Forest Management Plan- Sunfish Lake Park, City of Lake Elmo.

This Forest Management Plan is an addendum to the Natural Resource Plan completed in 2011.

The background information completed for the 2011 Natural Resource Plan for Sunfish Lake Park is quite extensive and provides the usual background information which is required in an approved Forest Stewardship Plan. Therefore the information in the Forest Management Plan will focus on the heavily wooded portions of the park, using information from the previous 2011 report and new field work conducted for the Forest Management Plan.

Contained within the plan are a number of management scenarios which the City can examine and weigh to achieve a positive outcome. The basic goal in all of these approaches is to maintain and promote a long term healthy and diverse forest. The City's ability to fund the projects, supply needed labor and equipment, and judge the acceptance of the Park users to the various disruptions and aesthetic changes, will determine the path it takes in achieving its goals.

Thank You,

Steven J. Kunde

SAF Certified Forester

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LANDOWNER:

City of Lake Elmo

3800 Laverne Avenue North

Lake Elmo, Minnesota 55042

Land is located in Washington County.

PREPARED BY:

Steven Kunde
4316 370th St.
North Branch, MN 55056

Society of American Forester, Certified.
Minnesota Plan Preparer # 1103

PLAN DATE: August 2015

Total Acres. 284

Legal Description: PIN's

1402921220001, 1502921110001, 1502921210002, 1502921210003, 1002921340001

This Forest Management plan is designed to assist your management activities of the natural resources on your property in harmony with the regional environment. Recommendations are based upon your goals and are for your consideration.

THE GOALS YOU IDENTIFIED FOR MANAGING YOUR PROPERTY ARE TAKEN FROM THE 2011 NATURAL RESOURCE MANAGEMENT PLAN.

General Management Goals

The 2011 management goals for Sunfish Lake Park are "to protect and enhance the natural resources of the site, to improve the native plant communities, improve wildlife habitat, and improve the nature experience of park users who visit the site to hike, cross-country ski, go horseback riding, watch wildlife, and enjoy the open spaces".

Within the General Management Goals are to "protect and enhance the natural resources of the site and to improve the native plant communities." The primary objective of the forest management plan is to provide a framework for long term structured management of the forest cover type. Additional goals are to:

- Increase tree species diversity.
- Increase tree age class diversity.
- Mitigate wind damage caused by 2013 storm.
- Reduce resulting fire danger from increased fuel load.

The first three of these goals can be accomplished by establishing or planting the future forest in the wind and diseased affected areas.

General Property Description: (Portions from 2011 report)

Sunfish Lake Park is located in Washington County, in the City of Lake Elmo (Township 29, Range 21W, covering parts of sections 10, 14, 15 and 16) and is primarily accessed by an entrance off Hwy. 5 to the south. It is a park of 284 acres and has been noted as a regionally significant natural area by the Minn. DNR. The park is just north of the Lake Elmo Park Reserve and is part of an ecological corridor from the Tri-Lakes area of Lake Elmo, down through the LE Park Reserve.

The park land is gently rolling to steep slopes with ravines and small wetland pockets. The property is bounded by farmland to the south and southwest, a landfill on the west and wooded property on the northwest. The northeastern and eastern portion of the property is developed with homes present.

Access to the park is available from the north, west, and south.

Minnesota Land Trust

A meeting was held on site with Ann Thies of the Minnesota Land Trust to discuss the possible forest management activities for the Park. Ms. Thies discussed the overall situation with the blowdown, buckthorn, and fire hazard and the management options to mitigate the problems and to enhance the forest long term. The work covered within the plan would fall within the covenant in section 3.3 as follows:

> **<u>Forest and Habitat Management</u>. The Protected Property may be used to create, maintain, restore, or enhance habitat for wildlife and native biological communities in accordance with a restoration or habitat management plan approved in writing by the Land Trust. The Owner may remove timber and other wood products and otherwise manage the vegetation on the Protected Property in accordance with this approved plan.**

Following is the request from Ms. Thies regarding individual site and management activities.

"We discussed your interim plan for the trails and we would like to see another proposal with just the specifics of what you want to do, where and when, with a map of locations. Referencing and showing photos will also help. How much work will be on-site and where. This request then needs to come from the City as the owner of the property, and to confirm that they understand and are in agreement with the trail plan."

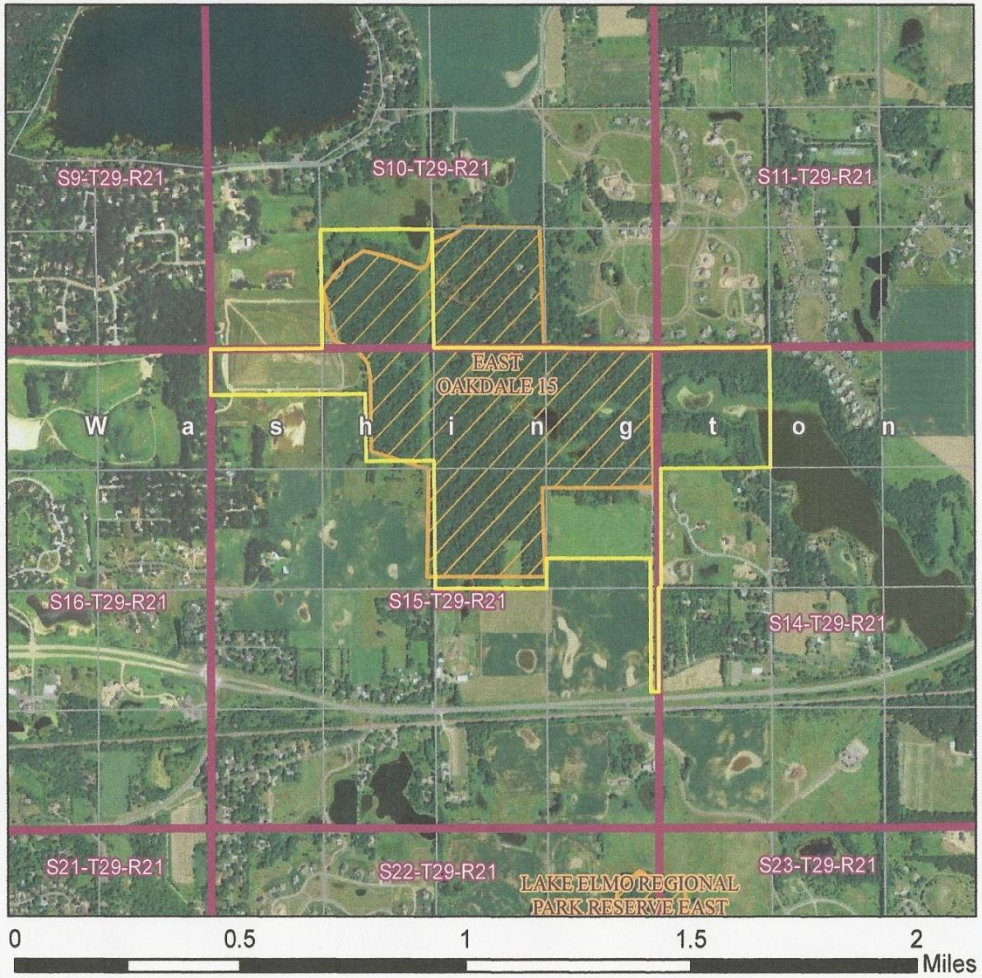
As the City moves forward with the overall management plan and decides at what level the activities will take place, a more detailed report outlining the specifics of each activity, it's exact location, and when each activity will take place can be given to the Land Trust for approval. A short work form would be beneficial to both the City and the Land Trust to plan the work and track the outcomes of the management activity. This work form could use aerial photography to show the location of the work, pictures attached and a description of the activities and time table. These specific details can be provided once the City decides the questions regarding funding of activities, park use disruption and general cover type management decisions.

Natural Heritage Information

The Minnesota Natural Heritage Database is a listing of endangered, threatened or special concern (ETS) plant or animal species. Following is information provided by the DNR with regards to ETS species on or near the property.

MBS Biodiversity Significance and Native Plant Community Map for:
Forest Stewardship Plan by Steven Kunde
for City of Lake Elmo - Sunfish Lake Park
NE1/4 and NENW Sec. 15, SESW Sec. 10, NWNW Sec. 14, all in T29N R21W
Washington County

GIS shapefiles of MBS Sites of Biodiversity Significance and MBS Native Plant Communities can be downloaded from the DNR Data Deli at http://deli.dnr.state.mn.us.



