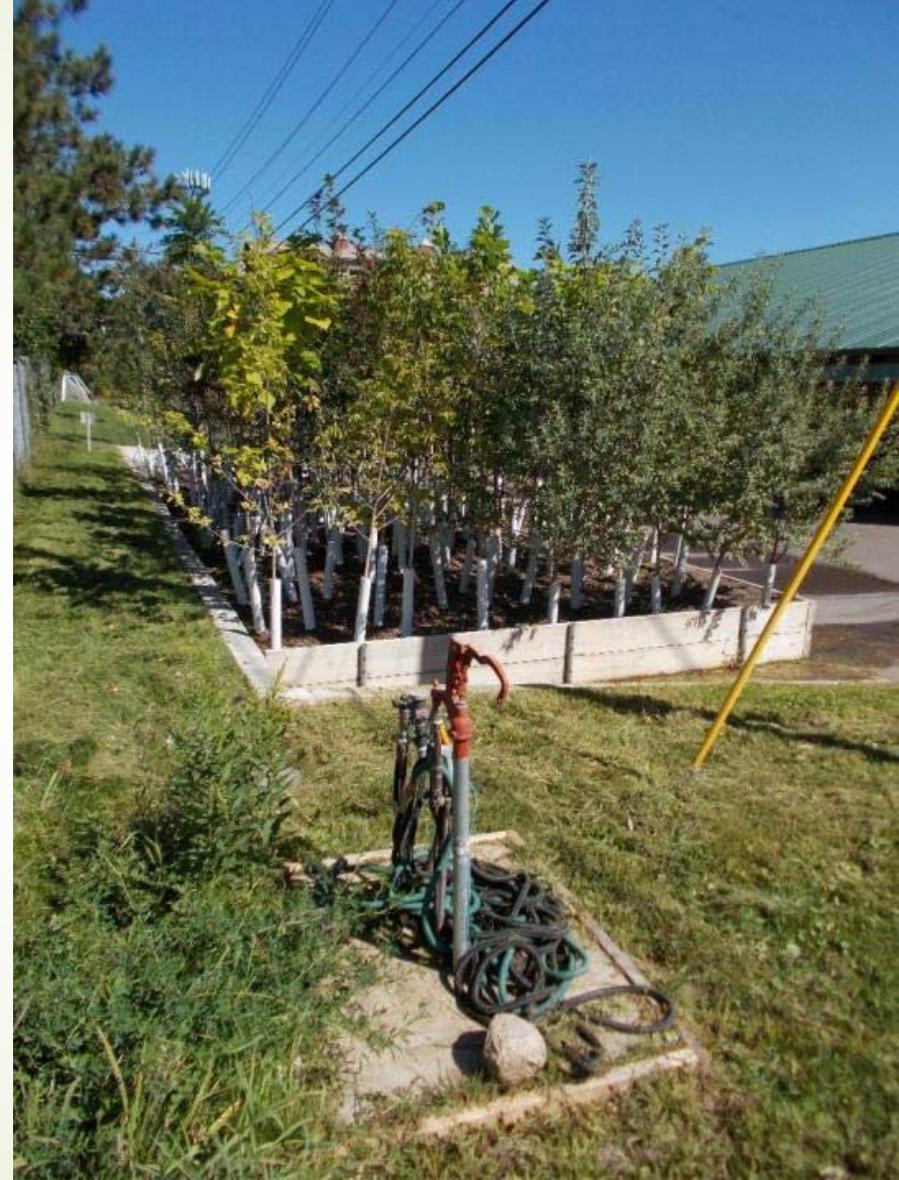
Water Source



The water source is the single-most important site feature for locating a community gravel bed. Without water, the plants will soon die. Even a period of a couple dry days without water will kill or degrade trees quickly.

City of Robbinsdale

Photo by Stephan Papiz



This bed is located a few feet from the water source. The 6 pop-up irrigation sprinkler heads are installed along the west side (left part of photo) of the gravelbed. There are a row of Austrian pines along the west side of the gravelbed that likely help to reduce overall water stress.

The simpler the irrigation system, the better...less to break down. Soaker hoses stretched along the rows of trees have been used successfully in some gravel beds, but squirrels and rabbits like to chew through them. Hoses with sprinklers and hooked up to a programmable water meter is a simple and inexpensive system. The more exposed to wind and sun a gravel bed is, the more water it will take. It's hard to predict the length of an irrigation cycle and the frequency of the cycles. Just experiment until you get it right for your site.

Harvesting Gravel Bed Trees



Depending on the species, community, region of the state and time-pressure for planting out the gravel bed trees, most communities start pulling trees in late summer (late August) through November. The later in the summer and into mid-Autumn (late October) is pretty ideal. Trees can be harvested by hand, digging out the trees with a shovel, a railroad ballast fork or a pick-axe. This is the time to call on all of your friends for help. You'll find the hardest trees to hand remove are the first ones. After that, you'll have loosened up the gravel a bit and have some room to work in.

City of Shakopee



Front end loaders with a variety of buckets, forks or rakes is the fastest, least labor-intensive and best way of harvesting gravel bed trees with the maximum amount of roots retained. As you scoop up the gravel and tree roots, the gravel easily separates from the roots with a couple of shakes.

City of Shakopee



These photos show what root systems can look like as the trees are harvested, note the amount of fine roots on these river birch and buckeye. They dry out pretty fast, so make sure that you've prepared something ahead of time to keep the roots moist: a sprinkler, tarps, livestock watering tanks, 30 gallon garbage bags, etc.

