Appendix A.2:
Zavoral Property Reclamation Plan and Topsoil Addendum

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Zavoral Property

Reclamation Plan
Scandia, Washington County, Minnesota
May 3, 2011

Client:

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Consultant:

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Critical Connections
Ecological Services, Inc.

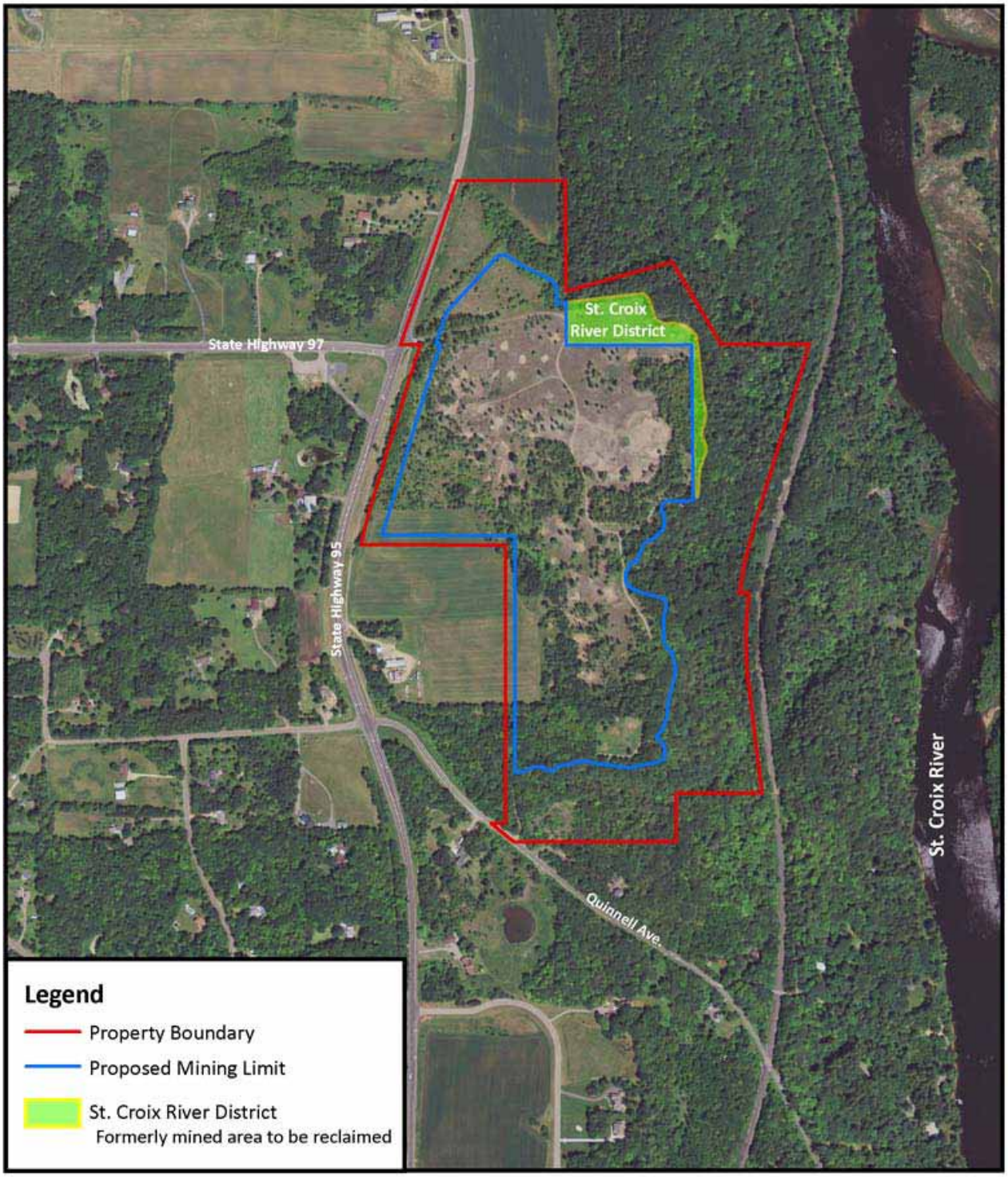
Intent of Reclamation

Tiller Corporation (Tiller) is providing this reclamation plan as a general requirement of the City of Scandia's Ordinance No. 103 which covers mining and related activities. The intent of reclamation for the Zavoral Mining and Reclamation Project site (**Figure 1** on the following page) is to re-establish vegetation, provide stable soil conditions for the site, and to create safe land use conditions following all mining phases over a 64 acre area. Areas of reclamation will take place concurrently with all mining phases and at the end of the last mining phase. To provide safe and stable end use conditions, the reclamation areas will be graded with slopes that do not exceed 4:1 and will have native vegetation planted that is appropriate for this area of the St. Croix River Valley. Currently the unreclaimed Zavoral property contains several old stockpiles and mining faces. Since the end of the most recent mining activity the site has slowly become established by volunteer, on-site seed sources. As a result, both native and non-native volunteer vegetation has now become established throughout the inactive mining areas. Much of the inactive mining area is now established with a low diversity of predominantly non-native grasses and forbs and wooded areas with native white pine, red cedar and cottonwood trees. Following the proposed mining by Tiller, reclamation will involve establishing dry prairie, mesic prairie and coniferous woodland communities which will provide important habitat for the area and a higher diversity of plant communities that does not exist at the site today. The final conditions proposed for the site includes: 35-40 acres of dry prairie, 15-20 acres of mesic prairie, 2-4 acres of coniferous woodland and approximately 2 acres of roadway. At the end of the mining project the site will be left in a self-sustaining state that is compatible with the surrounding landscape and land uses.

Initial Condition of Mining Site

Within the Zavoral site the majority of upland area located above (west of) the bluff line over to the western side of the property along Highway 95 was utilized in the past for sand and gravel mining activities, but now is currently inactive. The inactive mining area covered approximately 56 acres of the Zavoral site and is now dominated by a mix of native and non-native woody and herbaceous vegetation that has become established following the last gravel mining operation. Plant communities that are currently found within this inactive mining area can be described as being a combination of altered/non-native short and long grass communities, altered/non-native short and long grass with sparse trees communities, and altered/non-native forest and woodland plant communities.

Many small to medium sized topsoil, overburden and aggregate stockpiles occur throughout this area and are now re-vegetating with a mix of native and non-native trees, grasses and forbs including several primary and secondary noxious weeds. Mining faces with steep slopes, depressions, stockpile areas, and larger areas of somewhat level terrain are typical topographical features found throughout the area that was mined. Some areas lack vegetation altogether and are just exposed sand and gravel. A more detailed description past and present land use is contained in the Historical Land Use document prepared by Tiller and reviewed by CCES.



Zavoral Property
Site Location Map

0 225 450 900 1,350 1,800 Feet

NORTH

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Figure 1

Vegetation

Dominant woody vegetation found within the inactive mining area includes primarily cottonwood (*Populus deltoides*) and eastern white pine (*Pinus strobus*) trees that are 40 years old or younger. Additional trees growing with cottonwood and white pine are found scattered throughout and include: red cedar (*Juniperus virginiana*), quaking aspen (*Populus deltoides*), and paper birch (*Betula papyrifera*) with red oak (*Quercus rubra*), box elder (*Acer negundo*), American elm (*Ulmus americana*), and a species of willow (*Salix* spp.) found only occasionally. Cottonwood and white pine are typical early successional tree species (i.e. species that are the first to grow back after disturbance has taken place) and are common throughout the inactive mining area making up approximately 85-90% of all tree species. These trees have become established since mining has become inactive throughout the area and now occupy small pockets of deciduous and coniferous woodlands of various ages as well as being scattered throughout within some of the open grassland areas.

Most of the woody vegetation that has become established on-site is comprised of native tree species except for two tree species. The two non-native tree species that are found growing within the inactive mining area are Siberian elm (*Ulmus pumila*) and Scotch pine (*Pinus sylvestris*). Both of these tree species have become naturalized within parts of Minnesota and in the case of Siberian elm can be fairly common in highly disturbed areas like unreclaimed gravel mines. These two tree species are found only within the inactive mining areas and along the edges of the existing forests that are adjacent to the inactive mining areas. Because of their intolerance to shading, these two trees are not present within the interior of the forested areas within the Zavoral property and pose little threat to the ecological integrity of these forested areas.

Although tree cover within the inactive mining area is composed mainly of native trees, the vast majority of herbaceous grasses and forbs within this area are composed of non-native species. Several dominant grass species that are found throughout the inactive mining areas include: smooth brome (*Bromus inermis*), Kentucky blue grass (*Poa pratensis*), Timothy (*Phleum pretense*), and quackgrass (*Agropyron repens*). In fact a relatively high percentage of herbaceous plants in this area are considered to be noxious weeds. Often times it is quite typical to have a high percentage of weeds becoming established in inactive gravel mines where no reclamation has taken place. Several of the dominant herbaceous plant species found growing within the inactive mining area includes both primary and secondary noxious weeds. The Minnesota Department of Agriculture list plants as noxious weeds because they are injurious to public health, the environment, public roads, crops, livestock, and other property. Primary noxious weeds found within the inactive mining area include: poison ivy (*Toxicodendron radicans*), bull thistle (*Cirsium vulgare*), and Canada thistle (*Cirsium arvense*). Secondary noxious weeds found within the inactive mining area are giant foxtail (*Setaria faberii*), spotted knapweed (*Centaurea maculosa*), common lambsquarters (*Chenopodium album*), common milkweed (*Asclepias syriaca*), quackgrass (*Agropyron repens*), and annual ragweed (*Ambrosia artemisiifolia*). Unfortunately very few native herbaceous plants can be found growing within the inactive mining area with the vast majority being non-native weed species that have very little ecological value.

Soils

The soils of the Zavoral property and surrounding landscape are comprised of predominantly sandy and silt loam soil types typical of the St. Paul Baldwin Plains. The soils mapped within the reclamation areas of the Zavoral property include: Antiago silt loam with 2-6% slopes, Emmert gravelly loamy coarse sand with 15-25% slopes, Gotham loamy sand with 1-6% slopes, Pits-gravel, and Santiago silt loam with 6-15% slopes **(Figure 2)**. Of these soil types the majority of the reclamation areas occur within Pits-gravel and Gotham soils with smaller areas occurring within Antiago, Emmert and Santiago soil types.

The areas that were previously mined on the Zavoral site are classified as Pits-gravel and no longer have the original topsoil present. These somewhat barren soils occur on-site as sparsely vegetated areas with portions of exposed sandy soils. The soil types located immediately adjacent to the Zavoral mining and reclamation areas where agricultural practices still take place and where the forested slopes on the eastern side of the property are located include: Gotham, Santiago, Antigo, and Emmert. Remnants of these soil types occur within the mining and reclamation areas. Topsoil removed from these soil types during overburden removal will be stockpiled for use within each of the reclamation areas.

The following are the soil series descriptions for the soil types that are mapped within the Zavoral Mining and Reclamation Project area as well as the A horizon descriptions for each soil type. No soils or A horizon descriptions are available for the areas mapped as Pits-gravel.

Antigo Soil Series Description: The Antigo series consists of very deep, well drained soils formed in 20 to 40 inches of loess or silty alluvium and in loamy alluvium and in the underlying stratified sandy outwash. These soils are on outwash plains, stream terraces, eskers, kames, glacial lake plains, and moraines. Slope ranges from 0 to 30 percent. Mean annual precipitation is about 32 inches. Mean annual air temperature is about 40 degrees F.

Antigo A Horizon: Ap--0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; many fine roots; about 6 percent gravel and 2 percent cobbles; pH 6.8; abrupt smooth boundary.

Emmert Soil Series Description: The Emmert series consists of very deep, excessively drained soils that formed in sandy and sandy-skeletal glacial outwash on eskers, kames, terraces, and moraines. These soils have rapid or very rapid permeability. Their slopes range from 1 to 70 percent. Mean annual precipitation is about 28 inches. Mean annual air temperature is about 40 degrees F.

