Zavoral Property

Reclamation Plan

Scandia, Washington County, Minnesota

May 3, 2011 (revised October 8, 2012 and April 18, 2013)

Client:

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Consultant:

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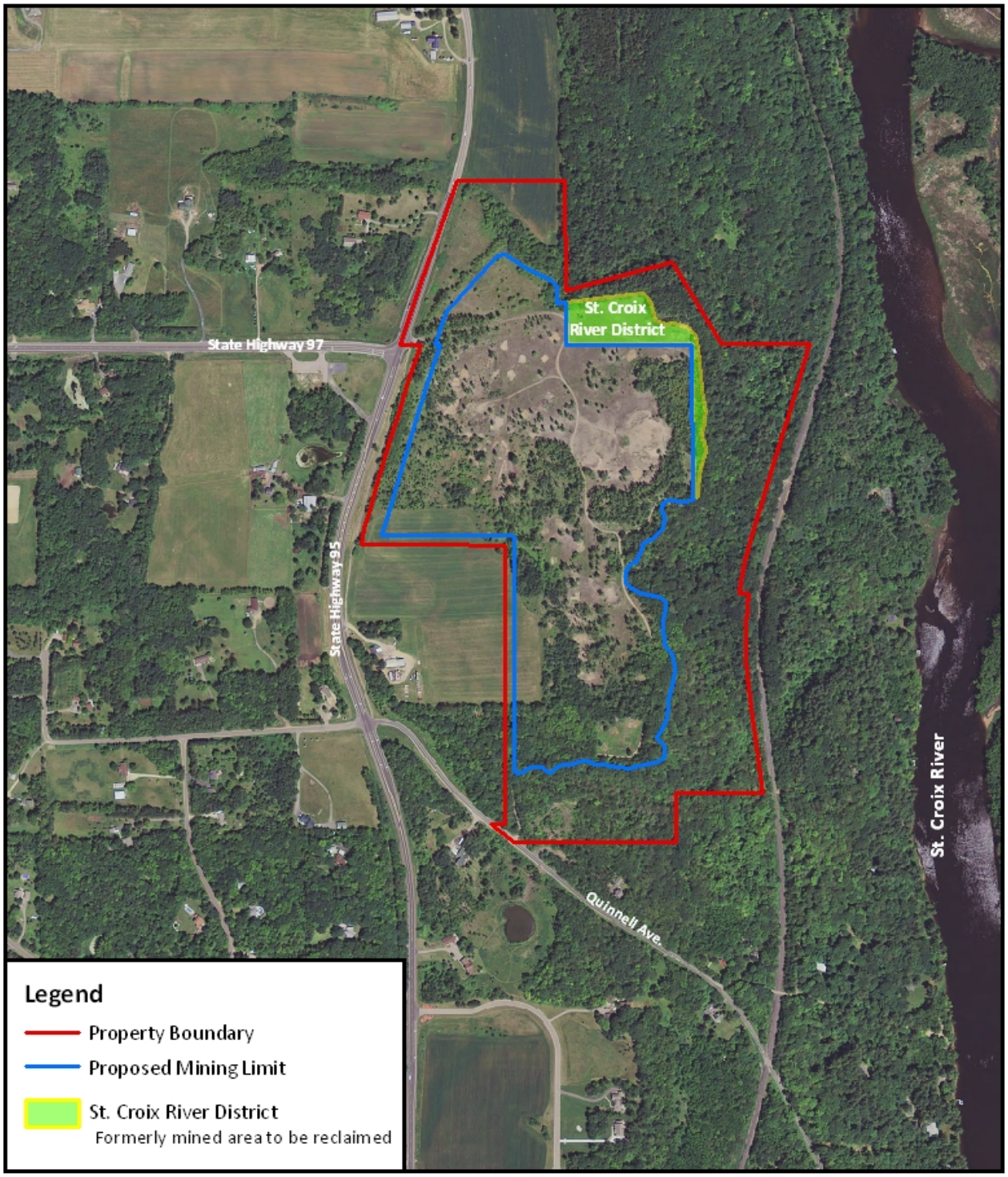
Intent of Reclamation

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 of 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

0 375 750 1,500 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.

