GLENN SPRINGS HOLDINGS, INC.

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August 28, 2012 Reference No. 007405

Mr. Gregory Sutton
New York State Department of Environmental Conservation
Region 9
270 Michigan Avenue
Buffalo, NY 14203-2999

Dear Mr. Sutton:

Re: Revised Operations, Maintenance, and Monitoring Upgrades
Site Drainage Improvement Work Plan
Durez Site
North Tonawanda, Niagara County, New York

Conestoga-Rovers & Associates (CRA), on behalf of Glenn Springs Holdings, Inc. (GSH), is submitting the attached Revised Operations, Maintenance, and Monitoring Upgrades - Site Drainage Improvement Work Plan for the Durez North Tonawanda Site located at 700 Walck Road in North Tonawanda, New York.

We expect to commence field activities on or about the week of September 10, 2012.

Should you have any questions, do not hesitate to contact the undersigned at 972-687-7506.

Very truly yours,

GLENN SPRINGS HOLDINGS, INC.

Clinton J. Babcock
Project Manager

CJB/adh/26
Encl.

c.c.: B. Sadowski, NYSDEC (email only)
J. Branch, GSH
D. Hoyt, CRA
J. Polovich, CRA
J. Pentilchuk, CRA

CONESTOGA-ROVERS
& ASSOCIATES

OPERATIONS, MAINTENANCE, AND MONITORING UPGRADES
SITE DRAINAGE IMPROVEMENT WORK PLAN

GLENN SPRINGS HOLDINGS, INC.
NORTH TONAWANDA, NEW YORK

Prepared For:

Glenn Springs Holdings, Inc.

PREPARED BY:
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JUNE 2012
REV. AUGUST 2012
REF. NO. 007405 (32)

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1.0 INTRODUCTION

This Drainage Improvement Work Plan (Work Plan) presents the Scope of Work to restore proper Site drainage and to reduce and/or eliminate the potential for surface runoff from the Former Durez North Tonawanda Site (Site). The work is being completed as required by the Site's continuing Operations, Maintenance, and Monitoring (OM&M) requirements. The Site is located at 700 Walck Road in the City of North Tonawanda (City), Niagara County, New York. A Site Location Map is provided as Figure 1. A Site Plan is provided as Figure 2.

There are two areas proposed for drainage improvements and multiple areas throughout the Site proposed for regrading to reduce and/or eliminate surface runoff to off-Site areas or limit ponding of Site surface runoff. They are as follows:

- The north/northeastern portion of the Site
- The eastern Site boundary
- Low-lying areas and areas of surface subsidence located throughout the interior of the Site

The area in the northeastern portion of the Site, referred to as the panhandle or uplands, receives overland runoff from sources both on and off the Site. This runoff accumulates in a drainage ditch located near the northern Site border. Under heavy flow conditions, this drainage ditch discharges to the eastern ditch that runs along the eastern property line adjacent to an abandoned CSX rail line Right of Way (ROW). The eastern drainage ditch then discharges to the City-owned Walck Road Sewer System that ultimately discharges to the Niagara River. This Work Plan is designed to reduce and/or eliminate the potential for runoff to leave the Site through improvements to the northern drainage ditch, the eastern drainage ditch, perimeter low-lying areas, and low-lying areas on Site.

1.1 WORK PLAN OBJECTIVES

The primary objective of this Work Plan is to improve Site drainage in such a manner as to reduce and/or eliminate surface runoff from the Site to off-Site areas. As a result of achieving the objective of this Work Plan, the opportunity for surface runoff will be reduced and/or eliminated.

The activities to support the Work Plan objective consist of:

- Construction of an engineered subsurface flow (SSF) wetland along the northern boundary of the Site
- Installation of improved drainage piping through the National Grid ROW along the northern boundary of the Site
- Reconstruction of the eastern drainage ditch to have the proper north to south slope, including the removal of a drainage culvert
- Lining of the eastern drainage ditch with a geotextile fabric and stone to prevent surface erosion and sediment transport and to decrease likelihood of the reestablishment of trees and shrubs
- Replanting of trees and shrubbery in designated areas along the northern and northwestern property line and along the property line to provide wildlife value to the surrounding habitat and to offset habitat loss resulting from the grubbing and clearing activities
- Regrading on-Site perimeter areas along the northern, eastern, and western property lines to direct surface runoff towards the interior of the Site
- Regrading low-lying areas or areas of subsidence within the Site with excavated soils from the SSF wetland and eastern drainage ditch improvements followed by capping with topsoil and reseeding.

1.2 REPORT ORGANIZATION

This report is organized as follows:

i) Section 1.0 – Introduction: Section 1.0 presents an overview and the objectives for the project

ii) Section 2.0 – Site Description and History: Section 2.0 provides a description of the Site location and Site history

iii) Section 3.0 – Scope of Work: The Scope of Work is presented and described in Section 3.0

iv) Section 4.0 – References: A list of the reference materials utilized in the preparation of this Work Plan is presented in Section 4.0

2.0 SITE DESCRIPTION AND HISTORY

2.1 SITE BACKGROUND

In 1977, Occidental Chemical Corporation (OCC) and the New York State Department of Environmental Conservation (NYSDEC) entered into negotiations regarding concerns over impacted surface sediment, Site soils, and groundwater. To address the NYSDEC's concerns, OCC entered into several agreements with the NYSDEC, including a Partial Consent Judgment (PCJ). The PCJ defined the Site as those properties located at 700 Walck Road (approximately 67.8 acres), the City storm sewer system known as the Pettit Creek Flume (PCF), and the discharge point of the PCF known as the PCF Inlet or Cove (approximately 5.5 acres in area). Following the execution of the PCJ, OCC engaged in multiple environmental investigations culminating in the Remedial Action for the Site in 1989/1990 with the installation of the Site's Interceptor Trench (IT) and an activated carbon water treatment system. Since 1989/1990, the Site has operated in accordance with the PCJ and the Site's OM&M requirements.