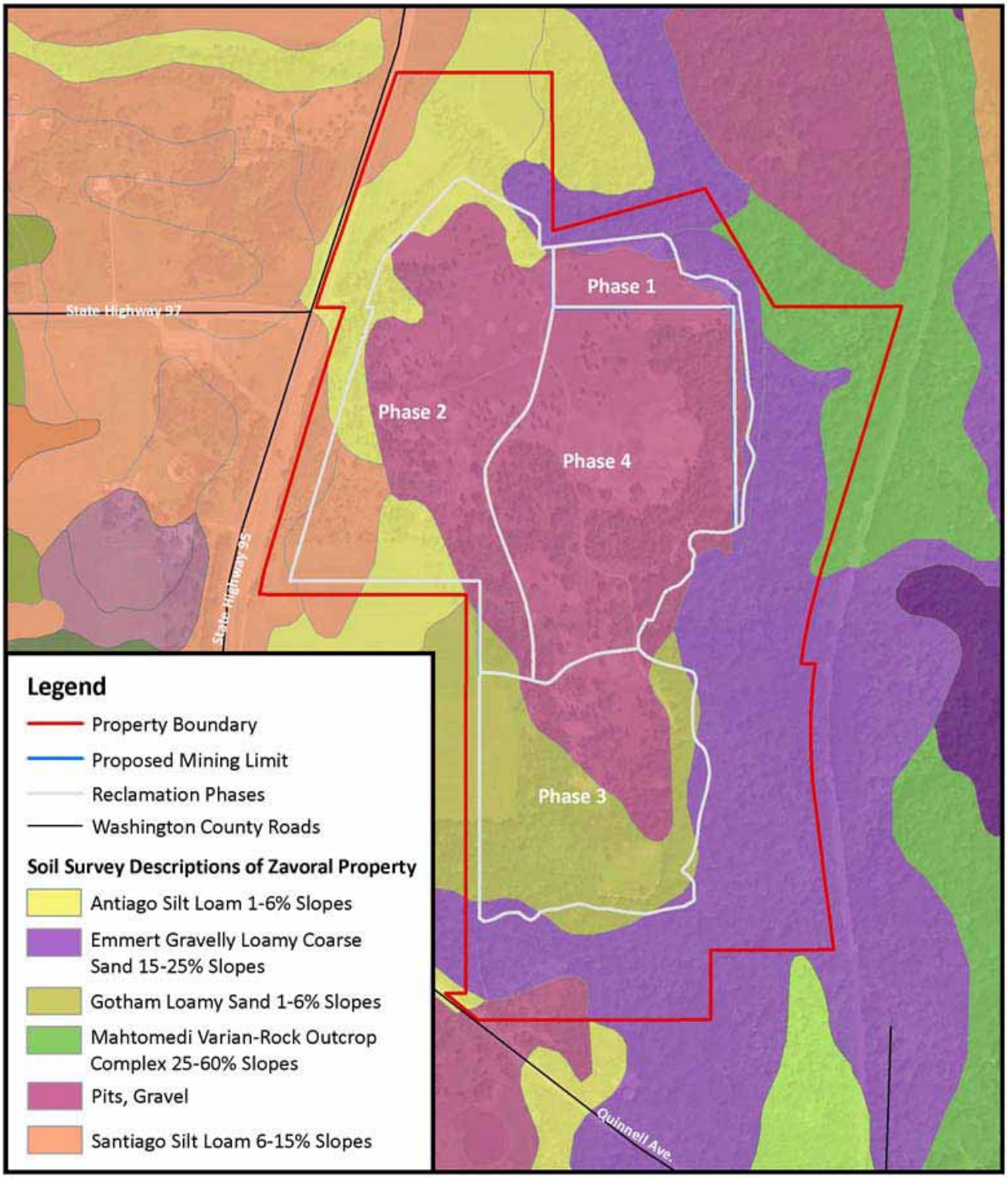
Emmert A Horizon: A--0 to 2 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR4/1) dry; weak fine granular structure; very friable; about 10 percent gravel; slightly acid; abrupt smooth boundary. 1 to 4 inches thick.

Gotham Soil Series Description: The Gotham series consists of very deep, somewhat excessively drained soils formed in sandy glaciofluvial deposits on moraines, outwash plains, stream terraces, and glacial lake basins. Permeability is rapid. Slopes range from 0 to 35 percent. Mean annual precipitation is about 32 inches. Mean annual air temperature is about 49 degrees F.

Gotham A Horizon: Ap--0 to 8 inches; dark brown (10YR 3/3) loamy fine sand, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; few roots; common pores; neutral; abrupt smooth boundary. 6 to 9 inches thick.

Santiago Soil Series Description: The Santiago series consists of well drained soils which are deep to a densic contact. They formed in loess or silty lacustrine deposits and in the underlying dense sandy loam till on ground moraines, disintegration moraines, and end moraines. Permeability is moderate in the silty mantle, slow or moderately slow in the lower part of the solum, and very slow in the substratum. Slope ranges from 1 to 45 percent. Mean annual precipitation is about 30 inches. Mean annual air temperature is about 42 degrees F.

Santiago A Horizon: Ap--0 to 10 inches; dark brown (10YR 3/3) silt loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine and few medium roots; 4 percent gravel; slightly acid; abrupt smooth boundary. 6 to 12 inches thick.



Zavoral Property
Washington County Soil Survey Map

0 162.5 325 650 975 1,300 Feet

NORTH

Critical Connections Ecological Services, Inc.

Figure 2

Methods and Processes of Reclamation

The primary goal of the Zavoral Reclamation Plan is to establish temporary and permanent vegetation in order to stabilize all newly graded slopes following each phase of mining activity. Vegetation re-establishment of the Zavoral site is designed around natural community restoration principles and prescriptions appropriate to the site context, the St. Croix River Valley, and the post-mining site conditions. Native vegetation that is adapted to sandy, well drained soils will be utilized to establish vegetation throughout the reclamation areas within the Zavoral Mining and Reclamation Project.

Reclamation will take place in four phases throughout the life of the mining operation. Phase 1 reclamation will take place as the first phase of mining occurs since it will not be part of any proposed mining. Reclamation Phases 2, 3 and 4 will take place as mining is completed.

There are primarily two types of reclamation activities that may occur; the ongoing reclamation activities and the mass reclamation activities. The ongoing reclamation activities generally occur each season. Often materials suitable for reclamation but not suitable for aggregate production are encountered and these materials are used for ongoing reclamation. In addition various local construction projects will encounter organic materials not suitable for the specific project and/or excess organic materials. If these organic materials are suitable for topsoil they will be accepted and placed in the ongoing reclamation area.

The mass reclamation activity occurs concurrently with removal of topsoil and overburden from an area in preparation for mining. The combined activities of topsoil and overburden removal and reclamation are commonly referred to as a stripping/reclamation project. These projects occur less frequently depending on aggregate demand. It is the intent and goal to proportionally open new areas for mining and reclaim areas during these projects. It is important to note that these two areas will not always be exactly the same size in area. Overburden removal and reclamation are three dimensional. For example, materials removed from a certain area in preparation for mining may or may not be enough and may be more than enough to reclaim exactly the same amount of acres as are being opened. However when you consider the mass reclamation combined with the ongoing reclamation, over time, there is proportional newly opened areas and reclaimed areas.

Reclamation of each phase will be initiated and completed in a timely manner to prevent erosion or sedimentation from occurring. A graphical depiction of the three phases of the mining operation and the four phases of reclamation are shown in **Figures 3** and **4**.

Reclamation Phase 1

The first phase of reclamation will take place in the northeastern portion of the proposed Project. This previously mined area is located within the St. Croix River District and USA Scenic Easement Areas. Removal of existing stockpiles and minor grading will take place to accomplish reclamation. These areas will not be part of any mining activity. Once existing stockpile removal and final grading within the Phase 1 Reclamation area is complete, reclamation of this area will begin. The Phase 1 Reclamation

planting plan will include the seeding and establishment of native dry and mesic prairie seed mixes and the planting of native white pine that are currently growing within other areas of the Zavoral site. The prescribed planting of this area will include a coniferous tree community intermixed with appropriate native prairie seed where openings occur. This community is similar to the predominant vegetation in immediately adjacent areas which have not been previously disturbed by mining activity. The transplanting of on-site native white pine trees to the Phase 1 Reclamation area from proposed mining areas, is intended to provide a local source of trees. Transplanting of on-site trees should take place in the early spring or fall when the optimum time to move young trees occurs.

Reclamation Phases 2, 3, & 4

Reclamation Phases 2, 3 and 4 will consist mainly of establishing dry and mesic prairie communities throughout the site by seeding. In addition to seeding, several small groupings of coniferous trees will be planted in ecologically appropriate locations. These reclamation plantings over the next several years will develop into natural plant communities that include dry prairie, mesic prairie, and coniferous woodland. In general within Reclamation Areas 2, 3 and 4 vegetation will be established by seeding throughout all open areas with dry prairie covering most of each area with the exception of the low depressional areas which will be planted as a mesic prairie community. Trees to be planted as part of the site's reclamation will typically be installed along the edge of the proposed mining limits close to the existing forested slopes to create a woodland transition between the existing forest and the newly seeded prairie communities. Since future management tasks may involve prescribed burns all coniferous trees (white pine) will be planted around the edges of the reclamation areas and not the interior.

The main haul road that is located within the Phase 1 mining area will remain in active use during all mining and reclamation phases and may remain after mining is complete. Consistent weed control along this road during all phases of mining and reclamation will be an important component of successful native vegetation establishment within the reclamation areas.

Screening Areas

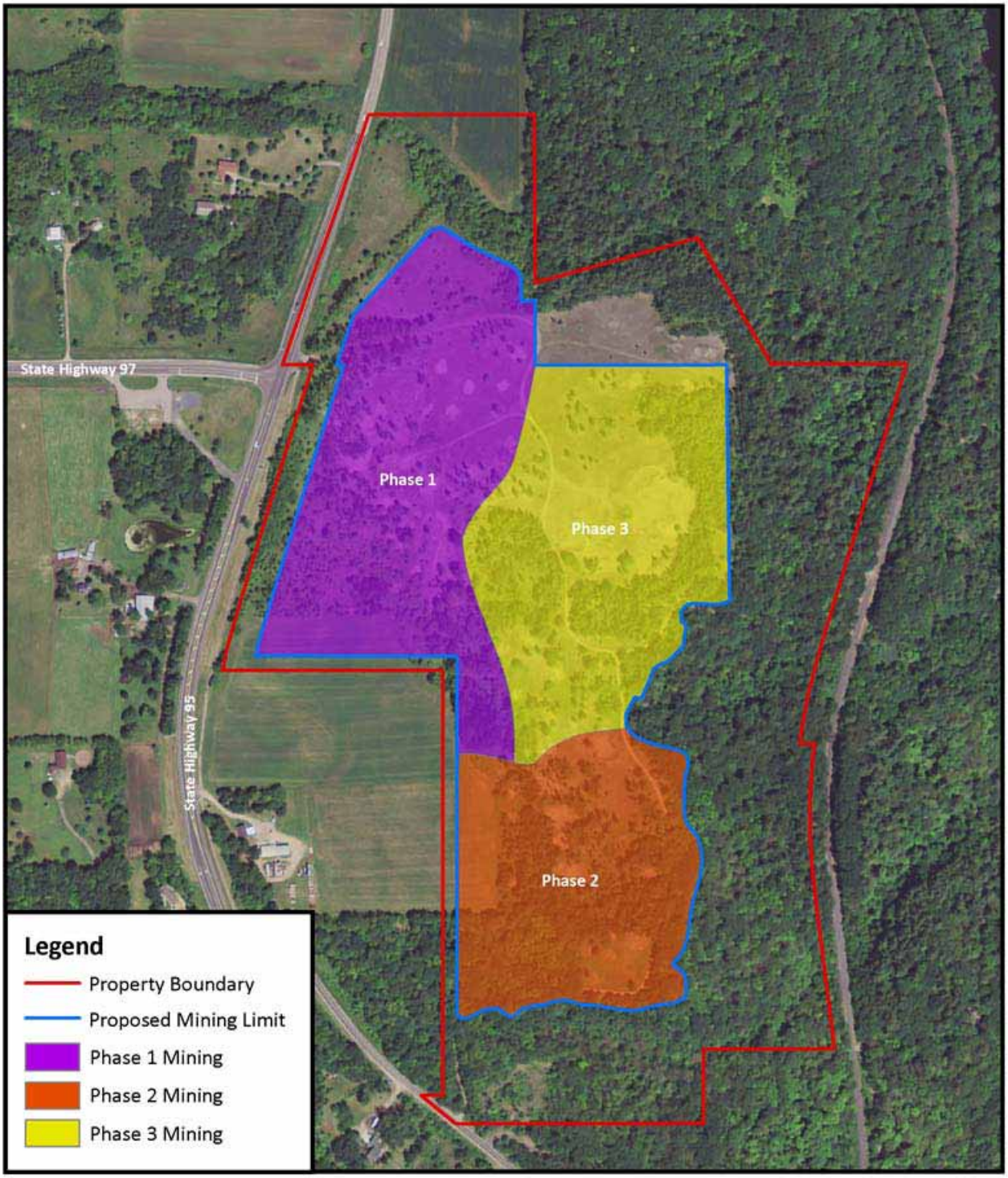
The proposed and existing screening berms located along State Highway 95 and along the southwest perimeter of the site occur within the 50-foot and 100-foot mining setbacks. The 50-foot and 100-foot mining setbacks are currently included as proposed reclamation areas in the reclamation plan figures. The purpose of the berms is to screen the mining and reclamation activities from nearby vehicle, bike, and pedestrian traffic in the area. Construction of the berms will take place as the site is being developed and may include transplanting of native white pine trees from within the site to provide additional screening. Transplanting activities for the screening areas would occur simultaneously with the transplanting activities proposed in Phase 1 Reclamation. See the Mining and Reclamation plan by Sunde Engineering, PLLC. (Sunde) for details on the height and extent of the berms to be constructed.

The screening berms will remain as needed to provide screening throughout the life of the project, with the potential for removal during certain phases of reclamation. The proposed and existing berms will

include similar prescribed reclamation and management tasks that are consistent with the vegetation and management goals of the four reclamation areas. Vegetation management tasks included for the 50-foot and 100-foot setback areas should involve some level of weed/invasive plant management including herbicide treatments and prescribed burning where appropriate.

Created Depressions

The final grading plan for the proposed reclamation areas shows six (6) created depressions located throughout the proposed mining limits. These created depressions have a depth from 0.5 feet to 1.5 feet and range in size from approximately 20,000 sq.ft. to 75,000 sq.ft. in area. In total they will cover approximately 5 acres. These created depressions are not designed to allow stormwater to collect and stagnate or to convert to a wetland type environment, but rather to encourage infiltration, add visual interest and develop some ecological diversity. Each depression will be planted with a native seed mix that will establish as a mesic to wet prairie plant community and will include species that tolerate a wider range of moisture levels than the dry prairie species. These depressions will serve as varied habitats that have the potential to add some function to the ecosystem similar to previous depressions that were unintentionally and incidentally created on site.