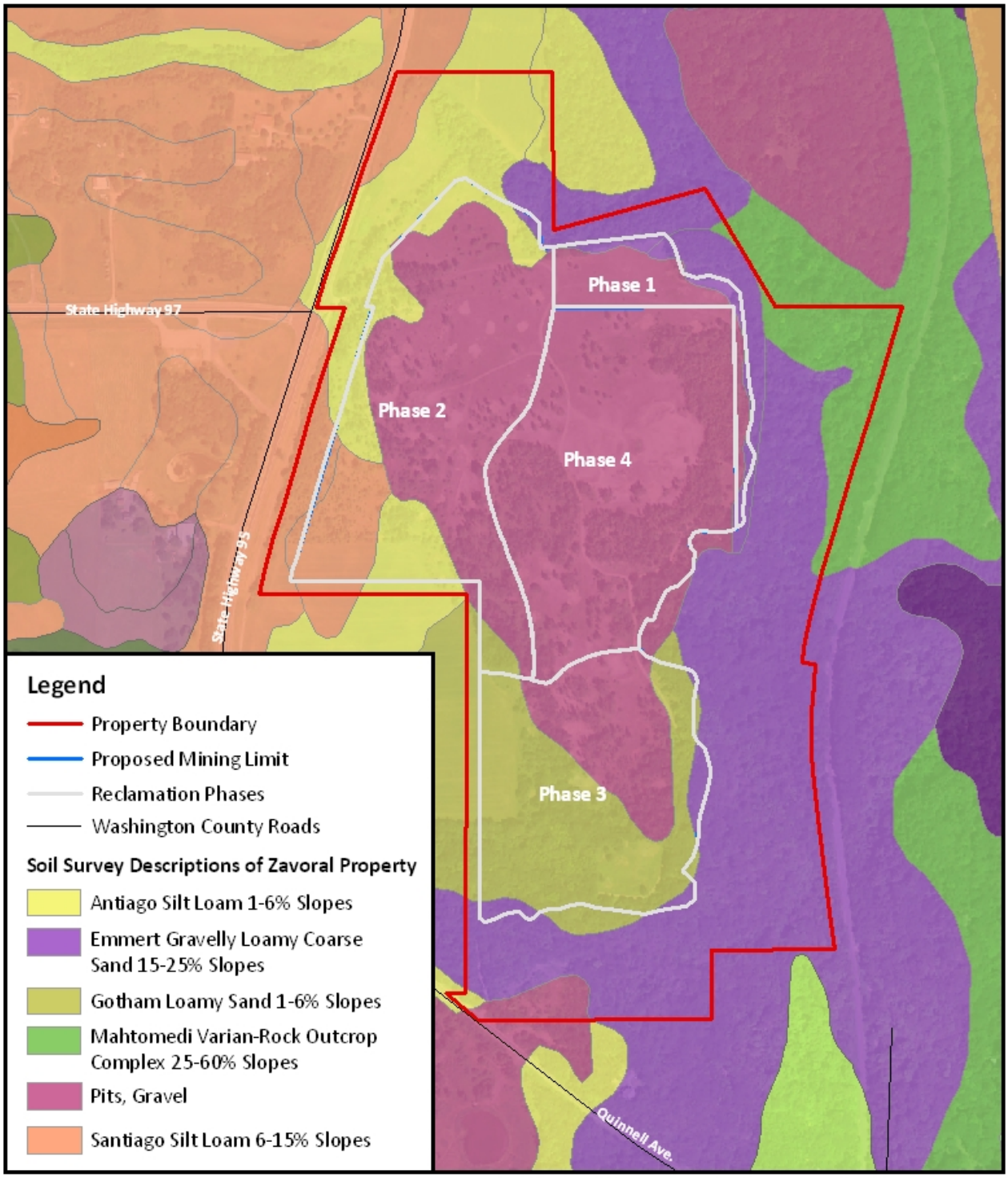
Emmert A Horizon: A--0 to 2 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR4/1) dry; weak fine granular structure; very friable; about 10 percent gravel; slightly acid; abrupt smooth boundary. 1 to 4 inches thick.

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

0 250 500 1,000 Feet

NORTH

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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. The trees will be planted in a staggered and dispersed pattern to create a more natural transition between forest edge and the reclamation area. To avoid disturbing most birds during the breeding season, trees that will be removed will be removed outside of the primary nesting season (May 1 through July 31).

Reclamation Phases 2, 3, & 4

Reclamation Phases 2, 3 and 4 will consist of establishing dry and mesic prairie communities throughout the site by seeding. The reclamation plantings over the next several years will develop into natural plant communities that include dry prairie and mesic prairie. 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.