Legend

- Property Line
- Counties
- PLS Sections
- PLS 40s

MBS Sites of Biodiversity Significance

- Outstanding
- High
- Moderate
- Below

Mapped Native Plant Communities near or on property

None

Created June 2015
Data valid for one year

Minnesota Natural Heritage Information System
Index Report of records within 1 mile radius of:
Forest Stewardship Plan by Steven Kunde
for City of Lake Elmo - Sunfish Lake Park

NE1/4 and NENW Sec. 15, SESW Sec. 10, NWNW Sec. 14, all in T29N R21W

DNR PFM Lead:
Tony Miller

Check ID: kunde_steven_29_21_15_250

Washington County

Rare Features Database:

Scientific Name, Common Name, County		Federal Status	MN Status	Draft Status	SGCN Status	State Rank	Global Rank
Terrestrial Community - Other Classification							
Oak - (Red Maple) Woodland Type	(Oak - (Red Maple) Woodland)		N/A			S4	GNR
Washington County							
Sand Beach (Inland Lake) Type	(Sand Beach (Inland Lake))		N/A			S1	GNR
Washington County							
Count of Terrestrial Community - Other Classification (types): 2							
Vertebrate Animal							
Buteo lineatus	(Red-shouldered Hawk)		SPC		SGCN	S3B,SNRN	G5
Washington County							
Etheostoma microperca	(Least Darter)		SPC		SGCN	S3	G5
Washington County							
Haliaeetus leucocephalus	(Bald Eagle)		Watchlist		SGCN	S3B,S3N	G5
Washington County							
Notropis anogenus	(Pugnose Shiner)		THR		SGCN	S2	G3
Washington County							
Count of Vertebrate Animal (types): 4							

Created June 2015

MBS Sites of Biodiversity Significance on or adjacent to the:

Forest Stewardship Plan by Steven Kunde for City of Lake Elmo - Sunfish Lake Park

NE1/4 and NENW Sec. 15, SESW Sec. 10, NWNW Sec. 14, all in T29N R21W

Washington County

DNR PFM Lead: Tony Miller

Check ID: kunde_steven_29_21_15_250

Site Name: EAST OAKDALE 15

Site Rank: Moderate

Site Description:

OAK WOODS ON ROLLING TOPOGRAPHY OF PITTED MORAINE. SANDY, GRAVELLY LOAM RIDGES AND DEPRESSIONS. CANOPY TREES OF RIDGES MOSTLY QUERCUS RUBRA, Q. ALBA, Q. MACRO- CARPA DISTRIBUTED EVENLY WITH SOME LARGE OPEN-GROWN SPECIMENS SUGGESTING THAT THE AREA MAY BE AN OVERGROWN SAVANNA. DRY DEPRESSIONS CONTAIN OAK & ULMUS RUBRA.

Site Name: LAKE ELMO REGIONAL PARK RESERVE EAST

Site Rank: Moderate

Site Description:

DEGRADED OAK WOODS ON ROLLING TOPOGRAPHY OF THE MISSISSIPPI OUTWASH. DARK SANDY LOAM SOILS. QUERCUS MACROCARPA & Q ELLIPSOIDALIS ARE DOMINANT TREES ACCORDING TO 1971 SURVEY BY SCANLON. WOODS HAD MANY DISTURBANCE SPECIES INCLUDING LONICERA TATARICA. NORTH END REPORTEDLY MORE DISTURBED THAN THE SOUTHERN PORTIONS.

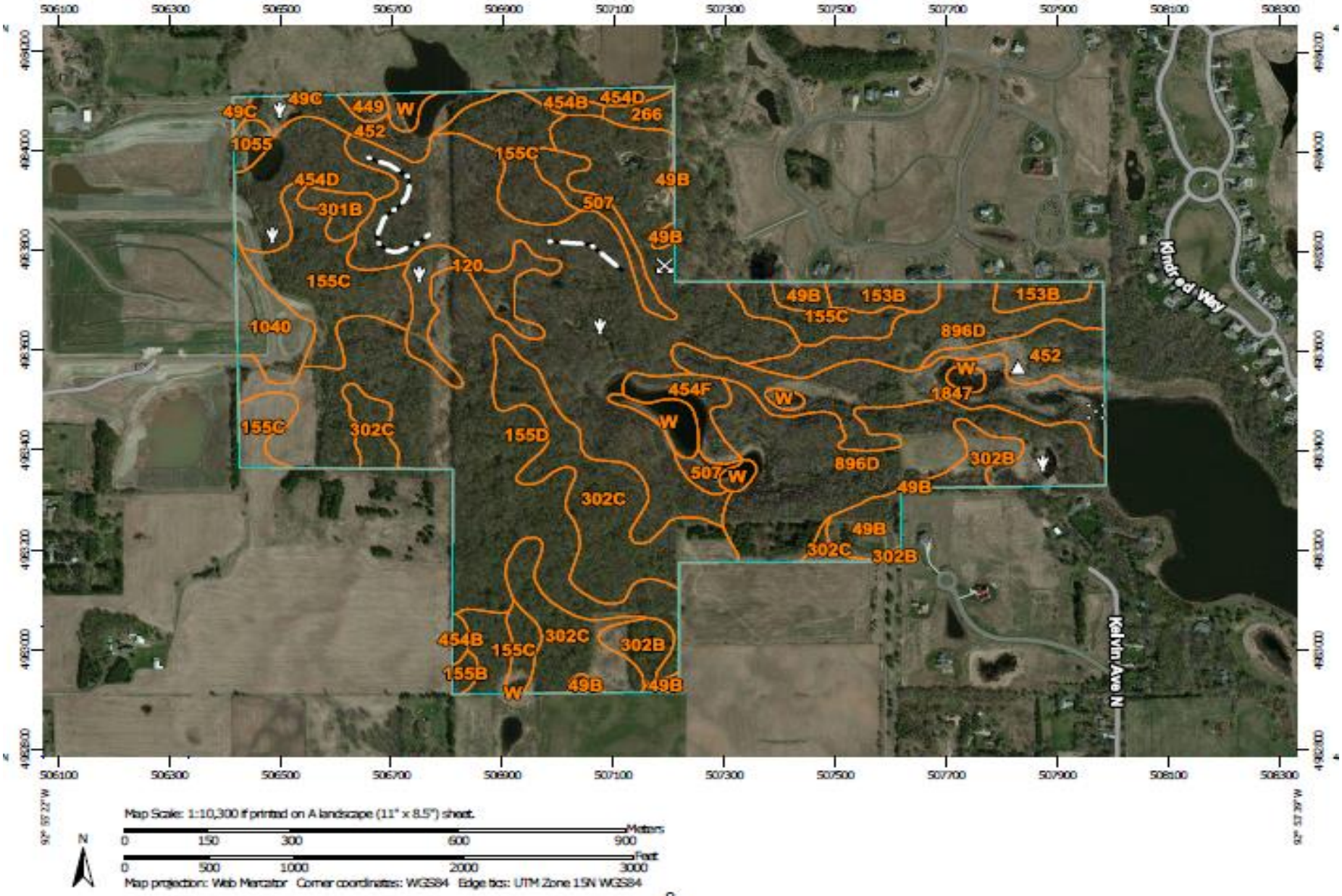
Cultural Heritage Information

The Cultural Heritage Database is a listing of identified historical or cultural sites which may have been identified on your property. No Cultural Heritage sites have been found on your property.

Soil Information

A soil map and soil information is provided. This information is useful when making management decisions. These could include determination of species to plant, wildlife plantings, drainage issues, road placement, etc. The soil map shows soil formations beyond the limits of the property. A complete soil report will be provided in a separate document.