Zavoral Property

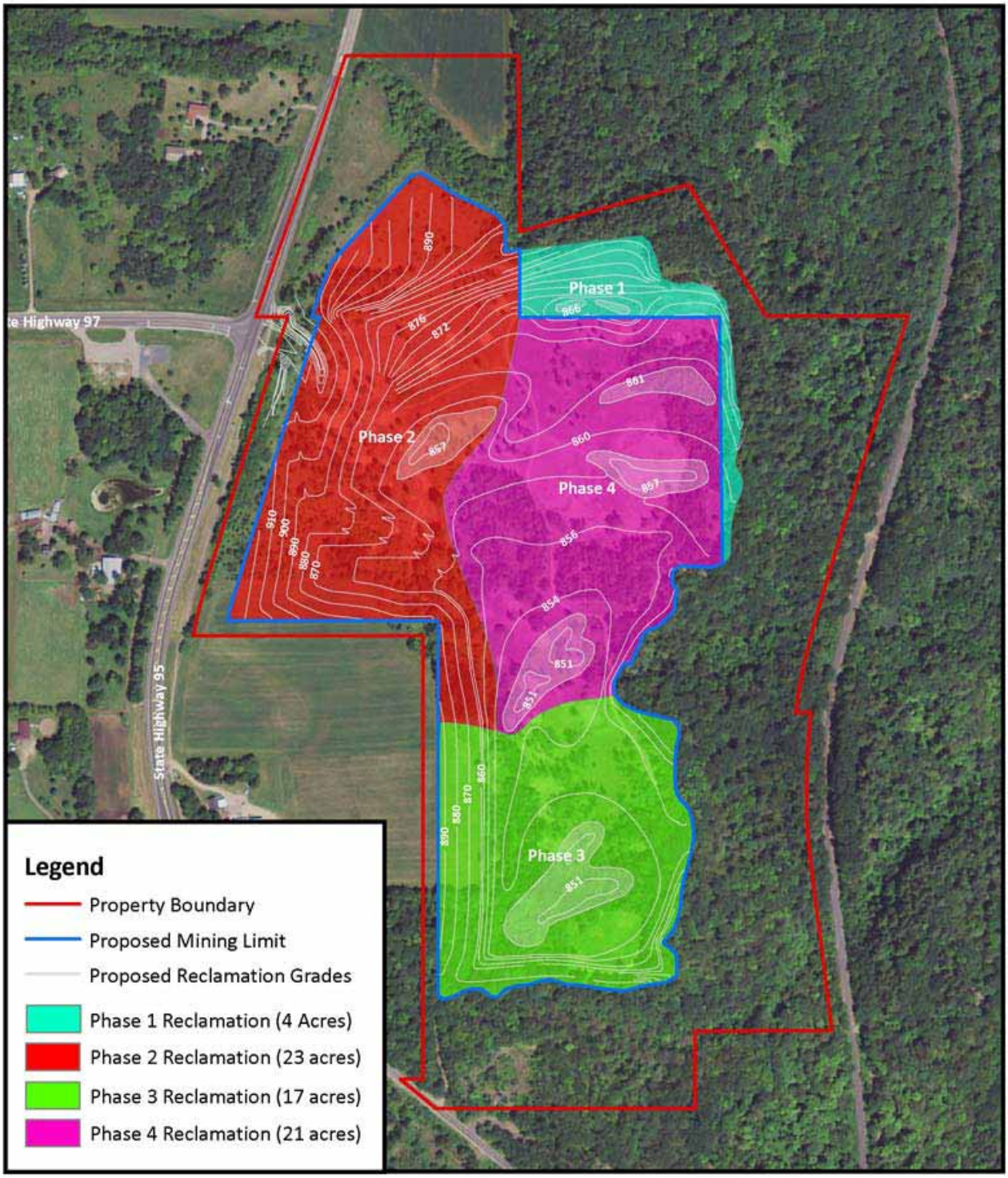
Zavoral Mining Project Map

Feet
0 125 250 500 750 1,000

NORTH

Critical Connections Ecological Services, Inc.

Figure 3



Zavoral Property

Zavoral Reclamation Project Map

0 125 250 500 750 1,000 Feet

NORTH

Critical Connections Ecological Services, Inc.

Figure 4

Site Preparations

Grading and Topsoil Reclamation

Once a mining area within a specific phase is available for reclamation the area will be final graded with slopes that do not exceed 4:1 (horizontal:vertical). Minimum final grades for each of the reclamation areas are shown in the Mining and Reclamation Phasing plans by Sunde. Final grading will be completed within areas of any given reclamation phase once a minimum of 4" of topsoil is placed over the surface of the ground and grading inspections are completed to plan specifications.

Currently topsoil is absent from much of the proposed mining area due to previous mining activity so stockpiling of all available topsoil will be needed for reclamation. To meet the requirements of the City's mining ordinance, and to achieve establishment of native seedlings within reclamation areas, organic material will likely need to be imported into the site. As topsoil is stripped or removed, it will be set aside on the site for re-spreading over the reclamation areas.

Topsoil to be used over the reclamation areas will consist of on-site material generated from removal of the soils that overlay the gravel deposits being mined and existing berms and stockpiles of topsoil. Due to the lack of available on-site topsoil, topsoil can be generated by mixing on-site sand with an acceptable amount of composted material in order to achieve the needed amount of topsoil for the reclamation areas. Topsoil over existing gravel deposits will be separated from any subsoil and overburden removed during the stripping process. If topsoil needs to be stored for longer than a month a temporary cover crop should be installed over the storage areas to prevent any erosion from taking place. To generate the needed volume of topsoil for each reclamation area on-site topsoil sources may need to be supplemented with compost or organic materials that will be imported onto the site. This soil mix will provide adequate organic matter and nutrients for the seed mixes and trees to establish within each reclamation area. Topsoil to be placed within each reclamation area will be graded to a minimum of four inches in depth.

Once topsoil is final graded in each reclamation area it will then be tilled to a minimum depth of approximately three inches before any temporary or permanent seeding takes place. The tillage will help improve seed-to-soil contact as well as increase the amount of initial infiltration giving the seeds moisture to begin establishment. Following tillage temporary and permanent seed can be installed.

Any trees to be transplanted as part of on-site reclamation should be moved prior to topsoil placement whenever feasible to minimize any touch-up grading to final grades needed after topsoil has already been placed. Timing of the transplanting of any native trees from Mining Phases 1, 2 and 3 should take place while trees are dormant when possible. The optimum time to transplant trees is prior to active growth in the spring and in the early to late fall once the trees slow down growth for the season. However trees can be moved outside of these optimum times with relatively good success. If trees are moved during the growing season watering will need to be closely monitored and performed as needed to successfully establish each tree.

Surface Hydrology

A stormwater pollution prevention plan (SWPPP) will be implemented for the proposed project in compliance with the NPDES permit. The plan will utilize Best Management Practices (BMPs) to minimize or prevent discharge of stormwater runoff from becoming contaminated or for sediment laden stormwater from being discharged off site. In addition to the SWPPP, erosion and sediment control methods have been developed for the individual phases including post-reclamation as illustrated in the Mining and Reclamation Stormwater Plans C1-C4 by Sunde. The Stormwater Plans depict the evolution of drainage patterns as topography is altered throughout the mining and reclamation phases. As mining progresses, the interior elevation of the site will be reduced, which directs the flow of surface water to the interior of the site. The Stormwater Plans also illustrate the BMPs that will be implemented throughout the life of the project.

The proposed project includes 64 acres, which includes approximately 53 acres that currently drain internally due to past mining operations which have lowered the grade below the elevation of the surrounding land. As a result, runoff generated within the internally drained area is not discharged off-site. About 11 acres within the project limits currently drain off-site.

There are three separate areas within the proposed mining limits that currently drain off-site as indicated in the SWPPP Site Map. Stormwater from each of these three areas drain to a separate spring creek that ultimately discharges into the St. Croix River. The northernmost area encompasses approximately 3.10 acres and is located within Phase 1 Mining. The stormwater flows off-site and drains towards an unnamed creek locally known as Zavoral's Creek. To prevent untreated off-site flow at this location a number of BMPs will be imposed as illustrated in Mining and Reclamation Stormwater Plan Phase 1 Mining. The southernmost drainage area consists of approximately 6.64 acres and is located within Phase 2 Mining. The area drains off-site to the southernmost creek located outside of the property boundary. To prevent untreated off-site flow at this location a number of BMPs will be imposed as illustrated in Mining and Reclamation Stormwater Plan Phase 2 Mining. The central drainage area consists of approximately 1.07 acres and is located in Phase 3 Mining. The stormwater drains off-site to a creek that is also unnamed. To prevent untreated off-site flow at this location a number of BMPs will be imposed as illustrated in Mining and Reclamation Stormwater Plan Phase 3 Mining.

After reclamation of the project the majority of stormwater runoff will be directed towards the interior of the site as illustrated in Mining and Reclamation Stormwater Plan Post-Reclamation. The exception is the northwestern most area of the project. This area will be reclaimed during Phase 2. The removal of the BMPs will not occur until vegetation and soil stability is well established. Until stability of the area is evident, stormwater flow will be diverted to the interior of the site.

Installation of Prairie Seeding Areas

For the vast majority of the reclamation areas seeding will be utilized to establish the dry to mesic prairie matrix. For this project the native seed mix will be placed by broadcasting and/or drilling the seed directly into the topsoil layer.

Seed will be installed with a seed drill that will accurately meter the types of seed to be planted and keep all seeds uniformly mixed during the drilling (Truax type). The drill should contain a minimum of two seed boxes; a fine seed box and a box for large/fluffy seeds, and it should be equipped with disc furrow openers and packer assembly to compact the soil directly over the drill rows. Maximum row spacing should be 8 inches. Small and fine seed should be drop-seeded onto the ground surface from the fine seed box. Large/fluffy seed should be placed to obtain a final planting depth of ¼ to ½ inch. All drill seeding should be done at a right angle to surface drainage.

Seed Mixes

Seed mixes were developed for the Zavoral reclamation project that included a mix for dry prairie and mesic prairie. The dry prairie mix will be used in the majority of open areas within each reclamation phase except for the low depressional areas. Plants that are listed in the dry prairie mix have adapted to growing conditions that range from dry to mesic. Lower depressional areas will be planted with the mesic prairie mix due to the lower points having more available moisture in the soil. Where the two seed mixes come together on-site a transitional zone approximately 150’ wide will have seed from both dry and mesic prairie installed. This seeding technique will create a more natural transition between the dry and mesic prairie communities.

The following are the two types of seed mix to be installed for planting areas of dry prairie and mesic prairie within each of the reclamation areas.

Dry Prairie Mix for dry prairie planting areas

Dry Prairie

	Common Name	Scientific Name	% of Mix
Grasses &	Big Bluestem	*Andropogon gerardii*	10.00
Cover Crops	Oats or Winter wheat*	*Avena sativa or Triticum aestivum*	30.00
	Side-oats Grama	*Bouteloua curtipendula*	5.00
	Nodding Wild Rye	*Elymus canadensis*	5.00
	Junegrass	*Koeleria macrantha*	3.00
	Little Bluestem	*Schizachyrium scoparium*	20.00
	Indian Grass	*Sorghastrum nutans*	15.00
	Prairie Dropseed	*Sporobolus heterolepis*	5.00
		subtotal	**93.00**
Forbs	Blue Giant Hyssop	*Agastache foeniculum*	0.40
	Lead Plant	*Amorpha canescens*	0.30
	Butterfly Milkweed	*Asclepias tuberosa*	0.20
	Canada Milk Vetch	*Astragalus canadensis*	0.20
	Partridge pea	*Chamaecrista fasiculata*	1.65
	Bird's Foot Coreopsis	*Coreopsis palmata*	0.20
	Purple Prairie Clover	*Dalea purpurea*	0.50
	Stiff Sunflower	*Helianthus pauciflorus*	0.20
	Rough Blazingstar	*Liatris aspera*	0.10
	Wild Bergamot	*Monarda fistulosa*	0.20
	Stiff Goldenrod	*Oligoneuron rigidum*	0.35
	Large-Flowered Bead Tongue	*Penstemon grandiflorus*	0.20
	Black-eyed Susan	*Rudbeckia hirta*	1.30
	Gray Goldenrod	*Solidago nemoralis*	0.30
	Heath Aster	*Symphyotrichum ericoides*	0.20
	Smooth Aster	*Symphyotrichum laeve*	0.20
	Hoary Vervain	*Verbena stricta*	0.50
		subtotal	**7.00**
		total	**100.00**

Rate: 14.0 PLS lbs/acre

Notes: *Oats are used in spring & summer and winter wheat in the fall

Mesic Prairie Mix for mesic prairie planting areas

Mesic Prairie

	Common Name	Scientific Name	% of Mix
Grasses &	Bluestem, big	*Andropogon gerardi*	15.00
Cover Crops	Oats or Winter wheat*	*Avena sativa or Triticum aestivum*	32.00
	Wild-rye, Canadian	*Elymus canadensis*	6.00
	Wheat-grass, slender	*Elymus trachycaulus*	6.00
	Rye-grass, annual	*Lolium italicum*	10.00
	Switch grass	*Panicum virgatum*	10.00
	Indian grass	*Sorghastrum nutans*	13.00
		subtotal	**92.00**
Forbs	Milkweed, butterfly	*Asclepias tuberosa*	0.40
	Milkweed, whorled	*Asclepias verticillata*	0.10
	Milkvetch, Canada	*Astragalus canadensis*	0.40
	Partridge pea	*Chamaecrista fasiculata*	1.65
	Prairie clover, purple	*Dalea purpurem*	0.60
	Tick-trefoil, showy	*Desmodium canadense*	0.40
	Sunflower, early	*Heliopsis helianthoides*	0.40
	Blazingstar, rough	*Liatris aspera*	0.40
	Blazingstar, tall	*Liatris pycnostachya*	0.40
	Bergamot, wild	*Monarda fistulosa*	0.20
	Coneflower, grey-headed	*Ratibida pinnata*	0.40
	Black-eyed Susan	*Rudbeckia hirta*	0.40
	Goldenrod, stiff	*Solidago rigida*	0.40
	Heath Aster	*Symphyotrichum ericoides*	0.05
	Smooth Aster	*Symphyotrichum laeve*	0.20
	Spiderwort, Ohio	*Tradescantia ohiensis*	0.40
	Vervain, blue	*Verbena hastata*	0.60
	Vervain, hoary	*Verbena stricta*	0.20
	Alexanders, golden	*Zizea aurea*	0.40
		subtotal	**8.00**
		total	**100.00**

Rate: 14.0 PLS lbs/acre

Notes: *Oats are used in spring & summer and winter wheat in the fall

Seeding Rates for Prairie Matrix

Dry Prairie Areas to be seeded with 14.0 lbs/acre

Mesic Prairie Areas to be seeded with 14.0 lbs/acre

*See graphical planting plan figure for location of dry and mesic prairie planting areas
*Seed mixes are subject to change based on species availability

Timing for Seeding

The optimum time for seeding in a native prairie is from spring to early summer when temperatures become warm enough for germination of warm season grasses and forbs. For warm season plant species to germinate the mean soil temperature needs to be above 65 degrees Fahrenheit. Planting native seed at this time of the year allows the warm season plant species to begin establishing early in the growing season. When seeding in the fall, this same type of seed mix will lie dormant until the following spring when germination takes place.