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

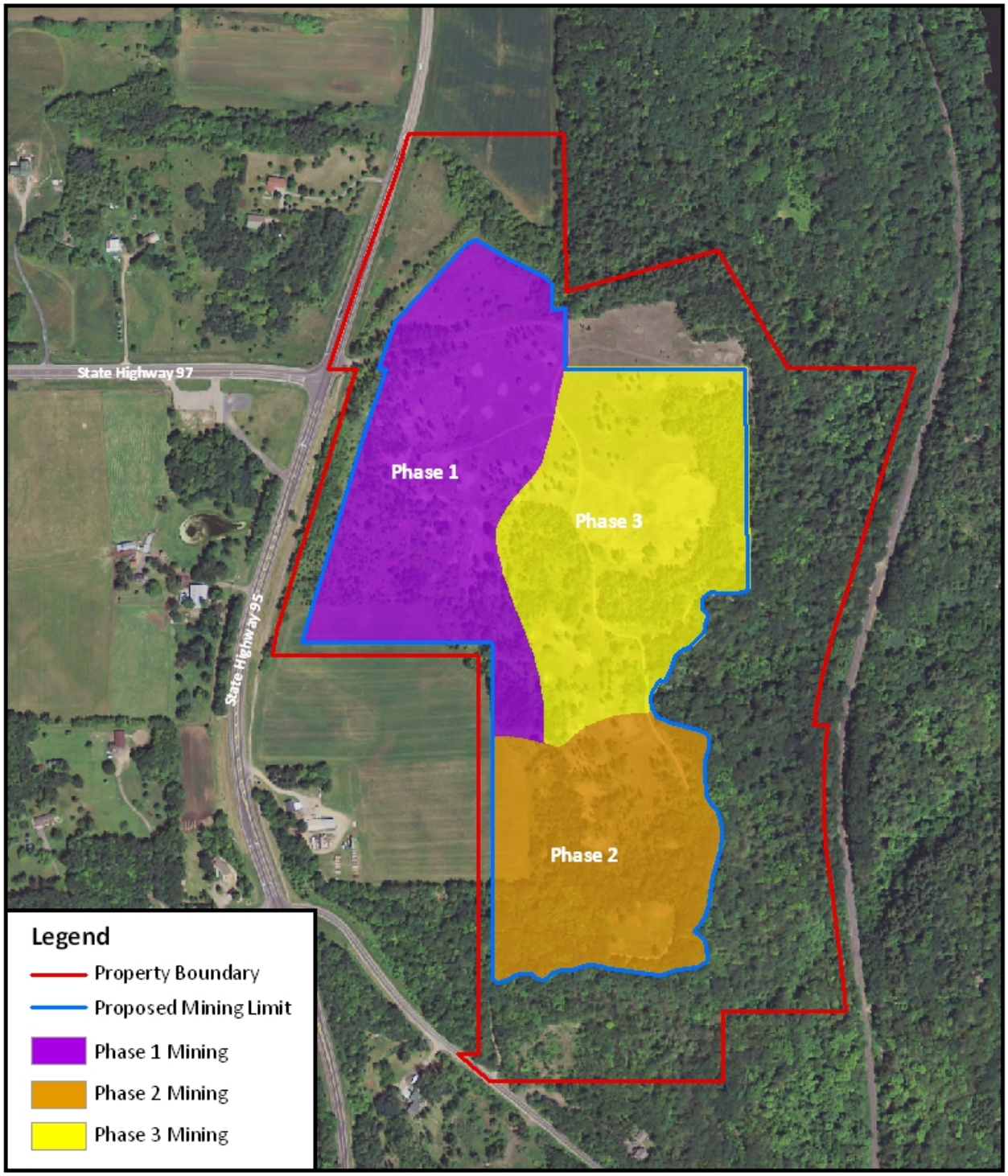
The proposed and existing screening berms located along State Highway 95 and along the southwest perimeter of the site occur within the 50-foot and 100-foot mining setbacks. The 50-foot and 100-foot mining setbacks are currently included as proposed reclamation areas in the reclamation plan figures. The purpose of the berms is to provide visual and noise screening of 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. Tiller should coordinate with the City to determine which berms could be removed after the mining is completed. 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