Custom Soil Resource Report
Soil Map

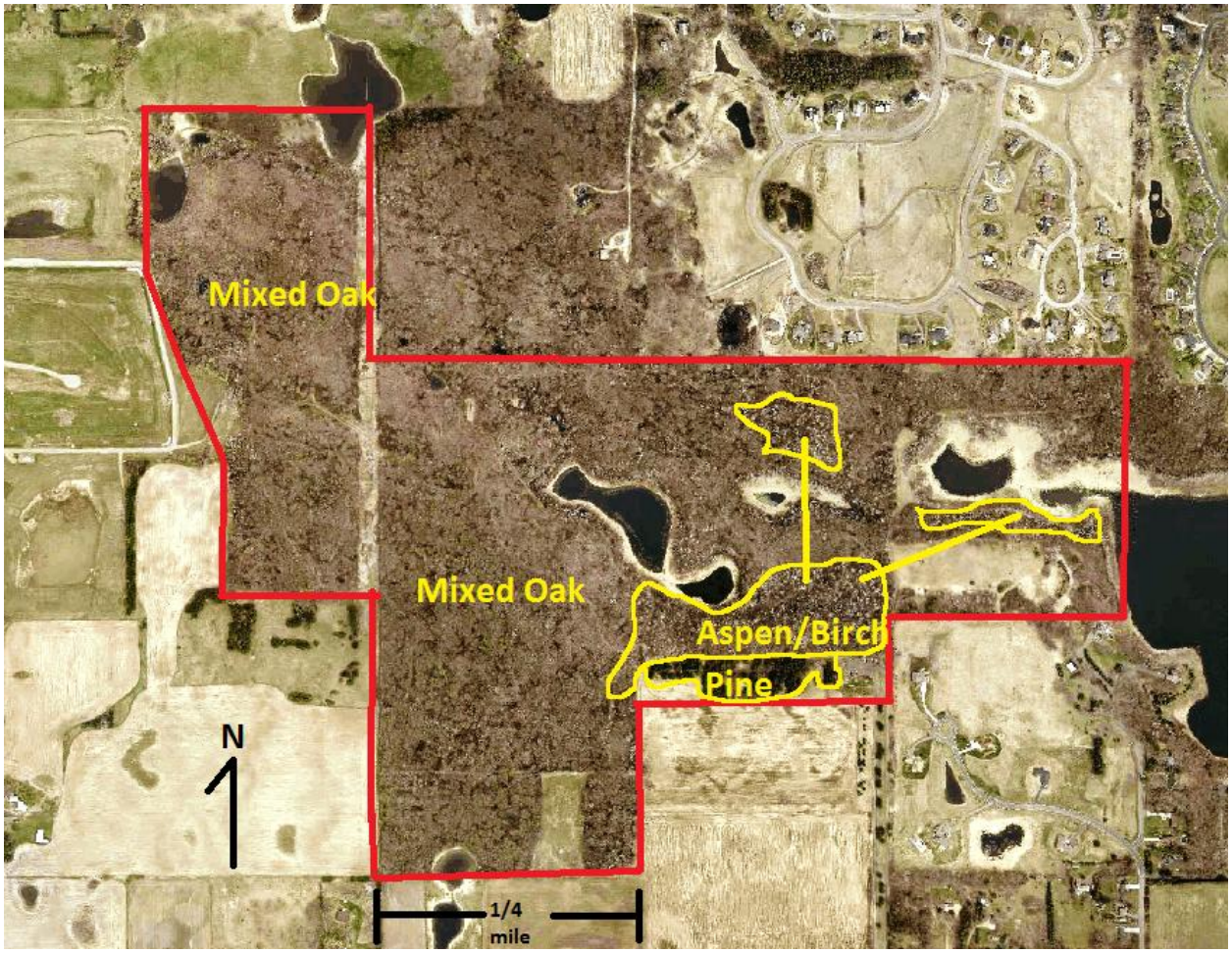


Map Unit Legend

Washington County, Minnesota (MN163)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
49B	Antigo silt loam, 2 to 6 percent slopes	6.1	2.1%
49C	Antigo silt loam, 6 to 12 percent slopes	0.5	0.2%
120	Brill silt loam	6.2	2.1%
153B	Santiago silt loam, 2 to 6 percent slopes	4.7	1.6%
155B	Chetek sandy loam, 0 to 6 percent slopes	0.7	0.3%
155C	Chetek sandy loam, 6 to 12 percent slopes	28.8	10.0%
155D	Chetek sandy loam, 12 to 25 percent slopes	102.5	35.6%
266	Freer silt loam	1.6	0.6%
301B	Lindstrom silt loam, 2 to 4 percent slopes	2.1	0.7%
302B	Rosholt sandy loam, 1 to 6 percent slopes	5.5	1.9%
302C	Rosholt sandy loam, 6 to 15 percent slopes	27.8	9.7%
449	Crystal Lake silt loam, 1 to 3 percent slopes	0.9	0.3%
452	Comstock silt loam	11.5	4.0%
454B	Mahtomedi loamy sand, 0 to 6 percent slopes	1.8	0.6%
454D	Mahtomedi loamy sand, 12 to 25 percent slopes	12.4	4.3%
454F	Mahtomedi loamy sand, 25 to 40 percent slopes	3.8	1.3%
507	Poskin silt loam	4.5	1.6%
896D	Mahtomedi-Kingsley complex, 12 to 25 percent slopes	39.4	13.7%
1040	Udorthents	5.4	1.9%
1055	Aquolls and Histosols, ponded	1.3	0.4%
1847	Barronett silt loam, sandy substratum	15.1	5.2%
W	Water	5.1	1.8%
Totals for Area of Interest		**287.7**	**100.0%**

Forest Cover Type Information

The following forest cover type information and management objectives are based upon field investigation and review of the 2011 Natural Resource Report.



Cover Type Information: Mixed Oak

Description

The mixed oak stand comprises the majority of the forested area of the park. This oak cover type contains a mixture of red oak, pin oak, bur oak, white oak, red maple, black cherry, hackberry, elm, ash, birch, aspen and an understory of ironwood. Within the cover type are several small ponding areas which contain small pockets of aspen and birch surrounding them on the lower ground where water levels can fluctuate. The oak forest is very important to wildlife and is ranked one of the highest valued cover types for many varieties of wildlife. Anywhere within the oak forest area there is adequate food, cover and water resources within a short distance

The diameters average 12 inches for the overstory trees with individuals in the 20 inch plus range. This represents a mature oak forest. The Basal area within the oak cover type which was not affected by wind damage averages 90, which indicates a fully stocked forest. In the areas of wind damage the basal area ranges from 20 to 60 depending upon the amount of tree loss the site has suffered. There are pockets within the stand which have extensive tree loss due to the storm.

The DNR Natural Heritage review indicates the cover type as an Oak/Maple type which is found within the site however the majority of the red maple are found in two predominant areas. There is a larger pocket of red maple in the northwest corner of the park and also on the eastern portion

of the park north of the larger pond. Red maple is a beautiful tree in the fall; however, its wildlife value is quite low compared to all oak species.

Within the oak type are a number of blow down areas ranging from a few trees, to the largest area in the northeast portion of the park, just south of the houses. The winds came from the west-northwest as can be seen in aerial photography. This largest area is approximately 4.5 acres in size. This area did have a higher number of aspen growing within it and the larger bigtooth aspen were blown down along with scattered oak on the site. The northeastern blow down site contains the aspen type and adjacent portions of the oak cover type which surrounds it. In the areas with the heaviest damage, there remains about a 40 percent residual crown cover. Some areas have less damage with trees leaning but not blown over.

This site sits on a higher portion of the park and was more exposed and vulnerable to damaging winds. There are numerous trees of various species which have broken off and/or tipped into healthy trees. These trees are leaning into healthy trees which can cause wounding as the trees are constantly moving in the wind and rubbing against each other. These leaning trees can also cause increases in oak wilt as they cause wounds and will eventually fall as the wood rots.

There are pockets of oak wilt within the oak cover type which have been identified in the past and mapped. The oak wilt in the park is generally contained in the red and pin oaks and will generally move through a portion of the stand and kill only the red and pin oaks through root grafting. The infection center will expand by grafting to oaks of the same species. The disease will move as long as there are other oaks of the same species present. The distribution of other oak species and other tree species in general will reduce the spread potential. This grafting does not (or very seldom) take place between different species such as red oaks to bur oaks or white oaks. Because the stand is made up of a nice mixture of reds and whites, the affect of the disease is lessened. The disease centers should be monitored during the growing season and efforts made to control the disease in areas where there is a larger population of the species affected where it could continue to move through the forest killing larger numbers of trees. It is important to not create any wounds to any oak specie during April, May or June. Generally tree work on oaks is late fall through the winter. See the oak wilt map at the end of this report.

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Cover Type Information: Aspen

The cover type identified as aspen are located as shown on the map on page 12. The aspen type was probably a result of seeding into open disturbed areas. The history of the site would indicate that the land was probably grazed and contained primarily bur oak with scattered red and pin oaks in a pasture setting. Once the grazing was ended the site began filling in with tree species. The red oak seeding in where there was enough light to thrive and the aspen seeding into the larger open areas where there was little tree cover and a disturbed soil.

Aspen is a specie that is a good wildlife tree and is often associated with birch. The aspen on the site are of both "Trembling Aspen" and "Bigtooth Aspen". The sites are primarily located on the eastern portion of the property, with the three main areas as indicated. There are smaller edge pockets of aspen/birch throughout the park, which occupy the edges of the wetlands. Often young aspen can be found growing in these areas as the fluctuating water levels in the ponds allow the trees to grow and populate the pond edge during drought times but are killed or knocked back during times of high water. The trees will constantly be going through a transition

of growing conditions which they have adapted to. Because the aspen need full light to establish, the opening of the pond fulfills that need.

The aspen cover types are generally medium to mature in age with the majority of the site in the 40+ year age class. At that age, the more mature aspen will begin to fail or decline in health and structure. The trees will develop cankers and begin dying from the top losing major limbs. These trees are also more susceptible to wind throw and damage during storms. In normal natural situations, the loss of these trees would be a natural transition to an intermediate stage of forest, which would occupy the site of the aspen as they fail. They would be replaced by many different species that have some shade tolerance, including oak, cherry, elm, ash, boxelder, white pine (if a seed source is present), hickory, walnut, etc.