Reclamation activity will be planned accordingly with the intent to achieve the optimum timeframes for seeding. If final grading does not occur during the optimum seeding time, reclamation areas will be seeded with temporary cover crops until native prairie seeding is appropriate; this will also minimize soil erosion and invasion by weedy species.

Dormant Seeding

When optimum seeding installation cannot be achieved following mining other methods of seeding installation can be utilized if necessary. If a dormant seeding method is used to install seed it is important to note different species are dormant at different times of the year. Dormant seeding for warm-season grasses occurs in early fall as they require 65 °F and above sustained soil temperatures and moisture to germinate. Cool-season grasses will germinate at colder temperatures, a soil temperature at a depth of 1” at or below 40 °F. Cool-season grasses generally germinate in a shorter period of time. Since there are few cool-season grasses specified in the seed mixes developed for the reclamation areas timing of dormant seeding should take place in late fall whenever possible. Many forbs will not germinate at all the first year when seeded in the spring as they require a freeze/thaw period (winter) to germinate. Thus, forbs may not appear until the following spring. Dormant seeding is not as reliable of a method for seed installation due to factors such as weather, snow cover, predation, and soil erosion. However, plantings do appear to contain a greater diversity of cool-season grasses and forbs when installed in the fall.

Temporary Erosion Control

After seeding, mulch may be applied in order to protect and enhance seed germination and to provide temporary erosion control. Since slopes will not exceed 4:1, a clean grain straw or native grass mulch may be applied. Mn/DOT recommends about two tons per acre of straw mulch in order to achieve 90% coverage of an exposed soil surface. If mulch applications are placed too heavily, it can hinder germination or smother new seedlings.

Weed Control

Active weed control within each reclamation area will be an important component to successful prairie seeding establishment. Without any weed control or vegetation management these areas will initially establish as prairie but may not be able to compete over time if aggressive, non-native vegetation also becomes established.

In order to manage weeds on-site following the installation of the seeding areas tasks involving mowing and herbicide treatment will likely be implemented starting the first year after seeding. Weed control should take place within each reclamation area for three full growing seasons following completion of each reclamation area in order to successfully establish the prescribed prairie seeding. As mentioned previously the main haul road for the mine will be constructed and left in active operations during all phases of mining and reclamation. Since the main haul road will bisect Reclamation Area 2, weed control along this traffic corridor will be vital to minimizing the spread of weeds throughout the other areas of reclamation.

In general, weed management for each reclamation area will involve mowing the newly planted areas once or twice a year following planting. This management technique helps minimize annual weed seed production which in turn will reduce the amount of herbicide needed to effectively control persistent problem weeds. In addition to mowing the newly planted reclamation areas, herbicide treatments may be utilized in order to control areas where aggressive, non-native weeds have become well established. Herbicide applications should be applied by a qualified professional herbicide applicator and all instructions on the label should be followed for proper application.

Vegetation Management of Reclamation Areas

Vegetation management that will take place within each of the reclamation areas will be critical to successful establishment of the prescribed plant communities. Once each reclaimed area is planted with permanent vegetation some level of vegetation management, erosion control, and weed management should take place to ensure the establishment of installed seed mixes and trees that were transplanted. Regular maintenance of each reclaimed area should take place for three growing seasons following the initial installation in each phase.

Seeded Prairie Areas

Following the first year of planting and seeding within any of the reclamation areas, site vegetation management will involve mowing twice during the growing season and also utilizing spot herbicide treatments to areas with weedy plants present. Mowing helps reduce weedy annual plants from setting seed and becoming established which can be common early on after a native seeding has been installed. Native plants that emerge after the first full growing season are relatively small in size and are not damaged by regular mowing. Native plants that establish from seed mixes can take 2-4 years before they flower which is why mowing is a very important technique used early on in establishing areas to prairie. Areas that were planted with trees should only be mowed around since mulch will be placed around each tree out to its dripline.

During the second year following planting and seeding of any reclamation area vegetation maintenance will involve mowing of the reclamation area twice and conducting herbicide treatments once or twice depending on the level of weedy species present.

Planted and Transplanted Tree Areas

For the trees that were transplanted into the Phase 1 reclamation area watering should take place once per week during times of little or no rainfall. If rainfall events accumulate to 0.5 to 1 inch of rain in a week then no watering will be needed for the following one week period. If there are extended periods of temperatures above 90 degrees Fahrenheit with little or no rainfall, the trees should be watered twice a week.

All transplanted trees should continue to be watered during the first growing season until late September or into October depending on the temperature. Most trees will be dormant before mid-October and therefore do not need to be watered. All evergreen trees (white pine) should be thoroughly watered at this time, to maintain good moisture levels in the needles to prevent or minimize winter desiccation (browning of the needles). If trees are transplanted in the fall of the year a watering plan should be implemented for the following growing season.

Mulching Transplanted Trees

All trees proposed to be transplanted into the Phase 1 reclamation area should be mulched after being planted. The wood chips generated during development of the mining area can be used as mulch. Mulch should be placed around each tree under its dripline to a depth of 4-6 inches. Wood mulch helps retain water for a longer period of time in the upper level of the soil horizon where the majority of root activity takes place. Mulch also helps moderate the temperature of the soil which is conducive to good root regeneration and growth. In the following three to four years after transplanting, additional mulch may need to be applied once more to ensure that each transplanted tree becomes well established. No additional mulch will be needed around each tree after the second application of mulch, since the native seeding should be established around each tree at this point and will most likely spread to the base of the tree.

Erosion Control

As vegetation germinates and becomes established within each reclamation area monitoring for any soil erosion should be an ongoing task that may require several site visits during each growing season until final soil stabilization occurs. For areas with poor vegetation establishment additional seeding and erosion control measures may need to be installed to prevent any erosion from taking place. Additional erosion control methods are outlined in the SWPPP for the Zavoral site.

Weed Management

Initial weed management for each reclamation area will involve mowing of newly seeded areas as well as herbicide treatment. Mowing should be done once or twice a year for the first two years following seed installation to minimize annual weed seed production. Herbicide treatment of areas with noxious weeds and non-native invasive plants present should be handled as problem plants become established. When treating an area with herbicide the most effective time of the season to treat the plants is typically in mid to late summer as plants are past their flowering stage and can take up chemical herbicides effectively. Continual monitoring for weeds within each reclamation area should follow for up to three years following seeding in order to effectively establish the native seed mixes.

Year One Maintenance of Reclamation Areas

Conduct a complete mowing of all seeded areas in June. Mow seeded areas to a height of 5-6 inches.

Conduct a second complete mowing in August. Mow planted areas to a height of 6-10 inches depending on native seedling height.

Spot spray problem weed species including Canada thistle, spotted knapweed and other problem plants using an appropriate herbicide following label directions.

Complete two spot herbicide applications as needed during the first growing season following in any seeded areas.

Year Two Maintenance of Reclamation Areas

Conduct a complete mowing of all seeded areas in June. Mow planted areas to a height of 6-10 inches depending on native seedling height.

Conduct a second complete mowing in August, if necessary. If weeds are under control conduct spot mowing in problem areas. Mow planted areas to a height of 6-10 inches.

Complete one to two herbicide applications as needed to control problem species. Use an appropriate herbicide and follow label directions.

Year Three Maintenance of Reclamation Areas

Conduct one spot mowing (if needed) or problem areas just before weed species set seed. Mow to a height of 6-10 inches.

Conduct one spot herbicide application (if needed) to problem species just before weed species flower. Use appropriate herbicides and follow label directions.

Construct burn breaks in October.

Conduct a prescribed burn of all areas seeded with prairie mix, avoid areas planted with white pine and other thin bark trees. Burn should occur between November and December if possible, before snow cover for the season.

Planting should begin to look like a prairie with grasses and flowers close to full size with some plants blooming for the first time.

Native species density should average approximately one seedling per square foot.

Prairie Performance Monitoring

Once a reclamation area has been planted with permanent vegetation annual monitoring should take place to assess the level of establishment for up to three full growing seasons following the initial installation. The following are general guidelines used to measure the level of establishment for areas planted with native seed. If guidelines are met from year to year establishment of plant communities like the dry and mesic prairies being proposed for the Zavoral site should be accomplished within 3 years. When guidelines are not met each year, additional seeding may occur as well as mowing and herbicide treatments. Typically each year the planting should have an increased number of species present from the seed mix.

Year 1 Monitoring

This section applies to the first full growing season after plant establishment. For areas planted in the fall it is the following growing season and for spring plantings it is the current growing season. Cover species for the dry and mesic prairie areas should be present over the entire site by the end of the growing season. Example species are oats (*Avena sativa*), winter wheat (*Triticum aestivum*), ReGreenTM (slender wheat-grass x winter wheat hybrid), and annual rye grass (*Lolium italicum*). Refer to the seed mixes installed for which species may be present during the first growing season.

Prairie Vegetation: Seedlings of at least 3 native grasses and 3 native forbs should be widely dispersed through the seeded area. Example prairie grass species are slender wheat grass (*Elymus trachycaulus*), Canada wild-rye (*Elymus canadensis*), big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*). Example forb species are black-eyed Susan's (*Rudbeckia hirta*), partridge pea (*Chamaecrista fasciculata*), blue vervain (*Verbena hastata*), hoary vervain (*Verbena stricta*), early sunflower (*Heliopsis helianthoides*), and bergamot (*Monarda fistulosa*). All of the species noted above will be present as seedlings and probably won't flower the first year except for partridge pea and black-eyed Susan's. Grass seedlings may be hard to pick out if the cover crops have put on a lot of growth. They will normally be 2-6 inches tall whereas the cover crops may be 1-2 feet tall.

Year 2 Monitoring

Prairie Vegetation: Prairie sites will generally be dominated by cool-season native grasses such as wild-ryes and wheat-grasses. Warm-season grasses will be present but may still be small in stature and scattered throughout the site. Several of the forbs from Year 1 should be blooming in Year 2.

Year 3 Monitoring

Prairie Vegetation: Year 3 is a transitional year for prairie plantings. There is almost always a visible transition from cool-season grasses (Canada wild-rye and slender wheat grass) to warm-season grasses (big bluestem, Indian grass, little bluestem, etc.). By later years, prairie plantings should be dominated by warm-season grasses and late successional forbs. Cool-season grasses will be nearly gone from the site. However, they may persist in wet depressions, or on north facing slopes or in partial shade. Annual (partridge pea) and biennial (black-eyed Susan's) forbs will also tend to fade out and be replaced by later successional forbs. Wetness, shading, aspect and temperature will tend to delay transitions.

Photo Examples of Dry and Mesic Prairies

Example 1: Dry Prairie

Example 2: Mesic Prairie

Phasing and Timing of Mining Operations and Reclamation

Timing for reclamation activity will be completed during four phases that will take place concurrently with mining operations and following the end of each mining phase. Based on project information mining operations will take place during three phases. As each mining phase is completed reclamation activity will then follow in a timely manner to re-establish temporary and permanent vegetation and to stabilize slopes.

The timeframe for mining activity is based on three alternatives. Alternative 1 proposes a project duration up to 10 years, with 6 to 12 weeks of mining operations per year, and an average of 3.33 to 1.67 years per phase respectively. Alternative 2 proposes a no-build therefore the proposed project area would remain unreclaimed. Alternative 3 proposes a project duration up to 5 years, with 12 to 18 weeks of mining operations per year, and an average of 1.67 to 1.1 years per phase respectively.

Annual inspections will occur each mining season.

Mining and Reclamation Phase 1

Mining Phase 1 = 23 acres Reclamation Phase 1 = 4 acres

Mining Phase 1 will be stripped and mined concurrently with Reclamation Phase 1.