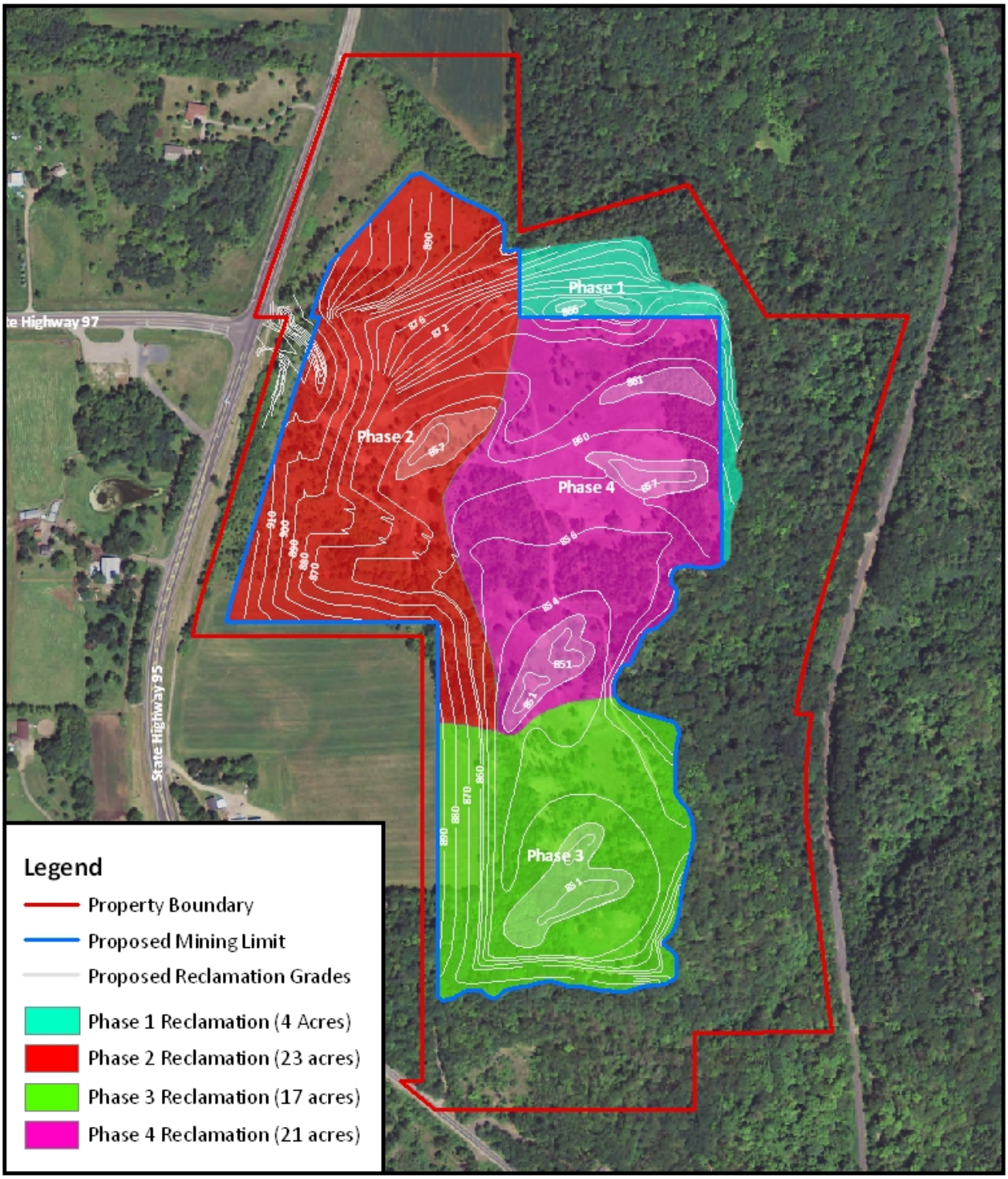
Zavoral Mining Project map

0 250 500 1,000 Feet

NORTH

Critical Connections Ecological Services, Inc.

Figure 3



Zavoral Property

Zavoral Reclamation Project Map

0 250 500 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" and an average of 6" of topsoil over the site 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. Topsoil that requires stockpiling prior to placement in the reclamation area will be stockpiled at a maximum height limit of approximately 880 feet mean sea level (msl). To meet the requirements of the City's mining ordinance, and to achieve establishment of native seedlings within reclamation areas, clean, non-contaminated fill 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. Soils should be tested by an agronomist in order to provide an acceptable topsoil to be used for reclamation. The agronomist should evaluate sand/silt/clay structure, fertility, and pH of on-site soils prior to use as topsoil.

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 added organic soil amendments 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 added organic soil amendments that will be imported onto the site. To the extent possible within each phase of reclamation, a single source supplier of clean, non-contaminated fill material should be used to maintain consistency of imported material and to ensure uniformity in the resulting manufactured soil. The soil mix should 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 depth of four inches with an average of 6" across the site. During final grading in each reclamation area the subgrade will be disked while the topsoil should not be disked prior to any temporary or permanent seeding.

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 either in early spring or late summer/early fall. The optimum time to transplant coniferous 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. The SWPPP depicts 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 SWPPP also describes and illustrates the BMPs that will be implemented throughout the life of the project.

The proposed project includes 64 acres, which includes approximately 52 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. Approximately 12 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. 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 3.43 acres and is located within Phase 1 Mining. The stormwater flows off-site and drains towards an unnamed creek locally known as Zavoral Creek. The southernmost drainage area consists of approximately 5.97 acres and is located within Phase 2 Mining. The area drains off-site to the southernmost creek located outside of the property boundary. The central drainage area consists of approximately 2.19 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 these locations a number of BMPs will be imposed as indicated in the site specific SWPPP.

After reclamation of the project the majority of stormwater runoff will be directed towards the interior of the site. 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.

Seeding Method #1:

Seed installed by a seed drill will have accurately metered types of seed planted and will have 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. The site should be lightly harrowed or raked following seeding if the seeder does not contain a cultipacker and cultipacking the site following harrowing is recommended to ensure a firm seed bed.

Seeding Method #2

Seed installed by broadcasting can be achieved with either mechanical "cyclone" seeders, by hand seeding or by any other method that scatters seed over the bare soil surface. Broadcast seeding may not be desirable if the weather is hot and dry and/or the soil moisture is content is low. It is essential that steps be taken to ensure good seed to soil contact when broadcast seeding is used.

Several types and sizes of broadcast seeders are available for use, ranging from fertilizer-type spreaders to power spreaders mounted on all terrain vehicles. Seed should be mixed thoroughly prior to seeding and should be mixed occasionally in the spreader to prevent separation and settling. The site should be harrowed or raked following seeding and should be packed using a culti-packer or equivalent following harrowing.

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	% by wt	Qty (oz.)	# seeds/oz.	# of seeds
Grasses	Big Bluestem	*Andropogon gerardii*	20.0	44.8	10,000	448,000
	Side-oats Grama	*Bouteloua curtipendula*	10.0	22.4	6,000	134,400
	Nodding Wild Rye	*Elymus canadensis*	5.0	11.2	5,200	58,240
	Junegrass	*Koeleria macrantha*	5.0	11.2	200,000	2,240,000
	Little Bluestem	*Schizachyrium scoparium*	20.0	44.8	15,000	672,000
	Indian Grass	*Sorghastrum nutans*	15.0	33.6	12,000	403,200
	Prairie Dropseed	*Sporobolus heterolepsis*	5.0	11.2	16,000	179,200
			80.0	**179.2**		**4,135,040**
Forbs	Blue Giant Hyssop	*Agastache foeniculum*	0.4	0.9	90,000	81,000
	Lead Plant	*Amorpha canescens*	0.4	0.9	16,000	14,400
	Butterfly Milkweed	*Asclepias tuberosa*	0.5	1.12	4,300	4,816
	Canada Milk Vetch	*Astragalus canadensis*	0.2	0.45	17,000	7,650
	Partridge Pea	*Chamaecrista fasiculata*	5.0	11.2	2,700	30,240
	Bird's Foot Coreopsis	*Coreopsis palmata*	0.2	0.45	10,000	4,500
	Purple Prairie Clover	*Dalea purpurea*	2.0	4.48	15,000	67,200
	Stiff Sunflower	*Helianthus pauciflorus*	0.5	1.12	4,000	4,480
	Rough Blazingstar	*Liatris aspera*	0.1	0.22	16,000	3,520
	Wild Bergamot	*Monarda fistulosa*	1.0	2.24	70,000	156,800
	Stiff Glodenrod	*Oligoneuron rigidum*	0.5	1.12	41,000	45,920
	Large-Flowered Beard Tongue	*Penstemon grandiflorus*	0.5	1.12	14,000	15,680
	Black-eyed Susan	*Rudbeckia hirta*	5.0	11.2	92,000	1,030,400
	Gray Goldenrod	*Solidago nemoralis*	0.3	0.67	300,000	201,000
	Heath Aster	*Symphyotrichum ericoides*	0.2	0.45	200,000	90,000
	Smooth Aster	*Symphyotrichum laeve*	0.2	0.45	55,000	24750
	Hoary Vervain	*Verbena stricta*	3.0	6.72	28,000	188,160
			20.0	**44.81**		**1,970,516**
Cover Crops	Oats or Winter Wheat*	*Avena sativa or Triticum aestivum*				