Buckthorn does occupy a large portion of the understory of the entire forest within the park. There is enough small buckthorn in the aspen stands to out-compete any other species as seedlings. Once the stand begins to open because of the loss of the aspen by wind storms or natural decline, these young buckthorn will grow rapidly and occupy the site. Experience has shown that if aspen and buckthorn are cleared at the same time to create an opening, the aspen will outgrow the buckthorn and reestablish itself on the site. It is not uncommon to see thousands of stems per acre of aspen repopulate a site after cutting takes place.

Two years after clearcutting, there should be at least 5,000 aspen root suckers per acre

Photo © University of Minnesota Extension

Natural succession of this forest cover type is to go from aspen to an intermediate shade tolerant forest, and then over time convert to a stand with larger numbers of shade tolerant maple and basswood. This process can take hundreds of years and in nature is interrupted by periodic

disruptive events like fire and wind storms. The forested areas in this region have always been in transition with pioneer forests, intermediate forests and climax forests being mixed and changed as events occur. This mixture of forest types is very beneficial to many species of wildlife with many different habitat requirements.

The aspen sites within the park have significant blow down areas and are advancing toward maturity. The decision will need to be made as to how to handle the aspen blow down areas and also the older aspen stands adjacent to the trail system in the southern portion of the park near the parking area.

Two options exist within the aspen blow down areas.

1. Create small patch cuts of approximately 1-1.5 acre in size and allow the regeneration to reestablish the aspen cover type.
2. Inter-plant the blow down sites with other species and move the stand to a mixed hardwood stand with some residual aspen but supplemented with hardwood plantings.

The trails with high populations of large mature aspen will continue to produce unsafe trees due to age and the general way aspen will die. The tops will slowly die off with large branches breaking and falling sporadically.

Options.

1. Leave the sites alone and monitor for hazard trees. Remove them on a yearly basis. Under-plant with shade tolerant species over time.
2. During a harvesting process remove a portion of the large trees so the areas can be inter-planted with other hardwood species. Over time convert the site from aspen only to a mixed hardwood forest cover type.

Cover Type Information: Pine

There is a small area of planted red pine near the parking area as shown on the cover type map. These pine were planted approximately 20 years ago and range in diameter from 5 to 8 inches depending upon their placement. Outer trees that receive the most light are larger and exhibit a more open grown appearance with a larger crown and side branching. The grouping of trees is somewhat congested in a few spots but the trees are healthy at this time with no apparent disease or insect problems. No management activities are needed at this time.

Plan Recommendations Overview

Although the Park is considered a "Natural Area," the land has been highly influenced by past and present human activity. In Pre-Colonial times some lands were burned for hunting and security purposes and later the Settlers controlled fires and cleared land and grazed the forests. In the present, the introduction of invasive species has dramatically changed the natural progression of the forest. All these factors have constantly changed the natural progression of the forest and made some form of management needed to maintain a vibrant and healthy forest cover type within the Park.

The greater purpose and ultimate goal of this plan is to maintain a robust forest ecosystem that can survive and flourish over the next 100 years and beyond.

Many of the management activities to achieve this goal vary greatly as to their short term impact and aesthetic impact. While the methods may vary dramatically, there are certain requirements and growing conditions that must be met to allow the various species of trees to flourish on the site. Some species need full sunlight to thrive while others can survive in a dense forest overstory. Soil conditions, and soil types, aspect (direction the slope of the ground is facing), competition, germination requirements, and browse susceptibility will all impact survivability.

The oak forest is naturally supported by fires moving through the understory and removing the invading shade tolerant species of thin barked trees and shrubs. It also removes the duff layer of compacted leaves and releases nutrients into the soil and opens up the soil to seed germination and allows the oaks to continue on the site. These fires historically would take place periodically, consuming the buildup of fuel that is found on the site presently.

With the mineral soil exposed, thousands of acorns would sprout and grow. Of these thousands of seedlings, only the ones that had enough light, moisture, and room to grow and weren't eaten by wildlife will make it to maturity, maybe 100 - 200 trees per acre.

Oak seedlings and saplings numbers are very low within the oak areas and also within the small openings created by the oak wilt pockets in the park. Even though the area would support oak or other forest tree regeneration, these small openings are being over-grown with buckthorn.

With the very low numbers of regeneration trees, the forest will slowly be lost to the thick dense stands of buckthorn. This will occur slowly as the large over-story trees are lost to old age, disease, wind storms, insect outbreaks, etc. As this happens, the buckthorn that are currently growing in the understory are given the light to "take off". As these buckthorn plants flourish, other trees and shrubs have little space or light to germinate and grow.

Therefore the five primary management activities that will focus on maintaining a forest cover type are:

- **Cutting/processing** of the blow-down areas and oak wilt infection centers to allow for planting or natural regeneration.
- **Buckthorn treatment** either on a large scale or on an individual planting site scale.
- **Planting** strategically to establish the future forest within the blow down areas and oak wilt sites and also to transition existing maturing aspen stands to lower maintenance mixed hardwood cover type.
- **Fire threat reduction** and improving the aesthetic quality of the trails by removing the scattered storm damage and hanging trees from various areas of the park.
- **Oak Wilt Inspection** completed on an annual basis.

The planting or promotion of natural regeneration is the ultimate management need for the goal of maintaining a forest long term in the park. Over the next 100 years the most important aspect will be planting.

Cutting/processing

Three different levels of intensity of treatments options which would provide for the ultimate goal of maintaining a forest cover are outlined below.

1. High Intensity

The use of a bio harvester or logger to remove the pockets of blow down, oak wilt and selected leaning trees would provide some income to the community for future forest management. The machines that are used are large track machines that can move a quantity of wood material in a short amount of time. While, these machines can scarify the top soil, they do not produce a significant amount of compaction due to the width of the tracks. They are capable of grabbing a large tree up to approximately 20 inches in diameter, cutting it and laying it down. The tree is then either moved as a full tree to a processing site on the edge of the park or it is de-limbed and the trunk is moved. The material removed is then separated into a log pile and chip pile. These materials are then chipped on site and hauled away or hauled in log form from the site. Often trees which have been broken or toppled by wind storms are not suited for logs because the tremendous forces which damaged them also caused the structure of the wood within the trees to be degraded. This is called "ring shake," it causes the growth rings within the wood to separate making it unsuitable for lumber.

The cutting process would involve laying out a plan that would address the exact areas and boundaries for the cutting area by marking the removal trees or marking the edges of the cutting zones. Once marked, the logger and city can review these sites and set up work areas for processing and identify access points and haul paths. Minnesota State Guidelines or current

BMP's (Best Management Practices) would be followed for standing dead leave trees and downed logs per acre for wildlife habitat. The process would be expected to take 2-3 weeks to accomplish with hauling taking place as needed and agreed upon.

Pros

1. The bio-harvest/logging time is relatively short, taking 2-3 weeks for the harvest portion when the park would need to have restricted access.
2. Although disruptive, the compaction to the soil will be reduced because of the large tracks and wide tires used.
3. It would be expected that the City would receive some income for the material removed, but this would depend upon restrictions and conditions that are placed upon the contractor. It should be noted that most cost-share programs will help pay for buckthorn control and planting but not for removal.
4. All sites would be safe for planting crews to proceed the following spring to replant the sites. Current conditions with heavily damaged and leaning trees are unsafe in off trail areas.
5. Buckthorn control in these areas would be less difficult.
6. This process would remove a significant amount of fuel wood which would aid in reduction of the possibility of a wild fire.

Cons

1. Aesthetically the logging or harvest sites will look as though they have been logged with scattered debris and some disruption of soil. This view can be disturbing to park users who are not accustomed to seeing this type of disruption. Brush will be bent down and crushed and there will be some damage to the trails, which will have to be restored. This can either be accomplished by city crews at a later date or could be incorporated within the cutting agreement. I have included a link to a YouTube video that shows a blow down clearing area using large equipment similar to what would be used within the park if this option is selected. https://youtu.be/d02HbvvcAQs

2. Medium Intensity

The use of city crews or firewood contractors to work on smaller areas at a time, over a longer period of time. This option could take place over one season or several depending on the time the city crews would have to complete the operation.

Crews would work on a smaller scale with smaller equipment to clear blow down in the selected areas and also work on the oak wilt pockets. The crews would cut and drag or haul material to a

landing where an outside chipping company or rental chipper could be used to process the material into chips, which would be used within the park trails and around the city.

It could be expected to take several seasons to work through all the blow down areas and oak wilt pockets within the park. These work areas would then need to be prepped for planting by removing all or a portion of the buckthorn within the cut area to allow for plant survival.

Pros

1. Probably more aesthetically pleasing due to the smaller scale and the flexibility of time with which to accomplish the activities. The individual sites will probably look about the same depending upon the equipment used to remove the downed and leaning and dead trees. What usually remain on the site are the broken brush and tops and branches that break off and are left. From an ecological perspective, the small woody material is important for wildlife habitat.

2. You may only need to close small portions of the park to users at a time. (With the high intensity program, the entire park would possibly need to be closed.)