City of Robbinsdale



Photo by Stephan Papiz

This is fairly typical of the profuse production of fine roots that a gravel bed promotes due to its perfect combination of moisture, oxygen and ease of growth. However, these fine roots can dry out and die in minutes if not kept moist. Also note how many fine roots there are and how little pea stone is clinging to them.

City of Robbinsdale



Photo by Stephan Papiz

Here is evidence that even bur oaks can produce vigorous fibrous root systems when placed in gravel, but with this species it is often a hit or miss result. This growth is after 5 months of being in the gravelbed from early June to early November.

Planting



Imagine being strong enough to pick up a 2 inch caliper tree like the planter in the photo if it was in a container or balled and burlapped. Not possible. This is one of the best features of bare root trees and gravel bed bare root trees...your back will last forever.

City of Shakopee



Shakopee loads their harvested trees on low trailers and covers them with wet tarps to keep them moist until planting time. Autumn is the best time for planting. It's cool, trees aren't losing much moisture and as long as you water the trees in well and mulch the soil over them, new roots will be growing well into December.

City of Shakopee



This is an example of the “scoop and dump” method of preparing soil, and incorporating some compost into the soil in the process. Large bed plantings like this are best done with a backhoe.

City of Shakopee



I guess there can be one or two problems if you use a backhoe for preparing planting sites. Might want to call Gopher State One Call before you get going. Luckily, this utility was abandoned and unmarked.

City of Shakopee



As much as mechanical equipment is nice and speeds up the planting process, many of the planting holes are still dug by hand. It takes no longer to prepare a planting site for a gravel bed tree than it does for a containerized tree. That mulch ring will keep the soil (and roots) from freezing for several weeks in the autumn and early winter.

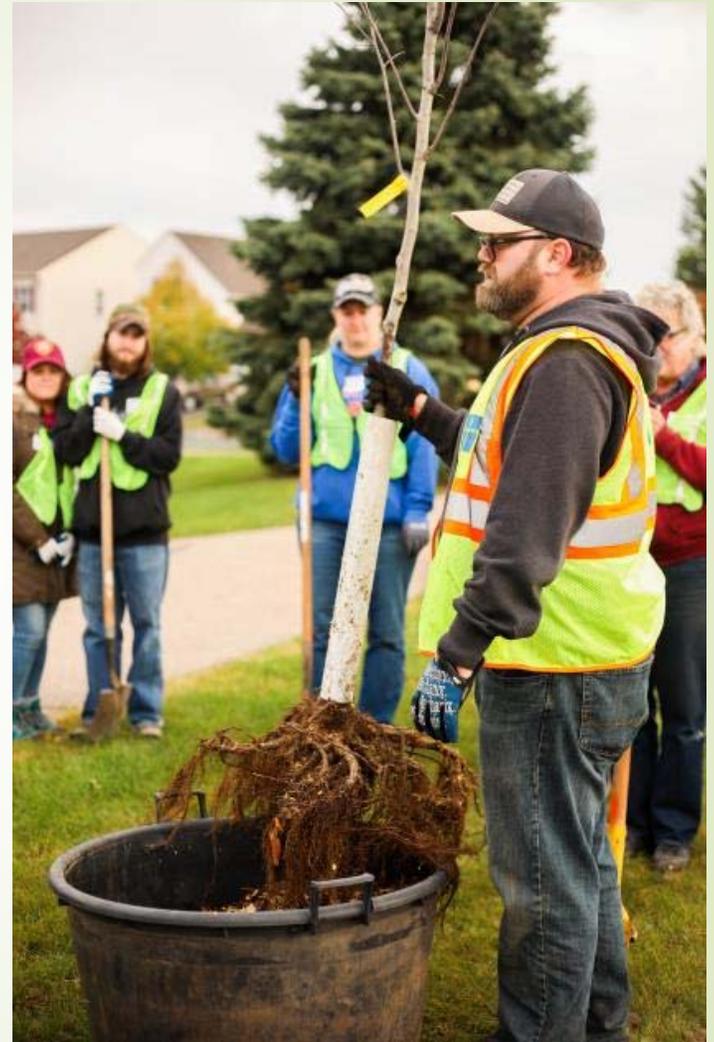
Hennepin County Forestry



A Dave Hanson – UMN - Photo

Dustin Ellis, forester for Hennepin County, has perfected a great technique for keeping harvested tree roots moist and getting mulch to the planting sites. He combines them. They end up being a bit heavier than just a standard bare rooted tree, but for volunteer planting projects, it's been very successful.

Hennepin County Forestry



A Dave Hanson – UMN - Photo

Trees harvested from the gravel beds are dipped in a hydrogel, placed in #45 containers, filled with mulch and transported to the planting sites.

Hennepin County Forestry



A Dave Hanson – UMN - Photo

Once the trees are delivered and staged in their planting sites, there's plenty of time for the volunteers or crew members to get out, dig the holes and plant the trees since the roots are moist and protected. Then the mulch is spread on the surface over the newly planted root system.

City of Robbinsdale



Photos by Stephan Papiz

Along with preparing planting holes by hand if necessary, the City of Robbinsdale primarily uses a 36" auger attachment to pre-dig holes to speed up the process. All trees are mulched by a county based work crew several days following planting and a TreeGator watering bag is left with every planted tree.



A Big Thank You To:

Jacob Busiahn, City of Eden Prairie

Dustin Ellis, Hennepin County Forestry

Stephan Papiz, City of Robbinsdale

Also: City of Saint Paul for providing today's
venue

Thanks to the municipal and county foresters that took the time to make this seminar a valuable learning experience and to Saint Paul's Parks and Recreation department for providing the venue for this forum on community gravel beds.