Seeding Rates for Dry Prairie Matrix

Dry Prairie Areas to be seeded with 14.0 lbs of pure live seed/acre

Seeds per Sq. Ft. = 140 seeds

Quantity of seed is based on a planting rate of 14 lbs of pure live seed/acre

Notes: Oats are used for spring and summer seeding and winter wheat for fall seeding
Cover crops seeding rate = 80 lbs/acre

A seed inoculant should be used for better establishment of legume plant species (native seed companies include this in the seed mix when legumes are present in the mix)

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

Mesic Prairie Mix for mesic prairie planting areas

Mesic Prairie

	Common Name	Scientific Name	% by wt	Qty (oz.)	# seeds/oz.	# of seeds/ac.
Grasses	Big Bluestem	*Andropogon gerardi*	20.0	44.8	10,000	448,000
	Canadian Wild-rye	*Elymus canadensis*	5.0	11.2	6,000	67,200
	Slender Wheat-grass	*Elymus trachycaulus*	5.0	11.2	5,200	58,240
	Switch Grass	*Panicum virgatum*	10.0	22.4	15,000	336,000
	Little Bluestem	*Schizachyrium scoparium*	20.0	44.8	15,000	672,000
	Indian Grass	*Sorghastrum nutans*	20.0	44.8	12,000	537,600
			80.0	**179.2**		**2,119,040**
Forbs	Butterfly Milkweed	*Asclepias tuberosa*	0.5	1.12	4,300	4,816
	Partridge Pea	*Chamaecrista fasiculata*	1.0	2.24	2,700	6,048
	Purple Prairie Clover	*Dalea purpurem*	0.5	1.12	15,000	16,800
	Showy Tick-trefoil	*Desmodium canadense*	0.2	0.45	5,500	2,464
	Early Sunflower	*Heliopsis helianthoides*	4.0	8.96	6,300	56,448
	Rough Blazingstar	*Liatris aspera*	0.4	0.9	16,000	14,400
	Tall Blazingstar	*Liatris pycnostachya*	1.0	2.24	11,000	24,640
	Wild Bergamot	*Monarda fistulosa*	2.0	4.48	70,000	313,600
	Grey-headed Coneflower	*Ratibida pinnata*	0.1	0.22	30,000	6,600
	Black-eyed Susan	*Rudbeckia hirta*	5.0	11.2	92,000	1,030,400
	Stiff Goldenrod	*Solidago rigida*	0.5	1.12	41,000	45,920
	Heath Aster	*Symphyotrichum ericoides*	0.5	1.12	200,000	224,000
	Smooth Aster	*Symphyotrichum laeve*	1.0	2.24	55,000	123,200
	Ohio Spiderwort	*Tradescantia ohiensis*	0.3	6.72	8,000	53,760
	Blue Vervain	*Verbena hastata*	2.0	4.48	93,000	416,640
	Golden Alexanders	*Zizea aurea*	1.0	2.24	11,000	26,640
			20.0	**50.85**		**2,366,376**
Cover Crops	Oats or Winter Wheat*	*Avena sativa or Triticum aestivum*				

Seeding Rates for Mesic Prairie Matrix

Mesic Prairie Areas to be seeded with 14.0 lbs of pure live seed/acre

Seeds per Sq. Ft. = 103 seeds

Quantity of seed is based on a planting rate of 14 lbs of pure live seed/acre

Notes: Oats are used for spring and summer seeding and winter wheat for fall seeding.
Cover crop seeding rate = 80 lbs/acre

A seed inoculant should be used for better establishment of legume plant species (native seed companies include this in the seed mix when legumes are present in the mix)

*See graphical planting plan figure for location of 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 (April 15th to June 20th) 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 (September 20th to October 30th) 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. In areas of steep slopes, straw erosion control blanket (straw blanket North American Green NAD S-75 type or other comparable weed-free mulch) should be used for mulching newly seeded areas.

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 two to three times a year or as necessary 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.

Tree Transplanting

Within Phase 1 of the reclamation area, a minimum of 100 white pine trees will be transplanted from areas to be mined to areas of reclamation. The intent of transplanting the trees is to provide a transition along the woodland/forested edges and the newly planted prairie areas.

Tree transplanting will be achieved by moving existing on-site white pines with a 65” or 90” tree spade depending on the height of the tree to be moved. Existing white pine trees that are currently located on level terrain, with an average height of 10 feet (minimum height 4 feet and maximum height 14 feet), and in excellent health will be selected for transplanting into the reclamation areas. The trees will be planted in a staggered and dispersed pattern to create a more natural transition between the forest edge and the reclamation area. Because 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. Transplanting of on-site trees should take place in the early spring or fall when the optimum time to move young trees occurs. To avoid disturbing most birds during the breeding season, trees that will be moved will be removed outside of the primary nesting season (May 1 through July 31).