3. There will be less disruption to the trails and soil if rubber tired equipment is used on the site. (However compaction of soils will be increased in some work areas that are not frozen)

4. The other management activities (buckthorn removal/treatment and planting program) can be planned over a three year period or so, instead of needing to be accomplished within the first year.

Cons

1. Often the actual ability to move large quantities of material on the site is beyond the capability of smaller crews and equipment available.
2. There will be a loss of revenue that would be obtained with a larger bio harvest format.
3. The actual removal process should be scheduled so it doesn't get bumped by other projects that come up. Later activities such as buckthorn treatment, planting prep, and tree ordering will depend upon the removal process being completed.

3. Light Intensity

From a pure habitat perspective, the amount of downed wood and standing dead wood is really a benefit to various species of wildlife. Therefore it would be possible to do a light intensity removal for fire suppression purposes in various areas while leaving the majority of the site with downed trees. The use of firewood contractors along various trails to remove enough downed

material to create fire breaks and creating a buffer zone on the edges of the forest line to reduce fuel load would reduce the opportunity for fire to become out of control.

Many of the trees are in areas of little use by park users and could be left where they are and crews could be used to get leaning trees or multiple groupings of trees on the ground by using chain saws and small equipment. Once on the ground, the wood absorbs moisture and will begin to rot.

Trees that are broken and leaning onto healthy oak trees would be felled or pulled off the healthy tree. These leaning trees can continually rub on a healthy tree and cause a wound, which can spread oak wilt in the park.

Pros

1. This option would be the least invasive to the site, as it leaves all the material except that which is removed for fire control on the site.
2. The cost would be less as the equipment requirements would be far less.
3. There would be an increase in habitat due to the increase in downed material in the forest.
4. There would be minor closures of the trails during work periods because little material would be removed.
5. Little disruption to the trails or soil in the cut zones would occur.

Cons

1. This option would increase the difficulty with both buckthorn management and planting of the site. It would mean having to maneuver through large areas of downed trees to reach planting sites and would inhibit larger scale buckthorn removal.
2. If aspen regeneration is a goal, it will inhibit that regeneration because of the shading of the ground, which inhibits root sprouting. I would expect some regeneration to come through these downed trees however.
3. It will hurt the aesthetic appeal of the park to many park visitors. A good education program could help visitors understand the benefits of downed trees to wildlife.
4. Long term maintenance costs will increase due to the numbers of dead trees near trail and use areas.

Public Acceptance

With any management activity there will be some form of disruption to the normal use of the park. Trails may have to be closed, some soil disruption will take place, and the sight of trees and brush being removed will disturb some users of the park. Therefore it is important to provide educational materials and signage within the park to help the public understand the goals and

reasoning for the management activities they will see within the park. This material and signage will also aid in recruiting possible volunteers for planting and buckthorn removal projects to help the City reach its cost share matching goals.

Buckthorn Control

Buckthorn control is critical to the establishment of regeneration of the future forest. Buckthorn inhibits natural regeneration of forest trees and native plant communities. At high levels of density on slopes, sheet erosion can occur as only a few small plants can survive under the buckthorn to hold the soil in place.

There are three basic control measures that could be implemented on the site. The options will be dependent upon the individual site and funding sources. This is a long-term battle that can be very difficult to win. I would expect buckthorn to be present within the Park for many years to come. Reducing it and managing it will help restore natural regeneration and also increase native plant communities.

During the development of this plan, I met with Mr. Wiley Buck of Great River Greening, which is a non-profit working with various groups and communities on buckthorn control programs. Mr. Buck has been successful in obtaining significant cost share money for these projects. I would recommend the City work with him or identify a coordinator within the City to oversee and seek out funding sources for buckthorn and planting projects.

The three primary Buckthorn management control measures within this plan are:

- Area-based Buckthorn control zones.
- Spot clearing for individual planting sites.
- Wide-scale treatment of seed bearing plants.

Area-focused control zones

These areas would coincide with planting areas to reduce competition, and also high value habitat or natural areas that would allow for using natural plant regeneration techniques. While

the removal methods could vary, the use of brush saws and herbicide is typically involved. The buckthorn removed can be chipped, removed, or burned on site.

Spot clearing for individual planting sites

To reduce the cost of large-scale removal and treatment of the buckthorn, a small area for each planted tree can be brushed and treated. By cutting the buckthorn and other taller material from an approximate 10 foot diameter circle around a transplant tree planting site, when planted, the transplanted tree will have the required light and space to grow.

Depending upon the site and the residual trees present, the number of planting sites will be anywhere from 50 to 100 per acre. The individual planting spots will need to be marked with a stake and then a crew would work to treat the buckthorn in those small spots during the fall or winter so spring planting could take place.

Wide-scale treatment of seed bearing plants

Once the buckthorn projects have begun, it is important to remove or treat seed bearing plants. This will limit the spread of large volumes of seeds within the park and surrounding property. This portion of the control will help in long term efforts to reduce the impact of buckthorn on the property.

Planting

With the existing buckthorn problem in the Park, the only way to ensure the future forest is through the planting of trees in the oak cover type or through the use of natural regeneration within the aspen stands. If aspen is clearcut it will out-compete the buckthorn.

The size of the planting stock and the actual planting method will vary depending on the site preparation and removal of downed material. Within the blow down areas, the perimeter would be marked and individual planting sites would be identified with a stake. Once that is completed, the buckthorn removal project would take place, providing a 10 foot circle of planting space.

If the buckthorn is treated on an area basis, the staking would be accomplished after the buckthorn removal is completed. In either situation the staking takes into account the adjacent overstory trees, scattered existing young trees, site conditions, soils, aspect, etc. to determine the species that will be selected to be planted. Some sites will have more sun than others and some will be heavily shaded. Because the planting sites have a residual amount of existing trees that

remain, the planting numbers would be in the 50 to 100 trees per acre range. Planting smaller trees reduces the cost and more could be planted. With larger trees such as saplings, less would be planted but it generally provides a higher survival rate.

Because of the high deer population, it would be wise to use some form of tree shelter for the plantings until the trees reach an acceptable height to resist deer browsing. This shelter can be the tube type which uses the stake for support or it could be a wire roll to protect them. Either option will require some initial cost and some maintenance going forward.

Plant selection and climate change.

Within the development of this plan, the US Forest Service Center for Climate Change was contacted for information regarding expected outcomes for this area and to help with plant species selection. Mr. Handler and I met at the Park and completed a walk through examination. Following is the report that was developed for the Park by Mr. Handler. Some aspects may be utilized more than others, but the basis is a good one for going forward whether or not the expected climate change scenarios occur. The tree species list developed for the Park is a good one to follow but other species of trees could be added if desired.

Climate change information for the Sunfish Lake Park management plan

Climate Change Summary

Climate is the long-term weather pattern for a region for a period of decades. Climate is one of the main factors that can determine the composition and extent of natural ecosystems, and the boreal-temperate forest transition zone is an example of the interplay between climate drivers and disturbances like wildfire. The earth's climate has changed over the past century, and these changes are expected to continue. The following section is a quick summary of observed and projected climate change and impacts to forests in Minnesota (Handler et al. 2014 and Minnesota DNR 2011). Some of the changes that have already been observed include:

- Annual temperature has increased by 1.9 °F since 1895, with accelerating warming since 1980
- Winter minimum temperatures have increased by more than 3.5 °F over the past century, with accelerating warming since 1980
- Annual precipitation has increased by more than 3 inches statewide, particularly in the spring and fall.
- Heavy rainfall events (3+ inches) have become much more frequent

- Lake ice break-up, leaf-out, and bird migration dates are shifting earlier into the spring

Climate change is projected to continue, although there will always be uncertainty in long-term projections. The best available science supports the idea that temperatures will increase across all seasons in Minnesota over the next century. Projected change is on the order of 5 to 9 °F by the end of the century, with winters likely to continue warming faster than other seasons. Precipitation is projected to increase up to 1 inch during winter and about 1 to 3 inches in spring by the year 2100. The greatest uncertainty exists for summer precipitation, with slight increases or large decreases possible. There may be greater moisture stress in summer and fall, because higher temperatures and longer growing seasons will lead to greater water loss from evaporation and transpiration. By the end of the 21st century the climate of Minnesota is generally projected to be hotter and more variable, with more moisture stress towards the end of the growing season and less characteristic winter weather.

Climate change will not affect all forest species, communities, and parts of the landscape in the same way. Additional stress will amplify some threats that forests already face, such as insect pests and diseases. Generally, boreal tree species are expected to decline and temperate or southern species are expected to be favored (see tables 1 and 2). Species and forest types that are more tolerant of disturbances may have less risk from climate change, and forests with greater diversity (species, genetic, and structural diversity) may also have less risk. Site-level characteristics like soils, hydrology, forest health issues, invasive species, and surrounding land-use can also influence whether a particular forest may experience more or less risk than elsewhere on the landscape.