Maximum active and open areas during Mining and Reclamation Phase 1 = 27 acres

Timing for the reclamation in Phase 1 is two weeks. The Phase 1 reclamation area includes an area approximately four acres in size and is located within the St. Croix River District and U.S.A. Scenic Easement. Sand and gravel operations are not planned for this area but will instead be reclaimed during the first phase of reclamation. Reclamation of this area will involve the removal of existing stockpiles and then final grading the area. Slopes within the Phase 1 area will be a maximum of 4:1 as depicted in the final mining and reclamation plan by Sunde. Once final grading with topsoil is complete for the Phase 1 Reclamation Area, trees will be transplanted into the area followed by seeding the area with a native seed mix described above. If required, watering of the transplanted trees will continue for the rest of the season after trees have been moved.

Mining and Reclamation Phase 2

Mining Phase 2 = 17 acres Reclamation Phase 2 = 23 acres

Mining Phase 2 will be stripped and mined concurrently with Reclamation Phase 2.

Reclamation Phase 1 will be vegetated by the start of Mining Phase 2.

Maximum active and open Mining and Reclamation Phase 2 = 40 acres

Timing for the reclamation in Phase 2 is eleven weeks. The Phase 2 reclamation area is located in the northwest part of the proposed project and after mining is completed in this area final grading with a minimum of 4” of topsoil will take place before temporary and permanent seed is installed to stabilize the soil. The main haul road located in Phase 2 Reclamation will remain active in order to access Mining and Reclamation Phases 2, 3 and 4.

Mining and Reclamation Phase 3

Mining Phase 3 = 21 acres Reclamation Phase 3 = 17 acres

Mining Phase 3 will be stripped and mined concurrently with Reclamation Phase 3.

Reclamation Phase 2 will be vegetated by the start of Mining Phase 3.

Maximum active and open Mining and Reclamation Phase 3 = 38 acres

Timing for the reclamation in Phase 3 is eight weeks.

Reclamation Phase 4

Reclamation Phase 4 will commence once Mining Phase 3 has been completed. Reclamation Phase 3 will be vegetated by the start of Reclamation Phase 4.

Maximum open area Reclamation Phase 4 = 21 acres

Timing for the reclamation in Phase 4 is nine weeks.

Relation to Adjacent Land Uses and Surrounding Drainage Features

The final site condition will be similar in nature to surrounding landforms characterized by gently sloping fields and steeper sloping bluff areas. For reclamation areas that border the forested bluffs native coniferous trees will be planted to create a natural transition between the existing forested landscape and the newly planted reclamation areas. This transition area will be created along the north and eastern side of Reclamation Phases 1, 3 and 4 with the intent of establishing similar tree species that are found within the adjacent forest systems. This transition zone will allow existing tree species found along the forested bluffs to seed into the reclamation areas and contribute to the overall species composition over time.

For reclamation areas that border agricultural fields to the southwest and to the north of the Zavoral site the transition will be from gently sloping agricultural fields to native dry and mesic prairie. Screening berms that occur along the southwest and west perimeters of the site may be removed in order to create a gradual transition between adjacent land uses. In addition, native vegetation in the screening areas may remain post-reclamation to provide screening and contribute aesthetically to the site.

Established drainage ways occur along the bluffs east of the proposed mining limits that convey stormwater runoff down through the bluffs to the St. Croix River. There will be a rise on the order of 1-6 feet from the base of the reclamation area to the eastern edge of the mining limits which will allow the site to remain internally drained after reclamation. The post-reclamation drainage patterns will therefore not contribute to erosion of the steeper slopes of the existing bluff area.

To the north of the proposed mining limits, a man-made drainage ditch for multiple sources of stormwater runoff, including agricultural and roadway drainage, begins near State Highway 95, continues east and ultimately discharges to the St. Croix River. The majority of post-reclamation areas within the site will remain internally drained, a condition that was established from past mining activity and will not impact the function of the existing drainage ways. The exception is the northwestern most area of the site. This area will be reclaimed during Phase 2. The removal of the BMPs will not occur until vegetation and soil stability is well established. Until stability of the area is evident, stormwater flow will be diverted to the interior of the site.

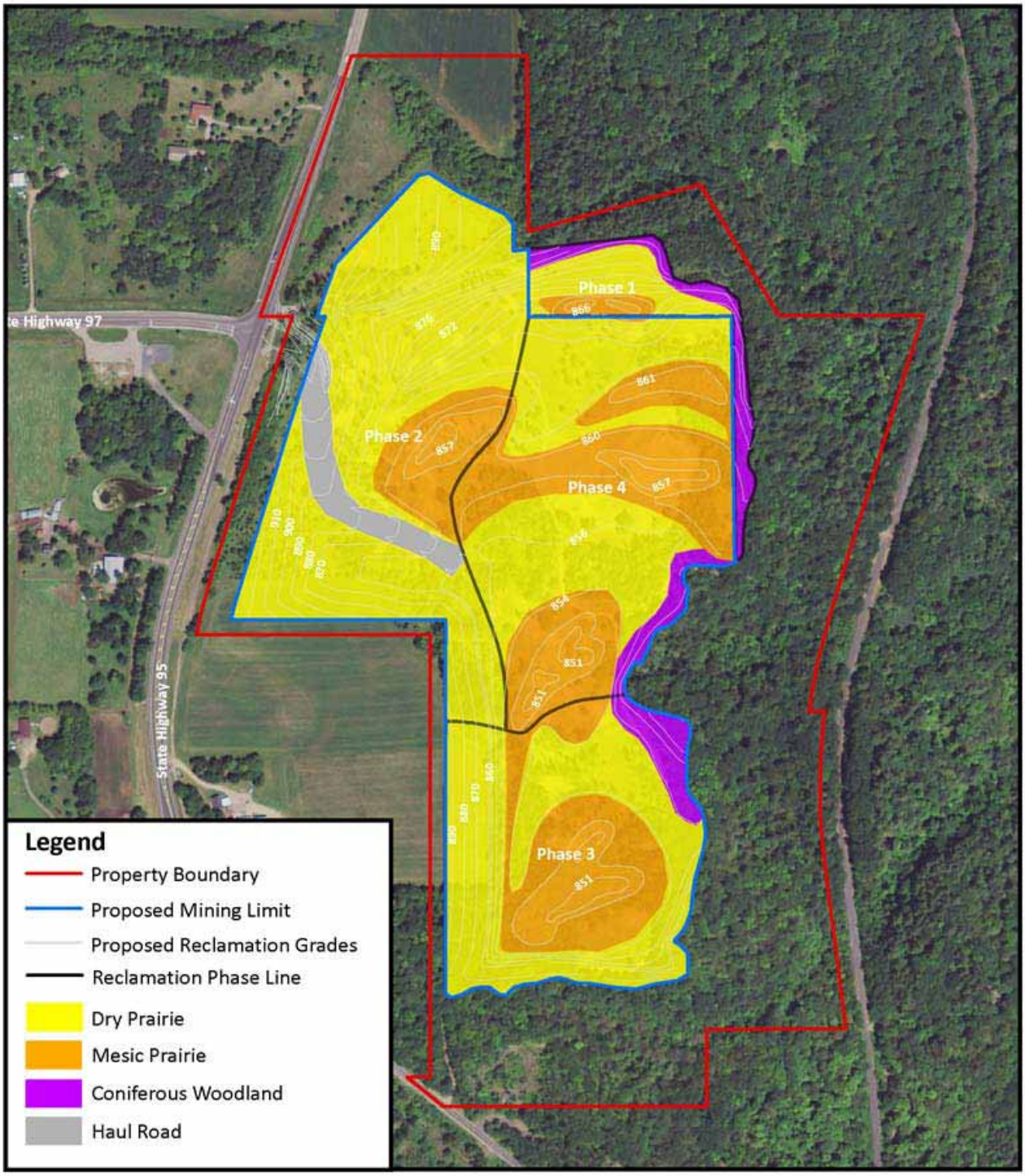
Final condition of site, including proposed contours and landscaping

Once mining and reclamation is complete for the Zavoral site the landscape will be left in a self-sustaining condition that meets or exceeds the requirements consistent with current local land use rules regulating sand and gravel mining reclamation (**Figure 5**). The site will have vegetation re-established that will provide stable soil conditions for future land uses. The 64 acre site will be covered by areas of native-dominated dry prairie, mesic prairie and coniferous woodland.

Final grading of the site will result in contours that conform to the City of Scandia's Reclamation standards contained in Section 8 of Chapter 4 of the Development Code Mining and Related Activities Regulations. The western portion of the site will slope from the existing grade along the State Highway 95 right-of-way down to the finished floor of the mining area. In this area, slopes will not exceed 4:1 in accordance with City regulations. The slopes of the bluff east of the site are typically steeper than this ranging from approximately 1:1 to 3:1. The slopes along the northern portion of the proposed mining limits will fan out to meet the existing slope along the northern portion of the property which gradually drops in elevation from approximately 910 feet above mean sea level to approximately 870 feet above mean sea level. The floor of the mining area will be graded to achieve a gently rolling landscape. There will be six (6) created depressions located throughout the proposed reclamation areas. These created depressions have a depth from 0.5 feet to 1.5 feet and range in size from approximately 20,000 sq.ft. to 75,000 sq.ft. These created depressions are not designed to allow stormwater to collect and stagnate or to convert to a wetland type environment, but rather to encourage infiltration, add visual interest and develop some ecological diversity. Each depression will be planted with a native seed mix that will establish as a mesic to wet prairie plant community and will include species that tolerate a wider range of moisture levels than the dry prairie species.

The floor of the mining area will be at an elevation that is similar to the elevation of the top of the bluff along the eastern boundary of the property. Establishing the final grades of the floor of the mining operation will eliminate the appearance of a bowl shaped reclamation landform. Instead, there will be a slight rise from the floor of the mining operation to the eastern edge of the mining limits. This rise will be on the order of 1-6 feet and will allow the site to remain internally drained after reclamation. The post-reclamation drainage patterns will therefore not contribute to erosion of the steeper slopes of the existing bluff area.

Essentially from west to east across the site there will be a downward slope of approximately 40 feet with a gently sloped and undulating floor within the mining area which meets the top of the existing bluff sloping down towards the St. Croix River. An access road will remain which will break up the slope in the northwestern portion of the site.



Zavoral Property

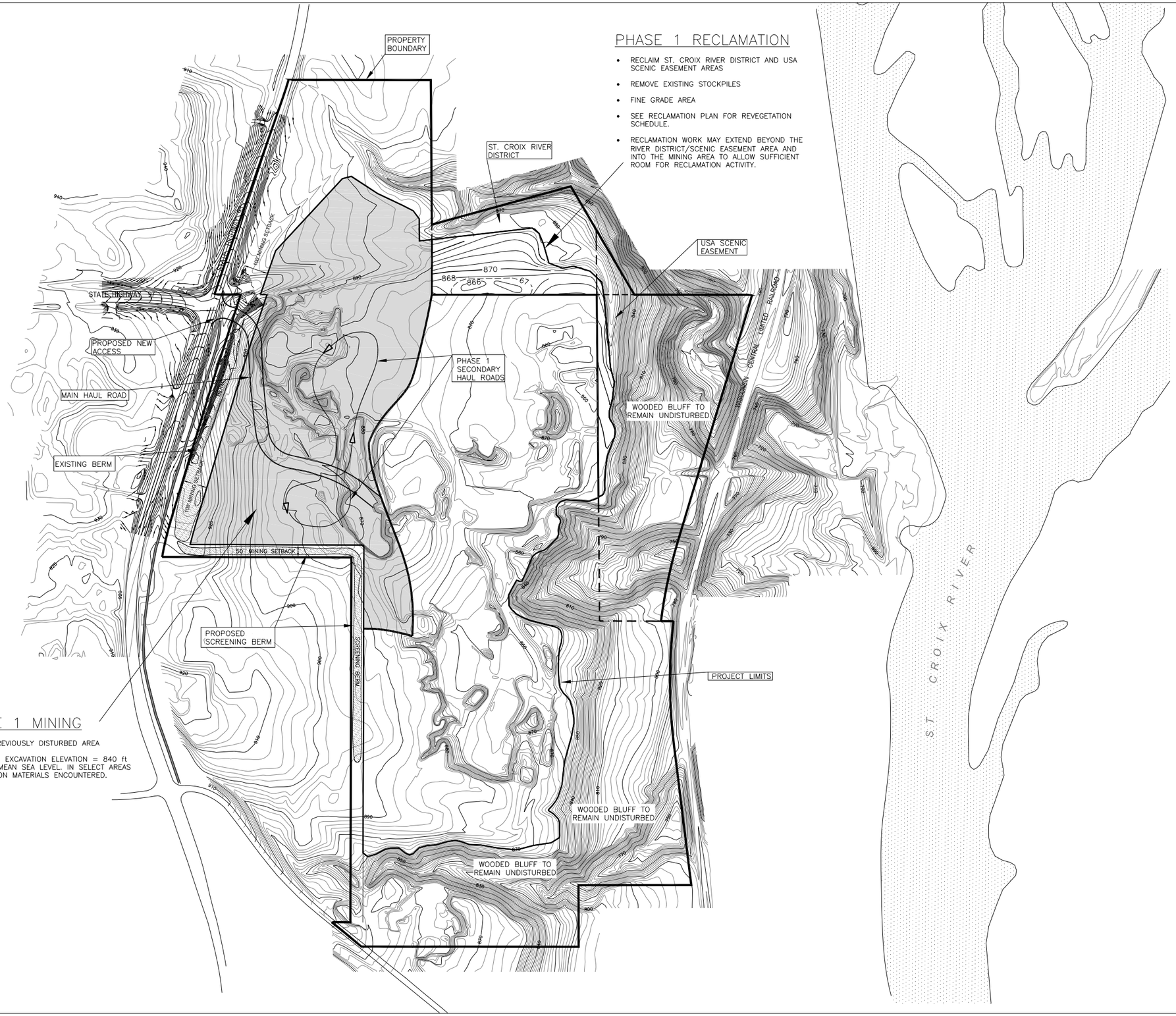
Zavoral Reclamation Final Conditions Map

0 125 250 500 750 1,000 Feet

NORTH

Critical Connections Ecological Services, Inc.