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. In the event that a reclamation phase does not meet the performance standards within the first three years following establishment, adaptive management measures will be implemented to correct any problems.

Seeded Prairie Areas

Following the first year of planting and seeding within any of the reclamation areas, site vegetation management will involve mowing two to three times a year or as necessary and also utilizing spot herbicide treatments to areas with non-native weedy and invasive plants present. Mower deck should be set off the ground 5-6" for the initial mowing and 6-10" for each additional mowing that is conducted during seed establishment. 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 one to two times a year or as necessary and conducting herbicide treatments one to two times a year or as necessary depending on the level of non-native weedy and invasive species present.

Transplanted White Pine Tree Areas

Following the transplanting of white pine trees into Phase 1 of the reclamation area a watering plan should be implemented for one year following their installation. In general 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. All white pine trees 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 white pine trees are transplanted in the fall of the year a watering plan should be implemented for the following growing season.

Due to the proposed locations of transplanted trees, a watering truck will be used to water all trees. Trees will be transplanted in such a way that access to the trees should be able to follow a single track. The single track to be used for accessing the white pine trees for watering will likely compact the soil. If

compaction occurs to the degree that limits native seed establishment, the area disturbed will need to be reseeded following completion of the 1-year watering program. If native vegetation does become established within the track, used for watering, then no additional seeding or grading should take place.

Survival rates of less than 80% will require replacement of the dead trees. Replacement tree species will be selected in consultation with the City and its consultant and approved by the City. Trees requiring replacement will be removed and a replacement tree will be planted in any accessible area within one of the four reclamation areas. Due to establishing native prairie around the transplanted trees, transplanting a new tree in the location of the dead tree is not recommended in order to minimize any re-grading or re-seeding that may need to take place.

Mulching Transplanted Trees

All trees proposed to be transplanted 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 two to three times a year or as necessary for the first year following seed installation to minimize annual weed seed production. During the second year of prairie establishment mowing should be conducted once (before weeds have set seed for the season) or as necessary. Herbicide treatment of areas with noxious weeds and non-native invasive plants present should be handled as problem plants become established. Continual monitoring for invasive weed species within each reclamation area should take place for up to three years following seeding in order for the seed mixes to become well establish.

The following paragraphs detail the common herbaceous and woody weed species that may be encountered during reclamation establishment and their recommended chemical and mechanical methods for control.

Spotted Knapweed (*Centaurea maculata*)

Spotted Knapweed is an invasive weed from Eurasia, often colonizing in degraded sunny uplands, fallow agricultural fields, and remnant prairies. Spotted Knapweed was observed throughout the unreclaimed mining areas within the Zavoral property.

Chemical methods for controlling Spotted Knapweed is best achieved with the use of a clopyralid based herbicide (Transline, Stinger, Curtail) in early June during bud growth. Use caution in higher quality areas since this chemical can persist in the soil for up to 30-40 days and can affect native plants of the sunflower and pea family. Treatments of herbicide to Spotted Knapweed can require more than one application to completely eradicate an established population.

Mechanical methods for reducing/controlling Spotted Knapweed can involve physical removal, frequent mowing, and the use of prescribed burning. When manually removing these plants, it is very important to remove the entire root system and basal rosette of leaves.

White and Yellow Sweet Clover (*Melilotus alba, M. officinalis*)

White and Yellow Sweet Clover are invasive biennial upland forbs from Europe that are commonly found along roadsides as well as in abandoned fields and disturbed upland areas. These invasive plants can degrade grassland areas by shading other sun-loving plants which in turn can reduce vegetative diversity.

Chemical methods for controlling sweet clover should involve the use of either a broad-leaf 2,4-D based herbicide (Weed-B-Gone) or a non-selective glyphosate based herbicide (Round-Up). Mechanical methods for reducing/controlling sweet clover can involve prescribed burning, hand pulling, and cutting/mowing before flowers emerge for the season. Prescribed burning to control sweet clover should involve a hot early complete first year burn followed by a hot late spring second year burn, (repeat after two years).

Leafy Spurge (*Euphorbia esula*)

Leafy Spurge is an invasive perennial forb from Europe and Asia that is commonly found in non-cropland disturbed environments like roadsides as well as abandoned fields and disturbed upland areas. This invasive plant can degrade moist and dry prairies by outcompeting native plants and can occur in sun to semi-shade environments. It is most aggressive in dry soil conditions where there is less competition from native plants.

Chemical methods for controlling leafy spurge should involve repeat applications of either a broad-leaf 2,4-D based herbicide (Weed-B-Gone) or a non-selective glyphosate based herbicide (Round-Up).

Mechanical methods for reducing/controlling leafy spurge can involve prescribed burning, hand pulling, and cutting/mowing before flowers emerge for the season.

Canada Thistle (*Cirsium arvense*)

Canada Thistle is a perennial weed that establishes in degraded sunny uplands, fallow agricultural fields, and remnant prairies. Canada Thistle was observed occasionally throughout the old mining areas within the Zavoral property.