Table 1: Tree species expected to increase in suitable habitat in the Minnesota and NE Iowa Section (222M) by the year 2100. Source: Climate Change Tree Atlas, www.nrs.fs.fed.us/atlas/tree/ecoregion_ew.html.

Boxelder	silver maple	Sycamore	osage-orange
Hackberry	bur oak	green ash	black willow
black locust	shagbark hickory	mockernut hickory	pin oak
eastern redcedar	slippery elm	eastern white pine	river birch
red mulberry	chinkapin oak	swamp white oak	honeylocust
eastern cottonwood	black oak	northern catalpa	bitternut hickory
American elm	wild plum	Ohio buckeye	pignut hickory
black walnut	white ash	black hickory	

Table 2: Tree species expected to decrease in suitable habitat in the Minnesota and NE Iowa Section (222M) by the year 2100. Source: Climate Change Tree Atlas, www.nrs.fs.fed.us/atlas/tree/ecoregion_ew.html.

quaking aspen	black ash	northern pin oak*	Chokecherry
northern red oak	bigtooth aspen	northern white-cedar	Red pine

sugar maple	white oak*	eastern hophornbeam*	pin cherry
paper birch	tamarack	black spruce	white spruce
American basswood	jack pine	red maple	black maple
black cherry*	balsam fir	Butternut	yellow birch

*These species are projected to decline under higher climate change scenarios, but they may persist or increase under mild climate change scenarios.

Adaptation

Preparing for climate change presents opportunities for forest managers and landowners to plan ahead, assess risk, and ensure that the benefits forests provide are sustained into the future. Landowner goals and management opportunities (or constraints) can help determine the most appropriate actions to prepare for climate change. Different adaptation actions can be used to resist change, boost resilience, or encourage change. Choosing a range of actions may be appropriate for many landowners, depending on their values and site-specific risks or opportunities. This plan made use of an "Adaptation Workbook" that has been produced to help foresters and landowners incorporate climate change considerations into forest management (www.forestadaptation.org/far).

In a site visit at Sunfish Lake Park with Stephen Handler of the Northern Institute of Applied Climate Science, we discussed the following management actions and their potential benefits for climate change adaptation:

Table 3: Management activity and potential climate change adaptation benefits for Sunfish Lake Park.

Management Activity	Benefits for Climate Change Adaptation
Across the entire site	
Treat buckthorn along trails (herbicide and mechanical removal).	Reducing buckthorn allows more opportunities for regeneration of native trees and understory species.
Remove downed trees and debris from recent blowdown events. Focus on hazard trees and combustible fuel, not decomposing wood.	Reducing fuel load will reduce the potential for a catastrophic or high-intensity wildfire.
Retain snags and coarse woody debris away from trails.	Retaining biological legacies and woody debris provides valuable habitat for animal and plant species.
Consider opportunities for planting tree species projected to increase under climate change. Consult table 1 above and think about site-level suitability for those species.	Gradually increasing the proportion of species that may be better able to tolerate future conditions will help the site transition over time and maintain forest cover on the property.
When planting trees, consider opportunities for	Planting stock from warmer, drier locations may be

planting stock from further south or west.	more tolerant of future stress. This might also introduce favorable genes into the local populations.
Identify vernal pools and wetlands; avoid management activities on these sites.	Protecting these sites may maintain habitat for wetland-dependent species.
Oak cover type	
Identify and treat oak wilt pockets throughout the park – cut infected trees and neighboring red oaks, sever root grafts. Avoid damage to oaks from April-July.	Containing oak wilt will help maintain a diversity of oak species.
Consider opportunities for prescribed fire.	Restoring fire to this landscape will control understory competition, allow more light to reach the forest floor, and promote native species regeneration.
Aspen cover type	
Create gaps (1/4-acre to 1 acre) within existing aspen stands to encourage aspen regeneration	Encouraging diverse age classes reduces overall vulnerability for this species. Sustaining this cover type reduces overall vulnerability for the property.
Identify bigtooth aspen stands that are suitable ages for regeneration and create gaps in these stands.	Bigtooth aspen is projected to be more drought-tolerant and less vulnerable to climate change than quaking aspen. Encouraging natural regeneration of this species can maintain overall species diversity and maintain the aspen cover type.

More Information

Much more information on observed climate trends and ecological indicators for Minnesota can be found here:

- Minnesota State Climatology Office: climate.umn.edu/
- Minnesota Department of Natural Resources "Climate" Web page: www.dnr.state.mn.us/climate/index.html

- University of Minnesota Extension “Extreme Weather” Web page: www.extension.umn.edu/extreme-weather/ drought-fire/climatology/
- Minnesota Phenology Network: https://www.usanpn.org/mnpn/home

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Handler, Stephen; Duveneck, Matthew J.; Iverson, Louis; Peters, Emily; Scheller, Robert M.; Wythers, Kirk R.; Brandt, Leslie; Butler, Patricia; Janowiak, Maria; Shannon, P. Danielle; Swanston, Chris; Barrett, Kelly; Kolka, Randy; McQuiston, Casey; Palik, Brian; Reich, Peter B.; Turner, Clarence; White, Mark; Adams, Cheryl; D’Amato, Anthony; Hagell, Suzanne; Johnson, Patricia; Johnson, Rosemary; Larson, Mike; Matthews, Stephen; Montgomery, Rebecca; Olson, Steve; Peters, Matthew; Prasad, Anantha; Rajala, Jack; Daley, Jad; Davenport, Mae; Emery, Marla R.; Fehringer, David; Hoving, Christopher L.; Johnson, Gary; Johnson, Lucinda; Neitzel, David; Rissman, Adena; Rittenhouse, Chadwick; Ziel, Robert. 2014. **Minnesota forest ecosystem vulnerability assessment and synthesis: a report from the Northwoods Climate Change Response Framework project.** Gen. Tech. Rep. NRS-133. Newtown Square, PA; U.S. Department of Agriculture, Forest Service, Northern Research Station. 228 p.

Minnesota Department of Natural Resources. 2011a. **Climate change and renewable energy: management foundations.** St. Paul, MN. Minnesota Department of Natural Resources, Climate and Renewable Energy Steering Team. Available at http://files.dnr.state.mn.us/aboutdnr/reports/conservationagenda/crest-ccref.pdf.

Swanston, C.W.; Janowiak, M.K. 2012. **Forest Adaptation Resources: Climate change tools and approaches for land managers** Gen. Tech. Rep. NRS-87. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. Available at http://www.nrs.fs.fed.us/pubs/40543.

Fire Threat Reduction

The threat of fire within the Park is due to the large amounts of downed material from the storm event and also, to a small degree, the oak wilt sites. The wind storms did the majority of the damage in the two aspen/mixed oak areas. However there were numerous trees scattered throughout the park that were broken or knocked down. All this material creates a threat for a ground fire to take hold within the park boundaries.

During the development of this plan the MN DNR Metro Fire Officer (Art Widerstrom) was contacted and completed a walk through on the property to discuss the downed material and the

potential for a fire within the Park. Before a fire report was written, Mr. Widerstrom had retired from the DNR. Following are his thoughts as described during several on site visits:

Generally fires within hardwood forests are uncommon due to the rapid green-up in the spring. They can, however, develop and move into a hardwood forest if a property with a grass/wetland fuel load is adjacent. Mr Widerstrom felt that with the significant blowdown and structure of the fuels (not fully on the ground), there was the potential for a significant fire in the right conditions of low humidity and high winds. The fires generally would enter the property from the south and west but other wind directions could fuel a fire in the right conditions.

The extensive trail system that really covers the entire Park area is ideal for fire control and can be the solution to reducing the fire danger. These trails provide access for removal or utilization of this downed material along the trails and also provide good access to the site should a fire start. Removal or chipping of the recently deposited materials within 50 feet of the trails will greatly reduce the chances of a fire spreading through the entire forested area. He suggested using a firewood contractor (one or more) to reduce the fuel load and obtain some income for use within the Park.

Based upon this information, it is recommended that firewood contractors be contacted to help reduce the threat by removing the newly downed woody debris from within 50 feet of the trails. Older downed and rotting material would be retained on the site and additional logs will be allowed to remain where fuel loading is at acceptable levels. Areas of firewood removal would be marked as the contractors move to new areas. Focus would first be on the extreme southern and western portions of the park along with the northern edge adjacent to home sites. The material to be removed would be marked for removal until the contractors and City felt comfortable in their working relationship. Timing, work area boundaries, and site selection for material storage would need to be worked out with the contractors.