Figure 5



PHASE 1 RECLAMATION

- RECLAIM ST. CROIX RIVER DISTRICT AND USA SCENIC EASEMENT AREAS
- REMOVE EXISTING STOCKPILES
- FINE GRADE AREA
- SEE RECLAMATION PLAN FOR REVEGETATION SCHEDULE.
- RECLAMATION WORK MAY EXTEND BEYOND THE RIVER DISTRICT/SCENIC EASEMENT AREA AND INTO THE MINING AREA TO ALLOW SUFFICIENT ROOM FOR RECLAMATION ACTIVITY.

PHASE 1 MINING

- MINE PREVIOUSLY DISTURBED AREA
- MINIMUM EXCAVATION ELEVATION = 840 ft ABOVE MEAN SEA LEVEL. IN SELECT AREAS BASED ON MATERIALS ENCOUNTERED.

NOTES:

1. TOPOGRAPHY FROM WASHINGTON COUNTY. AERIAL PHOTOGRAPHY FROM APRIL 2000.
2. GRADES REPRESENT PROPOSED MINIMUM RESTORATION GRADES.
3. SETBACKS ARE AS FOLLOWS:
   50' FROM PROPERTY LINE
   100' FROM ROAD RIGHT-OF-WAY.
   MINING AND RECLAMATION GRADING MAY OCCUR WITHIN 50' OF THE ROAD RIGHT-OF-WAY IF COMPLETED WITHIN ONE MINING SEASON.
4. MINING ACTIVITY WILL FOLLOW THE GENERAL PROGRESSION INDICATED ON THIS SERIES OF PLANS.
5. DEPTH OF MINING TO VARY THROUGHOUT THE SITE AND WILL DEPEND UPON THE QUALITY OF MATERIAL ENCOUNTERED. MAXIMUM EXCAVATION DEPTH WILL BE TO A MINIMUM ELEVATION OF 840 FEET ABOVE MEAN SEA LEVEL
6. THE MINING AREA WILL BE RECLAIMED TO APPROXIMATE GRADES ILLUSTRATED ON THIS PLAN. GRADES ILLUSTRATED REPRESENT A MINIMUM RECLAMATION ELEVATION. SLOPES WILL BE GRADED TO A MAXIMUM OF 4:1. SPECIFICS OF THE PLANTING AND REVEGETATION PLAN ARE DETAILED IN THE RECLAMATION PLAN.
7. SEQUENCING:
   1) CONSTRUCT HAUL ROAD.
   2) REMOVE EXISTING TREES
   3) CONSTRUCT NEW SCREENING BERMS AS INDICATED ON PLANS.
   4) BEGIN PHASE 1 RECLAMATION
   5) PROCEED WITH MINING, PHASES 1-3.

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TILLER CORPORATION

ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

DATE	REVISION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

Kirsten Pauly

Kirsten Pauly

DATE: 12/22/10 REG. NO.: 21842

INFORMATION:

PROJECT NO.: 02-626
DRAWN BY: NM
CHECKED BY: KP
APPROVED BY: KP
SCALE: Graphic
DATE: 12/22/10

DESCRIPTION:

MINING AND RECLAMATION PHASING

SHEET NO:

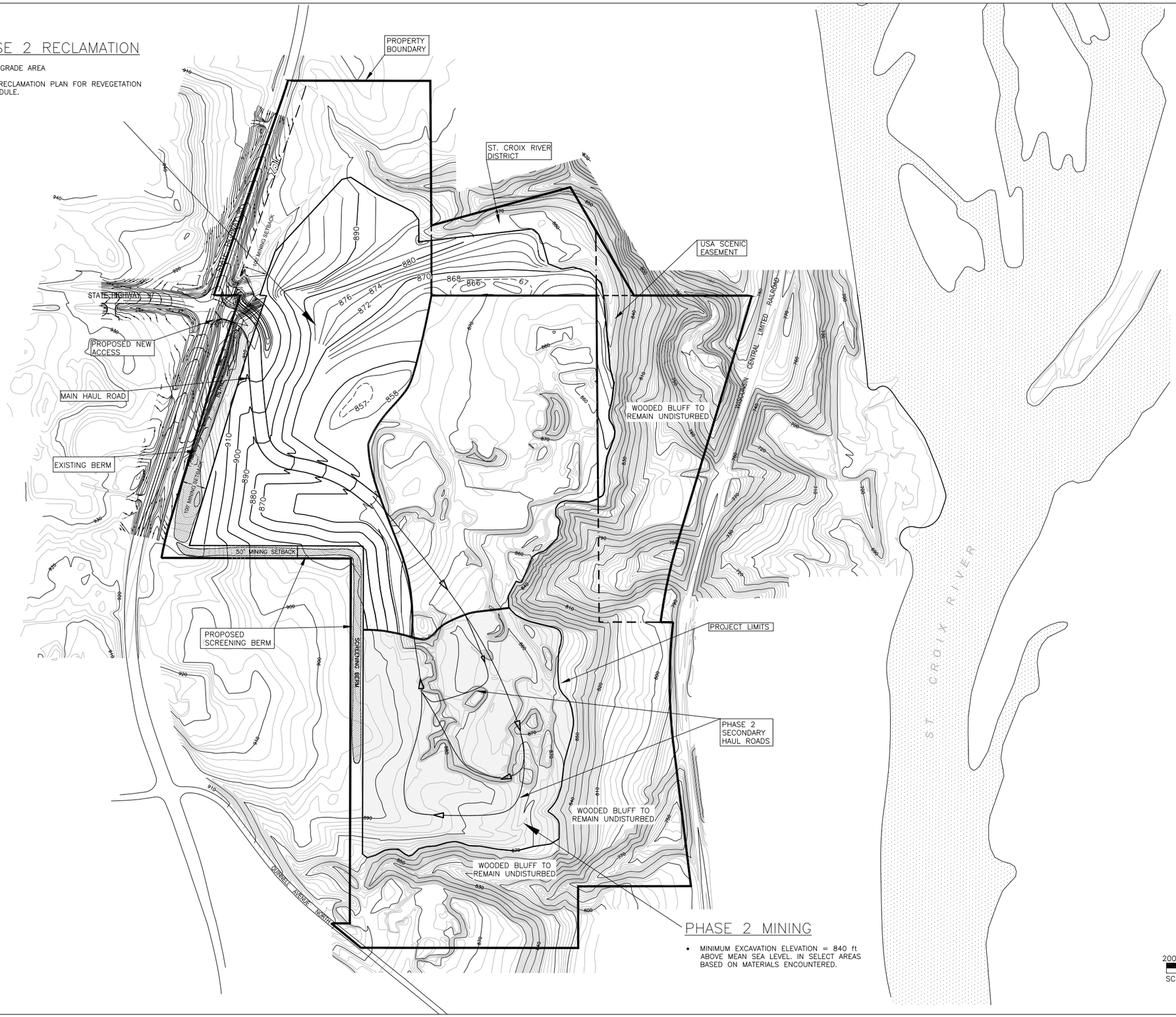
C1

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01\Phase 1 Mining Plan.dwg LAYOUT: Phase 1 Mining Plan

PHASE 2 RECLAMATION

- FINE GRADE AREA
- SEE RECLAMATION PLAN FOR REVEGETATION SCHEDULE.



PHASE 2 MINING

- MINIMUM EXCAVATION ELEVATION = 840 ft ABOVE MEAN SEA LEVEL. IN SELECT AREAS BASED ON MATERIALS ENCOUNTERED.

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TILLER CORPORATION

ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

DATE	REVISION
1/17/11	Phase 2 Reclamation Notes

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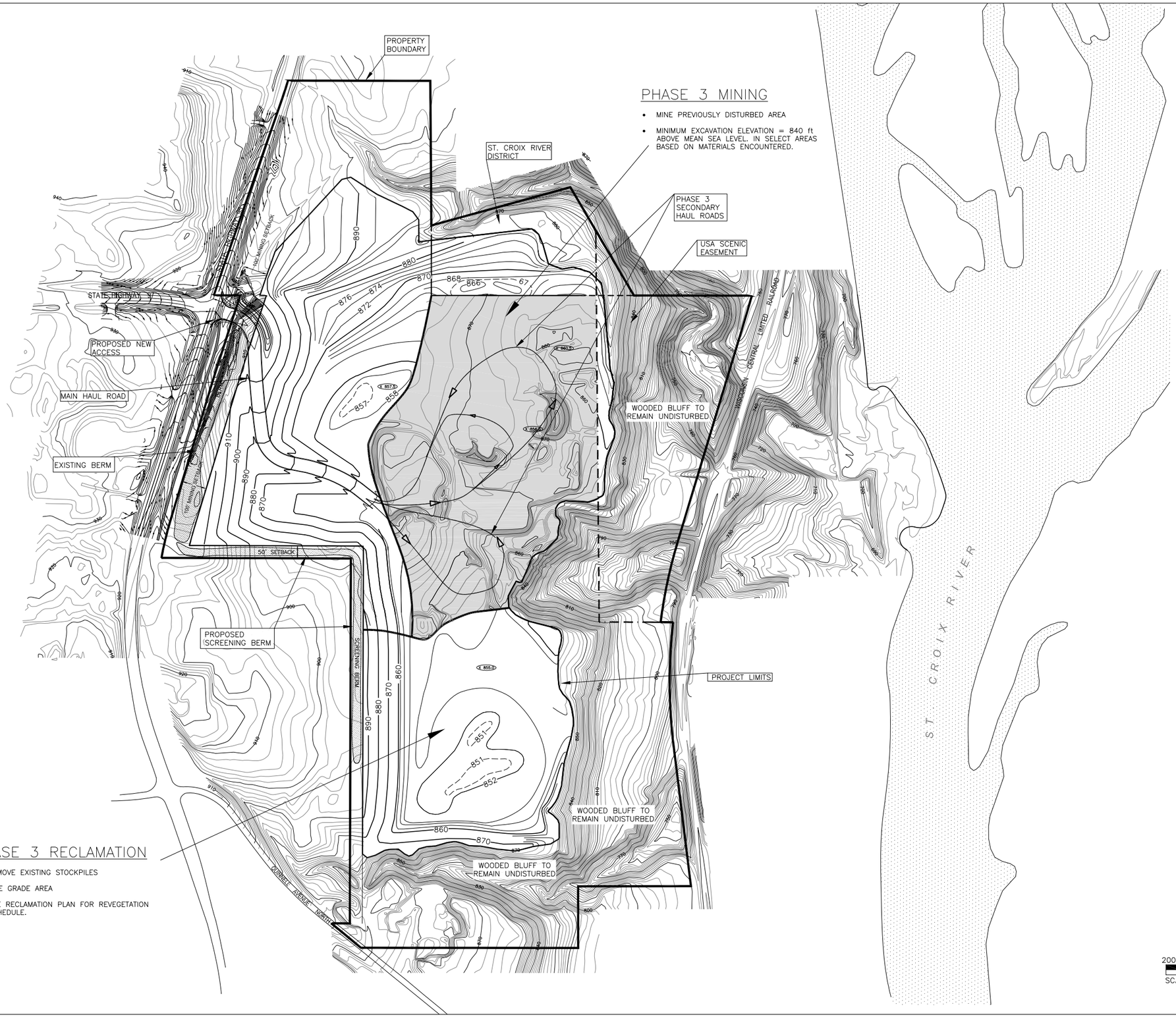
MINING AND RECLAMATION PHASING

SHEET NO:

C2

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01 submited to share site\Phase 2 Mining Plan C2 - Revised 1-17-11.dwg LAYOUT: Phase 2 Mining Plan



PHASE 3 MINING

- MINE PREVIOUSLY DISTURBED AREA
- MINIMUM EXCAVATION ELEVATION = 840 ft ABOVE MEAN SEA LEVEL. IN SELECT AREAS BASED ON MATERIALS ENCOUNTERED.

PHASE 3 RECLAMATION

- REMOVE EXISTING STOCKPILES
- FINE GRADE AREA
- SEE RECLAMATION PLAN FOR REVEGETATION SCHEDULE.