Chemical methods for controlling Canada Thistle is best achieved with either the use of a clopyralid based herbicide (Transline, Stinger, Curtail) or a glyphosate based herbicide (Round-Up). Treatments of herbicide to Canada Thistle can require more than one application to completely eradicate an established population. Mechanical methods for reducing/controlling Canada Thistle can involve physical removal, frequent mowing, and the use of prescribed burning. When utilizing prescribed burning to control Canada Thistle, burns should be conducted in May/June and consecutively for three years.

Reed Canary Grass (*Phalaris arundinacea*)

Reed Canary Grass is an aggressive invasive wetland grass that is very common to degraded wetlands within the Minneapolis/Saint Paul metropolitan area and throughout Minnesota. Reed Canary Grass is considered native to North America, but this species has been hybridized and cultivated as an aggressive and naturalizing forage grass that is also used for erosion control in agricultural landscapes.

Reed Canary Grass can be controlled with a grass-specific, systemic herbicide sethoxydim based herbicide (Vantage) or non-specific, systemic glyphosate based herbicides (Aqua Neat or Rodeo).

Grecian Foxglove (*Digitalis lanata*)

Grecian Foxglove is a biennial weed from Europe that establishes in savanna and prairie communities. In Minnesota Grecian Foxglove is found primarily in Washington County in the vicinity of the St. Croix River along sunny to semi-shaded road ditches. Currently no Grecian Foxglove has been identified within the Zavoral site. This plant has recently been placed on the state noxious weed list for eradication and if positively identified on-site should be reported to the Minnesota Department of Agriculture.

Since the habitat for this noxious weed will exist during reclamation, monitoring for its presence should be part of the annual vegetation monitoring that will take place for each reclamation phase. Chemical methods for controlling Grecian Foxglove is best achieved with the use of a glyphosate based herbicide (Round-Up). Mechanical methods for reducing/controlling Grecian Foxglove can involve physical removal. When removing this plant care should be taken to avoid direct contact with skin. Reports of human sensitivity and reaction from contact with this plant are known.

Common Buckthorn (*Rhamnus cathartica*)

Common Buckthorn is a European shrub that invades and establishes within native forest and woodland understories in Minnesota. Once Buckthorn establishes within natural communities, it can outcompete most native species and influence natural forest succession. Typically this plant occurs within forested and woodland areas but can also become established within open areas.

In general Common Buckthorn was observed at low levels within the wooded areas of the Zavoral property and will not likely become a problem/nuisance within the reclamation area. Control for newly established buckthorn seedlings can involve either chemical or mechanical methods. Chemical treatment is most effective with a glyphosate based herbicide (Round-Up) or basal bark spray treatment around the stem with triclopyr (Garlon 3A and 4, Pathfinder II (Garlon)). Mechanical methods for reducing/controlling buckthorn include hand pulling (when plants are small), mowing, and prescribed burning.

Exotic Honeysuckles (*Lonicera tatarica, L. morrowii,* and *L. x bella*)

Exotic honeysuckles are non-native shrubs that were introduced to North America as ornamental shrubs and can naturalize within forest and woodland understories in Minnesota. Exotic honeysuckles can become established in these types of plant communities and have the ability to outcompete other native shrub and herbaceous plants. Seeds of these non-native shrubs are readily spread by birds.

These non-native shrub species were observed in very low numbers within the forested and wooded areas within the Zavoral property and will not likely become a problem/nuisance within the reclamation area. Control for newly established honeysuckle seedlings can involve either chemical or mechanical methods. Chemical treatment is most effective with a glyphosate based herbicide (Round-Up) or basal bark spray treatment around the stem with triclopyr (Garlon 3A and 4, Pathfinder II (Garlon)). Mechanical methods for reducing/controlling honeysuckles include hand pulling (when plants are small), mowing, and prescribed burning.

Amur Maple (*Acer ginnala*)

Amur Maple is a non-native small tree from Asia that was introduced to North America as an ornamental small tree/shrub and can naturalize within old fields and woodland understories. Amur Maple can become established in these types of plant communities and have the ability to outcompete other native plant species.

This non-native tree/shrub species was not observed within the Zavoral property and will not likely become a problem/nuisance within the reclamation area due to a lack of local seed source. If Amur Maple does establish within the reclamation area, seedlings can be controlled by either chemical or mechanical methods. Chemical treatment is most effective with a glyphosate based herbicide (Round-Up) or basal bark spray treatment around the stem with triclopyr (Garlon 3A and 4, Pathfinder II

(Garlon)). Mechanical methods for reducing/controlling Amur Maple include hand pulling (when plants are small), mowing, and prescribed burning.

Other Woody Plants (Red Cedar, Box Elder, and Cottonwood)

These early pioneering native trees species often time can become established within areas of recent disturbance. If these tree species should become established within the reclamation area they can be reduced/controlled by mechanical methods such as frequent mowing during the establishment phase and the use of prescribed burning in future years. As the reclamation areas establish and native plants cover the ground, there will be fewer opportunities for these trees to become established.

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 (or as needed) herbicide applications during the first growing season following installation of any seeded areas.

Year Two Maintenance of Reclamation Areas

Conduct a complete mowing of all seeded areas in June or before weed species go to seed. 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 (or as needed) herbicide applications to control persistent problem species. Use an appropriate herbicide and follow label directions.