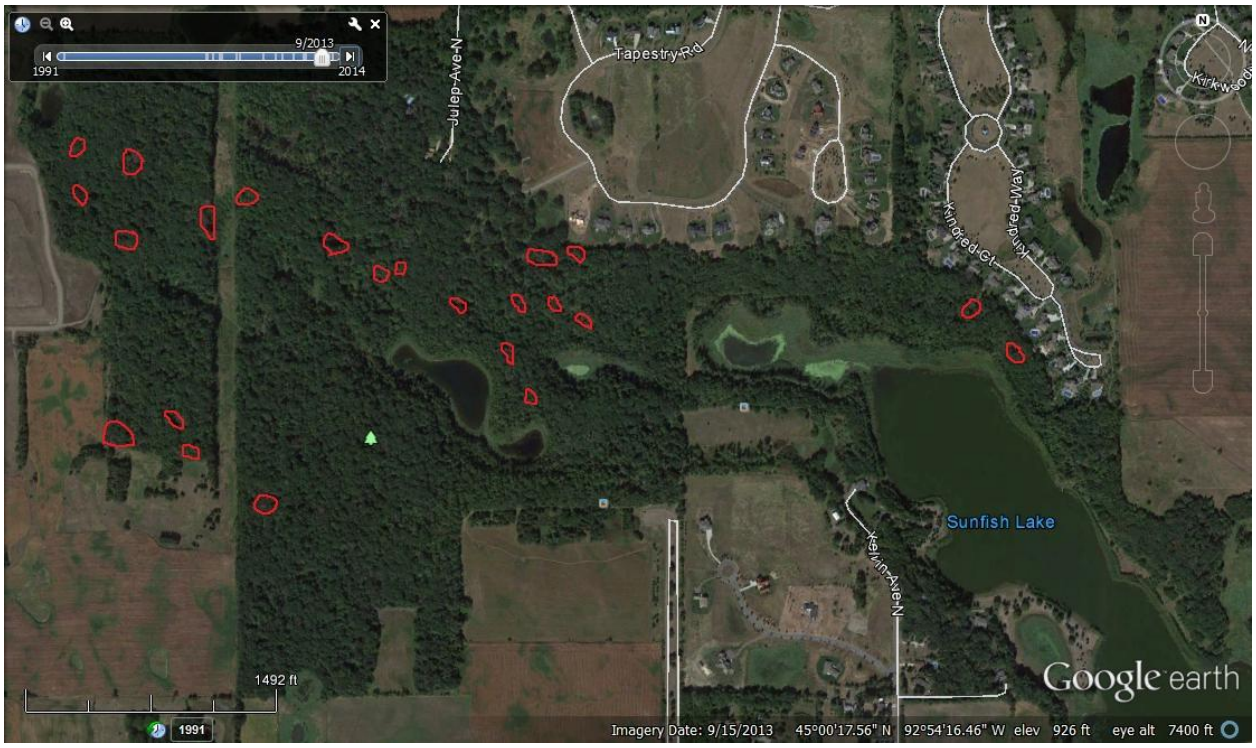
Oak Wilt Inspection

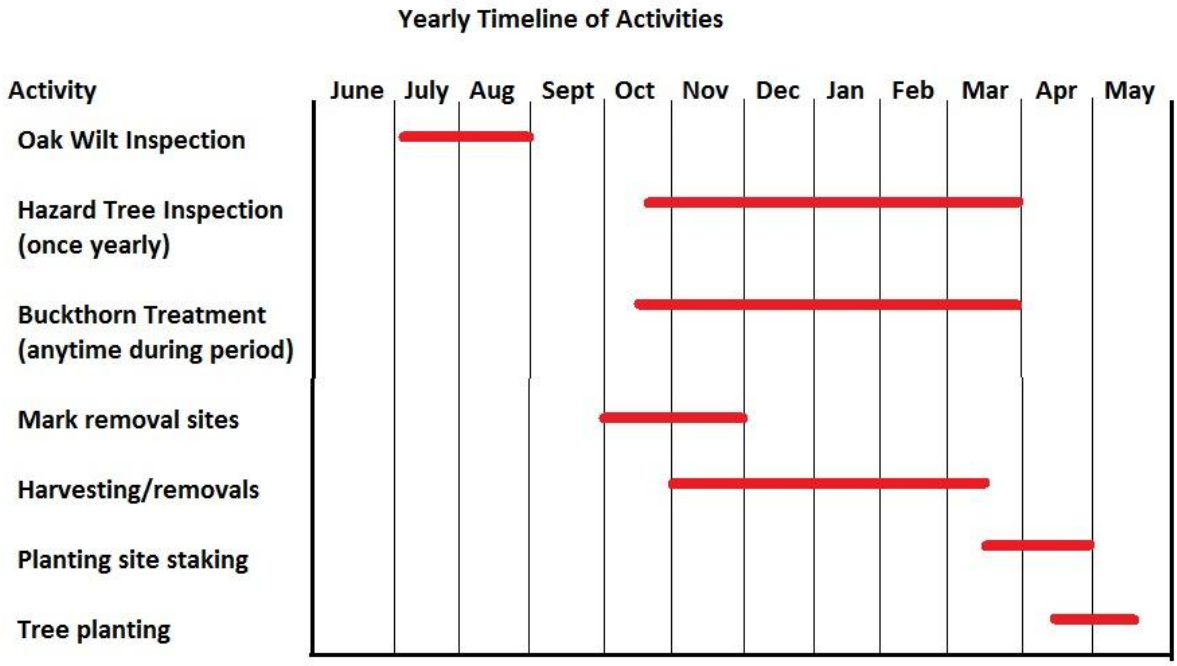
There are pockets of oak wilt within the oak cover type that have been identified and mapped. The oak wilt in the park is generally contained in the red and pin oaks and will generally move through a portion of the stand and kill only the red and pin oaks through root grafting. The infection center will expand by grafting to oaks of the same species. The disease will progress as long as there are other oaks of the same species present. The distribution of other oak species and other tree species will reduce the spread potential. This grafting does not (or very seldom) take place between different species such as red oaks to bur oaks or white oaks. Because the stand is

made up of a nice mixture of reds and whites, the affect of the disease is lessened. The disease centers should be monitored during the growing season and efforts made to control the disease in areas where there is a larger population of the species affected where it could continue to move through the forest killing larger numbers of trees. It is important to not create any wounds to any oak specie during April, May or June. Generally tree work on oaks is late fall through the winter.

Following is a map based upon ground and aerial inspection completed in 2015. The sites identified either exhibited active wilting trees or contained multiple dead standing oaks. The circles drawn do not represent the actual shape of the infection but indicate where an infection may be active. This is an overview and it is expected that not all infection centers may be identified. There are several sites that look as though they were past centers but have no current indicators that can be seen. Also, when the infection moves into bur and white oaks, the symptoms are more difficult to see both on the ground and through aerial observation. An ongoing yearly inspection program is needed to identify all the active infection centers and identify areas where control work would be appropriate.

Oak wilt map





1. Blowdown area photos.

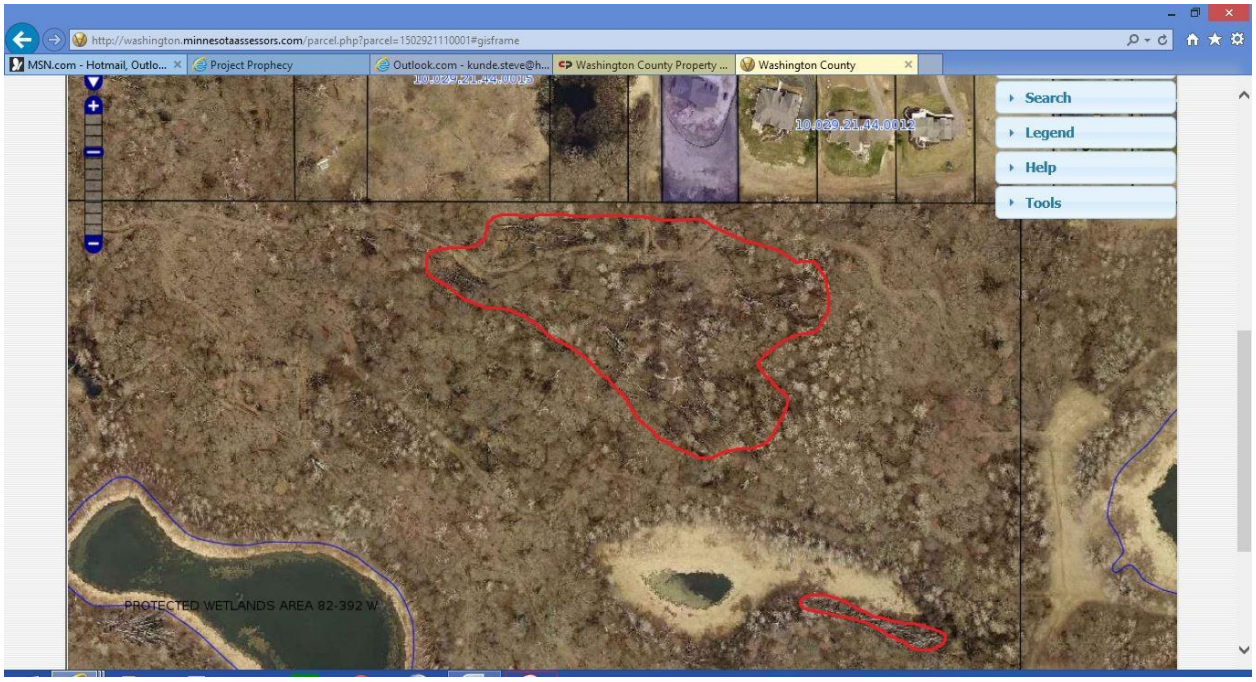
Following are two double sets of photos showing pre-storm photos and post-storm photos taken from Google earth. In both sets one can see the reduction in crown density that took place due to the storm. The loss of crown density varies throughout the various cover types with scattered larger trees lost throughout the park to areas where the crown density was reduced to approximately 40 percent. The small areas of aspen pockets that were contained within the northern oak cover type were hit the hardest, as was the larger grouping of aspen north of the parking area.