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SCANDIA, MINNESOTA

DATE	REVISION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

Kirsten Pauly

Kirsten Pauly

DATE: 12/22/10 REG. NO.: 21842

INFORMATION:

PROJECT NO.: 02-626

DRAWN BY: NM

CHECKED BY: KP

APPROVED BY: KP

SCALE: Graphic

DATE: 12/22/2010

DESCRIPTION:

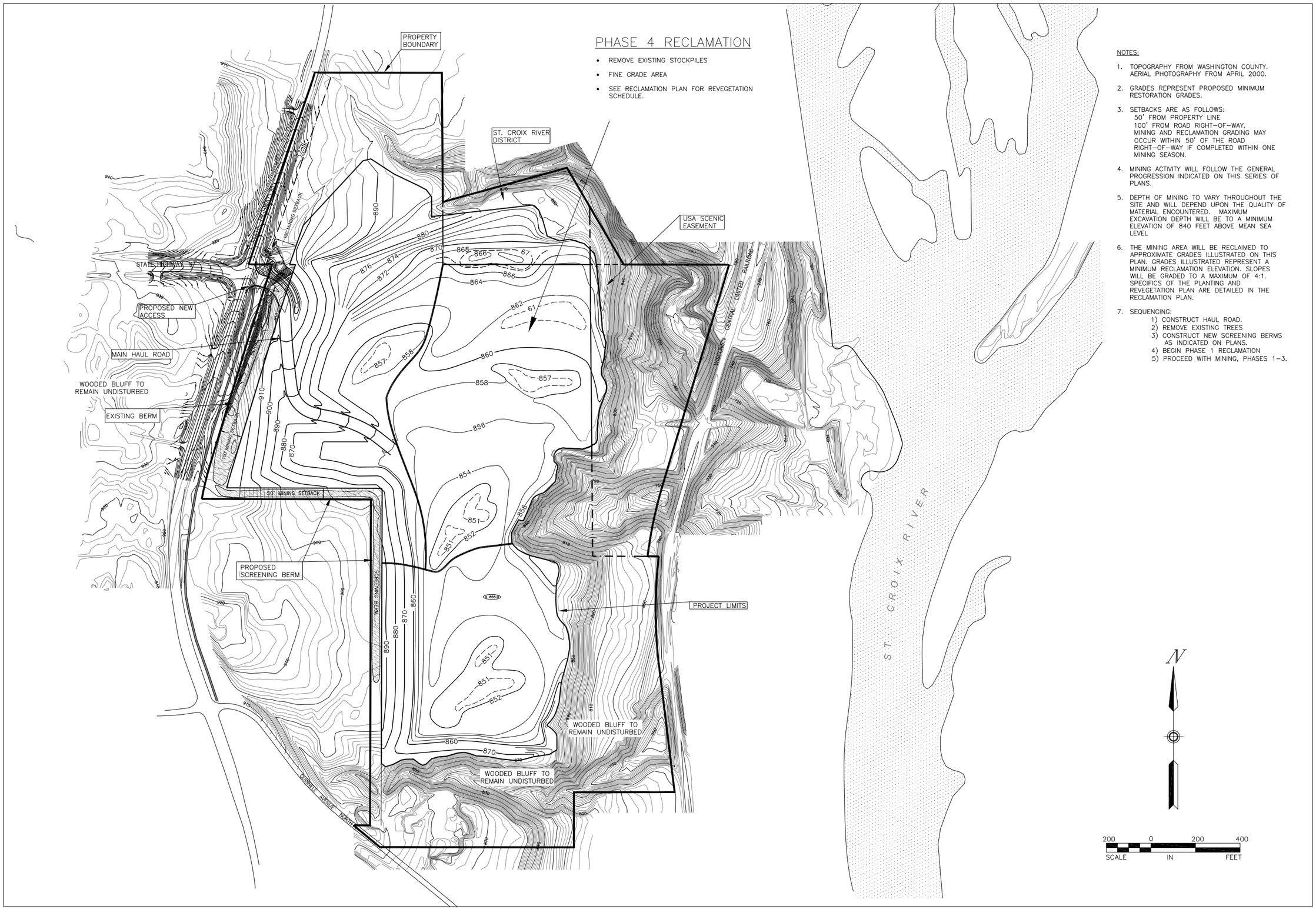
MINING AND RECLAMATION PHASING

SHEET NO:

C3

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01\Phase 3 Mining Plan.dwg LAYOUT: Phase 3 Mining Plan



NOTES:

1. TOPOGRAPHY FROM WASHINGTON COUNTY. AERIAL PHOTOGRAPHY FROM APRIL 2000.
2. GRADES REPRESENT PROPOSED MINIMUM RESTORATION GRADES.
3. SETBACKS ARE AS FOLLOWS:
   50' FROM PROPERTY LINE
   100' FROM ROAD RIGHT-OF-WAY.
   MINING AND RECLAMATION GRADING MAY OCCUR WITHIN 50' OF THE ROAD RIGHT-OF-WAY IF COMPLETED WITHIN ONE MINING SEASON.
4. MINING ACTIVITY WILL FOLLOW THE GENERAL PROGRESSION INDICATED ON THIS SERIES OF PLANS.
5. DEPTH OF MINING TO VARY THROUGHOUT THE SITE AND WILL DEPEND UPON THE QUALITY OF MATERIAL ENCOUNTERED. MAXIMUM EXCAVATION DEPTH WILL BE TO A MINIMUM ELEVATION OF 840 FEET ABOVE MEAN SEA LEVEL
6. THE MINING AREA WILL BE RECLAIMED TO APPROXIMATE GRADES ILLUSTRATED ON THIS PLAN. GRADES ILLUSTRATED REPRESENT A MINIMUM RECLAMATION ELEVATION. SLOPES WILL BE GRADED TO A MAXIMUM OF 4:1. SPECIFICS OF THE PLANTING AND REVEGETATION PLAN ARE DETAILED IN THE RECLAMATION PLAN.
7. SEQUENCING:
   1) CONSTRUCT HAUL ROAD.
   2) REMOVE EXISTING TREES
   3) CONSTRUCT NEW SCREENING BERMS AS INDICATED ON PLANS.
   4) BEGIN PHASE 1 RECLAMATION
   5) PROCEED WITH MINING, PHASES 1-3.

Sunde Engineering, PLLC.
CONSULTING CIVIL ENGINEERS
10830 NESBITT AVENUE SOUTH
BLOOMINGTON, MINNESOTA 55437
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TILLER CORPORATION

ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

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SCALE: Graphic

DATE: 12/22/10

DESCRIPTION:

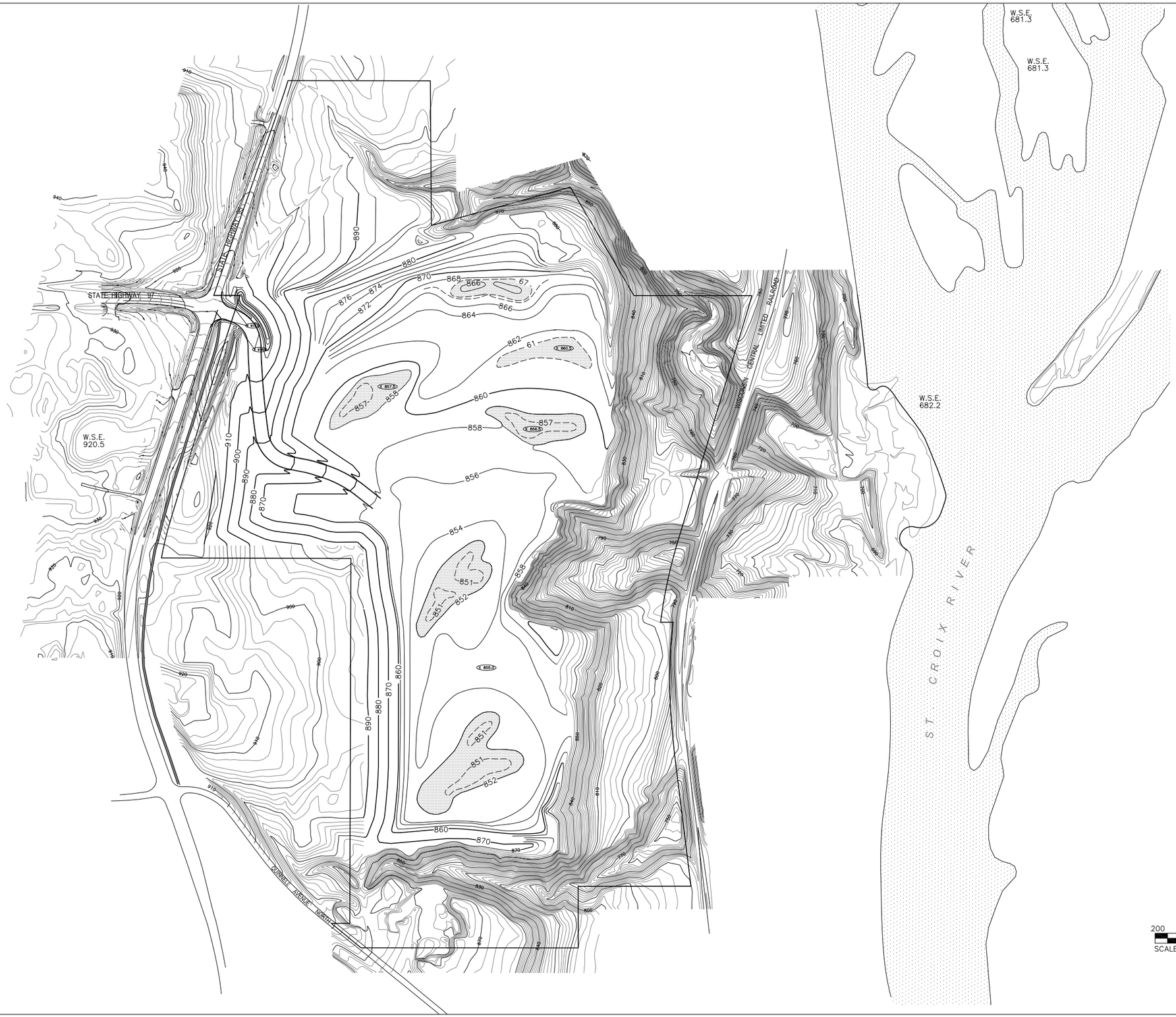
MINING AND RECLAMATION PHASING

SHEET NO:

C4

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01\Phase 4 Mining Plan.dwg LAYOUT: Phase 4 Mining Plan



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7. SCREENING BERMS MAY BE REMOVED AS PART OF FINAL RECLAMATION ACTIVITY.

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ZAVORAL MINING AND RECLAMATION PROJECT

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DATE: 12/22/10

DESCRIPTION:

RECLAMATION GRADES

SHEET NO:

C5

of

Zavoral Reclamation Plan
Topsoil and Prairie Establishment Memorandum
October 3, 2011

Executive Summary:

As part of the reclamation plan for the proposed Zavoral Mine in Scandia, Minnesota, Critical Connections Ecological Services, Inc. (CCES) has proposed native vegetation reclamation that establishes a native dry prairie plant community within the sandy soils that will remain post-mining. Part of the original reclamation plan proposed the establishment of native dry prairie vegetation within the relatively sterile and weed-free sandy soils that will remain post-mining.

The City ordinance requires that the Site is surfaced with a minimum of four inches of topsoil of a quality at least equal to that of the surrounding areas. Much of the topsoil and overburden materials have been removed from the Site during previous mining activity. An area of approximately eight acres that has not previously been mined, as well as a few remaining piles of organic-rich material will be stockpiled and utilized for topsoil during reclamation activities. Any additional topsoil required to complete the reclamation will be of a quality at least equal to that of the surrounding areas and will be imported to the Site from various local sources.

Stockpiled and/or imported topsoil(s) of multiple sources may not be suitable for native dry prairie re-establishment, will not be sterile, and will likely contain agricultural and noxious weed seed banks. Therefore, a vegetation reclamation approach that is based on the assumption of four to six inches of existing topsoil and/or imported topsoil from various sources will have lower diversity and ecological integrity goals and will be held to a lower performance standard. On the contrary, a vegetation reclamation approach that is based on the assumption of an engineered soil, that is a blend of sandy soils and imported sterile organic soil amendments, will be suitable for moderate diversity native dry prairie establishment, will be more readily and cost-effectively managed, will have higher species diversity goals and will be held to a higher performance standard.

The following are two summarized native prairie reclamation approaches for the proposed Zavoral Mine reclamation areas. Prairie Reclamation Approach 1 is the native prairie re-vegetation approach that is proposed in the original Zavoral Mine Reclamation Plan (May 3, 2011). Prairie Reclamation Approach 2 is an alternative approach that meets the City reclamation and re-vegetation standards, adheres to City ordinances for required topsoil thickness, and takes into account comments from City staff since the submittal of the Reclamation Plan on May 3, 2011.

For the purposes of this narrative, “Topsoil” is defined as per Scandia City Ordinance 103, Section 4.1, Definition (19): <u>Topsoil.</u> That portion of the overburden which lies within the "A" and "B" horizon of soil closest to the surface and which supports the growth of vegetation. Note that this definition of topsoil does not include specifications or requirements for size, organic content, pH, or soil type as found in the Minnesota Department of Transportation’s topsoil specifications.

Proposed Native Prairie Reclamation Approaches:

I. Prairie Reclamation Approach 1:

This approach focuses on reclamation of native dry prairie vegetation within an engineered topsoil consisting of sandy subsoil with added soil amendments. This method capitalizes on the relatively sterile and noxious weed-free soil conditions that will exist post-mining. Weed-free organic soil amendments are imported from a controlled location and mixed with sterile sandy soils on-site to create topsoil that is suitable for native dry prairie seedling establishment but nutrient-poor to a degree that will inhibit the growth of the most potentially problematic noxious weed species. Direct broadcast native seeding is performed following topsoil establishment. Vegetation establishment monitoring, native species inter-seeding, and weed management are conducted as needed to meet diversity performance standards that shall be consistent with moderate quality, naturally-occurring dry prairie plant community on sand-gravel soils in the St. Croix River Valley.

a. Topsoil Requirements for Approach 1:

The preferred type of topsoil to be used for reclamation (for the establishment of dry and mesic prairie) is engineered topsoil that blends sands and soil amendments together. Soil amendments will likely be imported from Plaisted Companies, Inc.[1] and mixed with sterile sand and gravel on-site to create topsoil that is suitable for native dry and mesic prairie seedling establishment but nutrient-poor enough to minimize the growth of most potentially problematic noxious weed species. At a minimum, 4" of the engineered topsoil will be placed over the reclamation area prior to seeding of native dry and mesic prairie.