Year Three Maintenance of Reclamation Areas

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

Conduct one spot herbicide application (if needed) to persistent 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. Burn should occur in late summer or fall 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. If guidelines are not met each year, adaptive management techniques such as additional seeding, mowing and/or herbicide treatments may occur in order to bring the reclamation area back up to a satisfactory condition. Typically each year the reclamation planting should have an increased number of species present from the seed mix. Vegetation establishment and monitoring will continue for a period of five years after completion of the Project in its entirety.

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*) and winter wheat (*Triticum aestivum*). 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

Reclamation success is defined as follows:

- 90% areal coverage of vegetation for each reclaimed area, within 3 years post-seed installation.
- Non-native and invasive plant species (as defined and listed by the Minnesota DNR) and potentially-aggressive native plant species (*Rhus* spp. and *Juniperus virginiana*) shall account for no more than 20% cover of the reclaimed areas at the end of the 5th growing season, post seed installation.
- The reclaimed areas shall contain at least 50% of the species for both grasses and forbs contained in the specified seed mixes at the end of the 5th growing season, post seed installation.

Phasing and Timing of Mining Operations and Reclamation

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.

Monthly reclamation activity progress reports will be submitted to the City during the growing season post-seed installation of each monitoring area. And an annual reclamation report will be submitted with the AOP application. Progress on reclamation shall be demonstrated in each AOP application.

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” and an average of 6” 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 Phase 1 area 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.

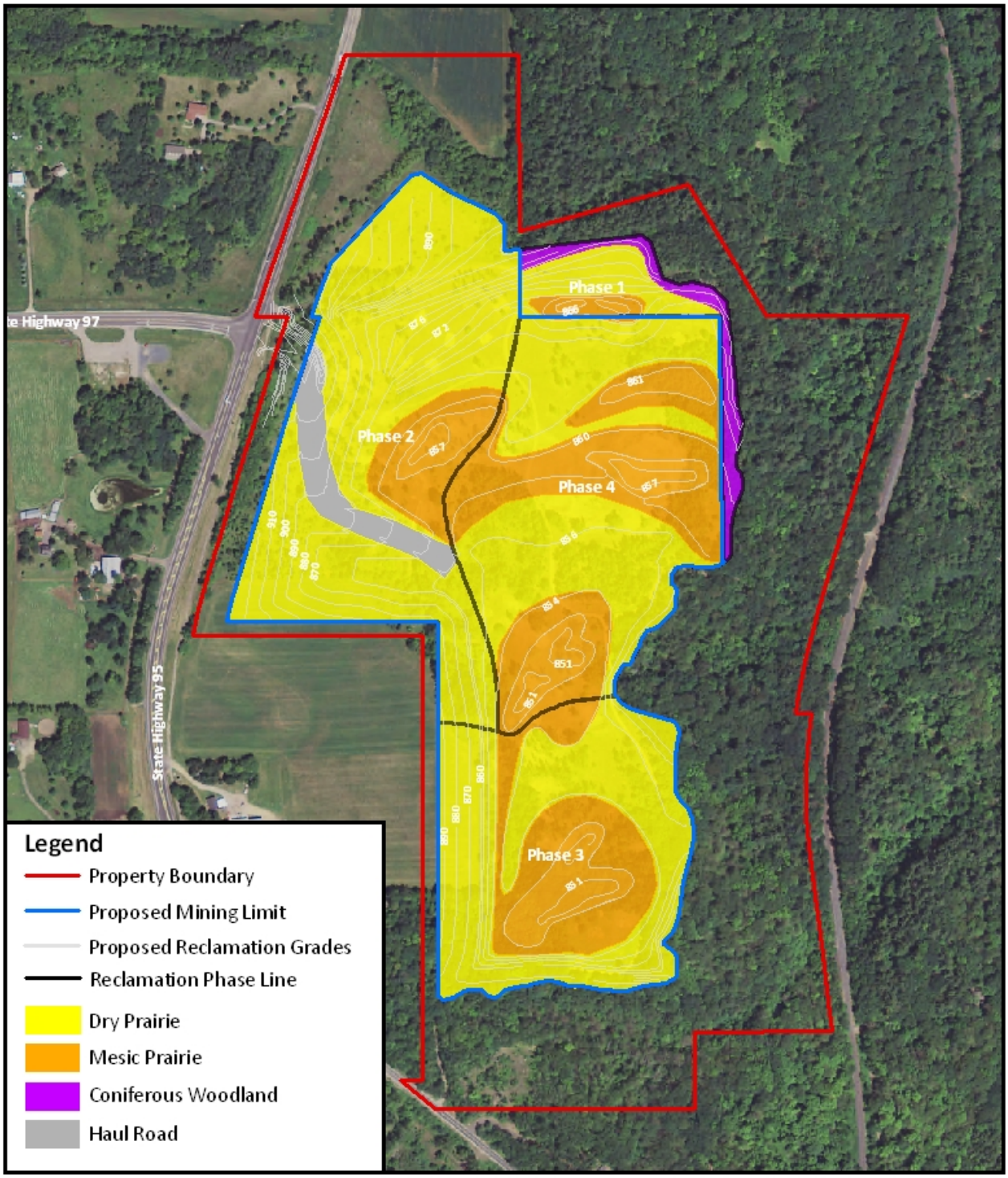
Final condition of site, including proposed contours and landscaping

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 additional ecological diversity. Each depression will be planted with a native seed mix that will establish as a mesic 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

0 250 500 1,000 Feet

NORTH

Critical Connections Ecological Services, Inc.

Figure 5