Following these photos are two more photos showing the size of the two major blowdown areas. These photos were taken from the County GIS property mapping site. By looking through the report file, one can access good quality photos of these areas. One can zoom in on the blowdown areas and see the actual downed trees.

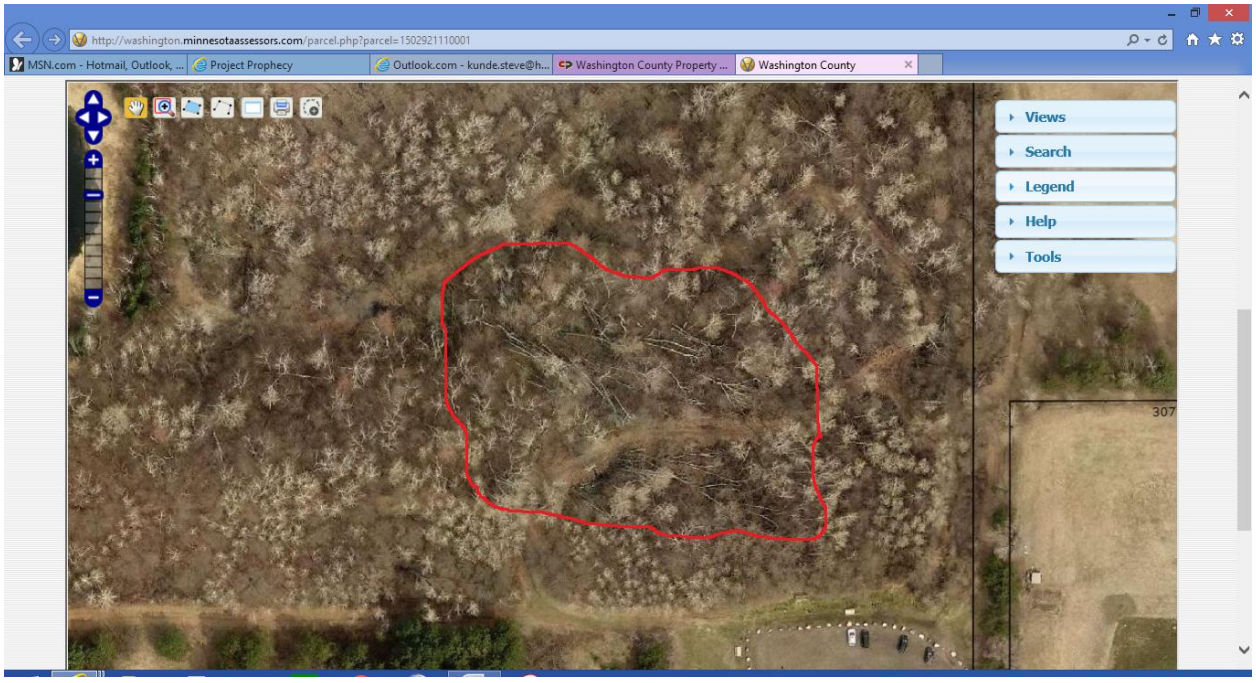
Crown density comparison 2010 vs. 2013 post-storm (North)

Crown density comparison 2010 vs. 2013 post-storm (South)

Blowdown area on north side



Blowdown area near parking lot



North, approximately 4.5 acres

South parking lot area, 1.5 Acres

Questions for the Park Board to consider

1. Would the City like to promote the regeneration of Aspen on the site near the parking area, or promote moving toward a more diverse cover type?

2. What level of intensity of removal and logging or salvage is acceptable to the Board and to the users of the park?

3. Is the funding available to support that level of activity?

- High intensity would generate some income through the harvesting company and also the firewood contractor.
- Medium intensity would require funding for City staff and equipment use along with rental fees for chipper. Firewood contractors would generate some income.
- Light intensity would require funding for dropping leaning trees and limbing trees to get trees trunk on the ground. Firewood contractors would generate some income.

4. State and Federal Cost Share Funding usually requires matching funds either in cash or in volunteer activities. This funding is usually available for control of invasive species and or planting activities. Does the City have the ability to supply these funds or work to contribute the needed combination of money and volunteer efforts?

5. Would the City work with outside Environmental groups like Great River Greening to facilitate the buckthorn control and planting programs?

6. Is the City willing and capable to complete two yearly oak wilt inspections within the park either by City staff or contractor?

7. Is the City willing and capable to establish yearly hazard tree identification and marking program, and associated removal along the pathways and highly used areas within the park? This identification and marking can be completed by either an outside contractor or by using City staff. A training course should be completed to properly identify the actual hazard trees.

Final Recommendations

The following recommendations are based upon completion of numerous on site visits, meetings with experts in various natural resource fields, and discussion with City staff.

1. Utilize firewood contractors to alleviate the fire danger that now exists. This will generate some income for the program and allow for the removal of quantities of suspended woody material which is of particular concern.

2. Choose the Medium Intensity option of removal. This option will utilize City crews to remove material on a more flexible schedule, utilize the chips produced within the park, limit park closures, and reduce the overall impact of the removal on Park trails and work sites. The work could take place over a 3 to 5 year period with removal work focusing within the blowdown sites first, then working on the oak wilt sites as needed. As these areas are cleared, treated for buckthorn and planted, the City will be developing a long-term management procedure to use in future weather events.

With the firewood contractors working along the trails first and then working within the blowdown areas to utilize the harder wood species, the City crew can focus on the downed aspen trees, which will be the easiest to cut and process into chips because of the softness of the wood.

During this process, the DNR recommended BMP's (Best Management Practices) would be utilized to leave scattered dead standing trees and downed logs for habitat purposes.

3. The level of the buckthorn control will be dependant on the ability of the City to obtain cost share funding or fund the projects internally. Whether an area based approach or a select planting site approach is used will depend on the funding and logistics of removing large amounts of buckthorn. I recommend working with Buck Wiley of Great River Greening to have the best chance of obtaining additional cost share funds. The organization also has extensive experience in producing and directing extensive volunteer involved events. The ability to coordinate these events will greatly reduce City staff obligations and workload. And because the organization has a working history with the Minnesota Land Trust, it should make compliance with the "Land Covenants" easily acceptable to the Trust management.

4. Utilize the recommendations of the Center for Climate Change to maximize the survival of future plantings. The planting lists provided are a good base of species to utilize in future plantings along with other species that may become available through various organizations. The Park may be used by the US Forest Service as a demonstration site in the future, which could make funding or assistance in the future possible.

5. Develop a good comprehensive sign and educational program for the Park. Through education, the Park users will come to understand the purpose of the work and come back to volunteer when the Park needs helpers to remove buckthorn or plant.

6. Establish an oak wilt program with two yearly inspections to identify and map the oak wilt sites. As the sites are located, a decision can be made as to the need for control work. Many sites will not need control work, as the disease will be limited by other species. The inspections can be done in two full days of work, one around July 4th, and the other at the middle to end of August. Oak wilt in red and pin oaks can easisly be seen from the air due to the bright orange color change of the leaves. I was able to take aerial photography for less than $100 dollars because of the close proximity of the airport. The photos can then be used for field checking and mapping with a handheld GPS. This will allow future inspections of the same spots using the GPS.

Only a small portion of the infected red and pin oak trees will produce the spore mats that can spread the disease to other oaks. These trees can easily be identified and rendered harmless by girdling or removing the tree. This will greatly reduce the chance of spread of the disease to new areas. For safety reasons, when to remove or girdle trees will be based upon how close to a use area the tree is located.

7. Establish a once yearly hazard tree inspection program. With the removal that has already taken place, the City has greatly reduced the threat of falling trees and limbs. I would recommend that one City staff member complete a hazard tree identification course and then complete the inspections yearly prior to any scheduled tree removal activity. This inspection is best completed in the dormant months of the year.

Resources and Assistance

Thanks to the following for the information and assistance provided.

Stephen Handler - USFS Climate Change Expert

Art Widerstrom - DNR (Retired)

Jeff Warhol - Three Rivers Park District Forestry Operations Manager

Wiley Buck - Great River Greening

Ann Thies - Minnesota Land Trust

Sam Klocksien - Wildwood Forestry