To generate the volume of topsoil needed for reclamation, a mix of approximately 80% sands and 20% MnDOT Grade 2 Compost will be used. By utilizing 20% compost with 30% organic matter, the blended topsoil will yield a 6% organic matter content across the whole site. The MnDOT specification for Topsoil Borrow and Select Topsoil Borrow is 3% - 20%. MnDOT Grade 2 Compost is a humus rich material that is derived from the decomposition of leaves and yard wastes. No animal or poultry manure is utilized in this type of compost. The texture of the compost is to be similar to shredded peat and should meet the following requirements.

[1] Plaisted Companies Incorporated is located at 11555 205th Ave. NW, Elk River, MN 55330. The company specializes in the production of engineered soils. Engineered soils from Plaisted have been successfully implemented for infiltration features at the Tii Gavo conservation development in Scandia.

	Min	Max
Organic Matter Content	30%	---
Carbon/Nitrogen Ratio	6:1	20:1
pH	5.5	8.5
Moisture Content	35%	55%
Bulk Density lbs/cu.yd.	700	1500
Soluble Salts (mmhos/cm)	10 maximum	

As an alternative to the MnDOT Grade 2 Compost, peat moss may be used as a soil amendment to achieve the desired organic matter content (3%-20%) within the reclamation material. According to the MnDOT specification, the peat moss shall be of the hypnum, sphagnum, or reed sedge types as defined in ASTM D 2607. The peat moss shall be a processed product reasonably free of wood and other extraneous matter and shall contain no weed seed or bacterium that may affect plant growth. The peat moss shall be uniform throughout, meeting the following requirements.

	Min	Max
Moisture Content, % by mass	25	70
Ash Content, % by mass	----	25
pH	3.0	7.5
Fiber Content, %	33	----

This engineered topsoil will provide the adequate amount of organic matter for establishment of dry and mesic prairie but will not be so nutrient rich as to favor or encourage problematic weeds. Soils rich in nutrients favor weedy growth which can limit the success of prairie establishment and increase the costs involving weed management. This type of engineered topsoil used for reclamation will provide a planting medium that will allow a moderate diversity of dry and mesic prairie species to establish. By utilizing topsoil that is not rich in nutrients, weed management may be minimized as compared to using naturally occurring topsoil from sources that may not be as weed-free.

Prior to the placement of the engineered topsoil, slopes will be graded and back-filled to the approximate reclamation grades. Final preparation will include scarifying, mixing, and compacting the top six inches of the subgrade.

II. Prairie Reclamation Approach 2:

This approach closely follows the City's mining reclamation ordinance. Under this approach, Tiller Corporation shall stockpile the limited remaining native topsoil located within proposed mining areas (approximately 8 acres), and shall import additional topsoil of at least equal quality from various other local sources. This reclamation approach would meet the City's required four inches of topsoil, at a minimum, and

would average six inches of topsoil throughout the reclaimed prairie areas to satisfy the City staff's recommendations. Following establishment of topsoil within reclaimed areas, a simplified native mesic prairie species mix shall be broadcasted and worked into the topsoil. The simplified native mesic prairie mix will achieve the City's minimum quality and vegetation diversity requirements and will provide coverage of native prairie graminoids and forbs to provide an improved habitat condition, suppress weed establishment, and facilitate cost-effective vegetation management in the short and long terms. Vegetation establishment monitoring, native species inter-seeding, and weed management shall be conducted as needed to meet or exceed the minimum vegetation performance standards that are consistent with City ordinance for reclaimed mining areas.

a. Topsoil Requirements for Approach 2:

The alternative to utilizing engineered soil for reclamation (establishment of dry and mesic prairie) is to import natural topsoil from local sources. This method closely follows the City's mining reclamation ordinance, which would include stockpiling the topsoil remaining on the site and importing additional topsoil of at least equal quality from other various local sources. This reclamation approach would meet the City's required four inches of topsoil, at a minimum, and would average six inches of topsoil throughout the reclaimed prairie areas.

By utilizing topsoil from a variety of sources the potential for a weed seed bank to be present is very high. The introduction of problematic weeds will result in a higher weed/native plant ratio in the established vegetation. If topsoil of unknown origin is used as topsoil for reclamation the expectation should be that of a lower diversity of native prairie species to be established and lower performance standards to reflect the challenges of increased weed management with topsoil that is not weed-free.

Prior to the placement of topsoil, slopes will be graded and back-filled to the approximate reclamation grades. Final preparation will include scarifying, mixing, and compacting the top six inches of the subgrade.

Prairie Establishment:

Vegetative reclamation that will follow the proposed mining at the Zavoral site, will involve the establishment of native dry and mesic prairie throughout most of the 64 acres to be reclaimed. In its current state, the area of the Zavoral property that was formerly mined is being reclaimed naturally with early successional native trees and weedy herbaceous plant species. The site has very little topsoil development since mining last took place. Plants that are adapted to dry soils with low fertility have become established throughout the former mining areas.

From an ecological perspective for reclamation on this site, the selection of dry and mesic prairie plant species that can tolerate these types of soil conditions should be utilized to establish vegetation for reclamation. The seed mixes that have been developed for this project do include native species that can establish and thrive in dry, low fertility soil conditions. The following two sections are general descriptions of the two prairie communities being proposed for reclamation.

Dry Prairie

Dry prairies typically occur within the prairie region of Minnesota on soils that are predominantly sandy or gravelly. The soils typical of dry prairie have a shallow soil profile, a thin layer of organic matter, low water-holding capacity, and are dry most of the year, even in years when rainfall is normal. Dry prairies are a fire-dependent plant community, and without frequent fire can be changed because of the encroachment of woody plants like trees and shrubs. Prairie grasses and wildflowers like the ones specified in the seed mix for the Zavoral reclamation are adapted to frequent fire, and respond favorably following fire.

Vegetation found in dry prairies is usually less than three feet tall, and needs direct sunlight to thrive. Since water availability is usually limited in these types of prairie systems, the plants often times grow in a more scattered arrangement on the landscape with gaps of exposed soils often common. Even with the scattered arrangement of plants in a dry prairie the roots are usually very dense and efficient at capturing enough moisture to thrive and keeping the soil stabilized. Typical vegetation of a dry prairie includes many different grasses and forbs like the plant species specified in the seeding table below. Most of the area to be reclaimed will be established with dry prairie except for the low depressional areas that will be planted with mesic prairie.

Table 1. Dry Prairie Seed Mix for Zavoral Reclamation

Grasses	Big Bluestem	*Andropogon gerardii*
	Side-oats Grama	*Bouteloua curtipendula*
	Nodding Wild Rye	*Elymus canadensis*
	Junegrass	*Koeleria macrantha*
	Little Bluestem	*Schizachyrium scoparium*
	Indian Grass	*Sorghastrum nutans*
Forbs	Blue Giant Hyssop	*Agastache foeniculum*
	Lead Plant	*Amorpha canescens*
	Butterfly Milkweed	*Asclepias tuberosa*
	Canada Milk Vetch	*Astragalus canadensis*
	Partridge pea	*Chamaecrista fasiculata*
	Bird's Foot Coreopsis	*Coreopsis palmata*
	Purple Prairie Clover	*Dalea purpurea*
	Stiff Sunflower	*Helianthus pauciflorus*
	Rough Blazingstar	*Liatris aspera*
	Wild Bergamot	*Monarda fistulosa*
	Stiff Glodenrod	*Oligoneuron rigidum*
	Large-Flowered Bead Tongue	*Penstemon grandiflorus*
	Black-eyed Susan	*Rudbeckia hirta*
	Gray Goldenrod	*Solidago nemoralis*
	Heath Aster	*Symphyotrichum ericoides*
	Smooth Aster	*Symphyotrichum laeve*
	Hoary Vervain	*Verbena stricta*

Mesic Prairie

Mesic prairies typically occur in the same region of Minnesota as dry prairies do but occur on different soil types and landscape position. In southern and western Minnesota mesic prairies were once the dominant vegetation type, but have since been almost completely converted to agricultural uses since European settlement.

Mesic prairies occur in soils that are somewhere between wet and dry. Most mesic prairies are found on loam and sandy loam soils. Rainwater soaks in but doesn't collect from the surrounding area. Mesic prairies may closely resemble dry communities, but grasses grow more vigorously and there are more flower species. This type of prairie like dry prairie is also fire-dependent in which it depends on frequent fire to exist as a prairie. In the absence of frequent

fire, mesic prairies will become invaded by trees and shrubs, and in time will become woodlands and forests.

Vegetation in mesic prairies can be seen as thick and lush with many types of flowering plants and grasses. Unlike dry prairies, mesic prairies are usually seen as continuous vegetation with less exposed bare ground. Individual plant species of a mesic prairie can reach heights of 6 feet or greater, and with shorter plants create a layered landscape. Typical vegetation of a mesic prairie includes many different grasses and forbs like the plant species specified in the seeding table below. Areas to be planted with mesic prairie include the low depressional areas within each reclamation area.

Table 2. Mesic Prairie Seed Mix for Zavoral Reclamation

Grasses	Bluestem, big	*Andropogon gerardi*
	Wild-rye, Canadian	*Elymus canadensis*
	Wheat-grass, slender	*Elymus trachycaulus*
	Rye-grass, annual	*Lolium italicum*
	Switch grass	*Panicum virgatum*
	Indian grass	*Sorghastrum nutans*
Forbs	Milkweed, butterfly	*Asclepias tuberosa*
	Milkweed, whorled	*Asclepias verticillata*
	Milkvetch, Canada	*Astragalus canadensis*
	Partridge pea	*Chamaecrista fasiculata*
	Prairie clover, purple	*Dalea purpurem*
	Tick-trefoil, showy	*Desmodium canadense*
	Sunflower, early	*Heliopsis helianthoides*
	Blazingstar, rough	*Liatris aspera*
	Blazingstar, tall	*Liatris pycnostachya*
	Bergamot, wild	*Monarda fistulosa*
	Coneflower, grey-headed	*Ratibida pinnata*
	Black-eyed Susan	*Rudbeckia hirta*
	Goldenrod, stiff	*Solidago rigida*
	Heath Aster	*Symphyotrichum ericoides*
	Smooth Aster	*Symphyotrichum laeve*
	Spiderwort, Ohio	*Tradescantia ohiensis*
	Vervain, blue	*Verbena hastata*
	Vervain, hoary	*Verbena stricta*
	Alexanders, golden	*Zizea aurea*

Representative Project Examples

Tii Gavo, Scandia, Minnesota – Use of Engineered Topsoil and Native Seeding / Planting

An example of a project where a similar 80% sand/20% compost topsoil mix was used is at the Tii Gavo Conservation Development located in Scandia, MN. In 2008, CCES assisted the developer and project team with the specifications and installation of eleven infiltration basins throughout the development. The eleven basins comprised a large component of the Tii Gavo's storm water management system and cover approximately 1.40 acres. The basins themselves were planted with mesic native prairie species into a topsoil mix that consisted of 80% sand and 20% MnDOT Grade 2 Compost. Basins were planted in the fall of 2008 with vegetative plugs and were weeded once in 2009 and 2010. By 2011 all basins had become fully established with mature native vegetation. In a time span of three growing seasons these basins are now covered by over 90% native vegetation with minimal weed species present. The picture below is of one of the planted infiltration basin at Tii Gavo in 2010. The basin itself was planted with mesic prairie species and side slopes were seeded with dry prairie species.

Tii Gavo Infiltration Basin planted in 2008, photo taken in September of 2010

Evan Whitby Property, Columbus, MN– Dry, Mesic, and Wet Prairie Seeding into Sterile Sands

Located in Columbus, MN the Whitby Property is another project example of establishing native dry and mesic prairie into low nutrient topsoil. CCES was contracted by the Whitby's to implement several ecological restoration tasks within their 80 acre property including seeding in native prairie. Restoration work began on the Whitby property in 2006 and was completed in 2008. As part of the restoration, on-site areas were excavated in very sandy soil to create open water habitat and to generate fill for a future building pad. The side slopes of these excavated ponds were left without topsoil intentionally to seed into following site grading. Areas without topsoil were essentially fine sands and were seeded in 2006 with local ecotype prairie species. By 2008 the seeded areas had established with nearly 85% native cover. Weed control was minimal over the two years following installation due to a lack of nutrients from the soil. These planted prairie areas are currently managed by rotational prescribed burning and spot herbicide treatment by the landowner.

Side slope of established native mesic to dry prairie species, photo taken in August of 2008

Blaine Preserve – Dry, Mesic, and Wet Prairie Restoration on Sterile Sands

Located in southeastern Blaine, Minnesota is the Blaine Preserve commercial development which CCES was involved with the restoration of the mesic prairie and wet meadow/rich fen within its 60 acre conservation area. Portions of the site were direct seeded and over seeded with native mesic and dry prairie species into nutrient poor, sandy topsoils. Much of the restoration area is on very fine, sandy soils with low organic matter. Seeding the upland prairie areas began in the fall of 2007 and involved broadcasting seed onto bare exposed soils as well as interseeding into areas with patchy native vegetation following herbicide applications and prescribed burning. During 2008, additional seeding took place in others parts of the conservation area with similar dry and mesic prairie species that were used in 2007. By 2010 areas that had been direct seeded and over seeded in 2007 and 2008 had become well established with native dry and mesic prairie species that were seeded. Weed control within these seeded areas was maintained to just a few small areas by spot herbicide treatments. This conservation area is currently being managed with rotational prescribed burning to maintain the quality and integrity of the dry-wet prairies that make up this unique native plant system. The 60+ acre Blaine Ponds Conservation Areas will ultimately be dedicated as a state Scientific and Natural Area.

Mesic to Wet Prairie Restoration on Sandy Soils in Blaine, MN. Photo taken in August of 2008