This section presents an overview of the Site history and its current status.

2.2 DUREZ NORTH TONAWANDA HISTORY

Founded in 1921 by Harry M. Dent as General Plastics, Inc., the Site changed its name to Durez Plastic and Chemical Co. in 1926. In the mid-1950s, the company joined Hooker Chemical until Hooker Chemical was purchased by OCC in the mid 1960s. OCC operated the facility until it began slowly shutting down operations in the mid to late 1980s and ceased operations in 1995/1996. The Site manufactured various chemicals and plastics for use by industry. The primary chemicals used at the Site were phenol and formaldehyde. These chemicals were used largely for the production of phenolic resins and molding compound products.

During the period that the plant was operating, there were several areas where waste material was buried or where spills from operations had occurred that have resulted in impacted surface and subsurface soils, as well as groundwater beneath the facility.

Demolition of all plant structures was completed in December 1997. The Site is currently a vacant field with a groundwater collection and treatment system in operation 365 days a year. All approved remedial activities have been completed, and the Site is in the OM&M phase of the Remedial Action.

As part of the OM&M activities for the Site, daily inspections of the Site are required and performed. Inspection of the Site during wet weather conditions indicates evidence of Site surface water runoff into the off-Site drainage ditch.

In addition, over the last several years, the New York State Department of Health (NYSDOH) has received a number of calls from area residents expressing concerns or complaints regarding surface runoff from the Site, especially along the northern property line. The property on the north side of the Site does slope to the north towards a drainage ditch and low-lying area that appears to be off Site; however, a majority of the area is within the Site property boundary. The recent commencement of a new housing development to the north-northwest of the Site has elevated the sensitivity of the perceived surface runoff concerns. It should be noted that surface runoff from the surrounding undeveloped properties ultimately enters a small drainage ditch that eventually connects to the on-Site drainage ditch. In addition, the City has recently announced that Meadow Drive will be extended from its current dead end location to Erie Avenue. The resulting extension will likely lead to additional housing development adjacent to the Site to the north and increased sensitivity towards Site drainage.

Based on the evidence of runoff from the Site during recent inspections, Glenn Springs Holdings, Inc. (GSH) has recommended the maintenance activities included in this Work Plan to address and improve Site drainage to reduce and/or eliminate surface runoff from the Site to off-Site areas.

2.3 SEDIMENT CHEMISTRY

Numerous investigations have been completed at the Site and within storm water drainage systems (i.e., ditches and buried pipes) and associated City storm sewer systems during the past 30 years. Although Site Chemicals of Concern (COCs) include the chlorinated toluenes, chlorinated benzenes, and phenols, the following discussion will focus primarily on the chlorinated dibenzo dioxins and furans, specifically 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) due to its toxicity, the availability of published cleanup standards, and its relevance to the proposed scope of work outlined in this Work Plan. Although the discussion will focus on 2,3,7,8-TCDD, since published cleanup standards exist, it is worth noting that the primary dioxin and furan congeners related to the Site are the less toxic pentachlorodibenzo-dioxins (PCDD), tetrachlorodibenzo-furans (TCDF), pentachlorodibenzo-furans (PCDF), hexachlorodibenzo-furans (HCDF), and heptachlorodibenzo-furans (HpCDF); however, there are no published cleanup standards for these congeners. 2,3,7,8-TCDD makes up less than 10 percent of the overall dioxin and furan content present in sediment samples.

As indicated previously, numerous investigations have been completed in the past 30 years; however, the focus of the following discussion will be on sediment samples collected from within the eastern drainage ditch and the relationship of the dioxin and furan content relative to historical Site data.

In November 2009, as part of the "Video Inspection and Sediment Sampling Work Plan – Pettit Creek Flume System" (CRA, March 2009), four discrete surface soil samples were collected from the eastern drainage ditch (Figure 3). Samples were collected from this drainage ditch since it was determined during previous investigations that the drainage ditch emptied directly into the City's Walck Road storm sewer, which, prior to 1993, drained into the Pettit Creek Flume Sewer System and ultimately to the Pettit Creek Cove and little Niagara River. The historical detection of dioxin and furans within sediment samples collected from the Pettit Creek Cove was the primary driver for the collection of the four sediment samples from the eastern drainage ditch once it was discovered that the ditch discharged directly into the Walck Road storm sewer. The east drainage ditch is a common ditch that lies on the property boundary for the Site and an abandoned CSX rail line. A review of historical records also indicates that during Plant operation, several Site ditches discharged to the east drainage ditch.

Although present, 2,3,7,8,-TCDD is not the primary dioxin/furan of interest at the Site and makes up only a small portion of the total dioxin and furan content of the sediment samples. As a result, it is more appropriate to determine the total Toxic Equivalents Quotient (TEQ) for the samples. The TEQ is a mechanism that considers the toxicity of each dioxin and furan congener relative to 2,3,7,8-TCDD. The TEQ is determined by multiplying the concentration of the individual congener by the toxicity factor (TF) for that congener. The individual TEQs are then summed to provide a total TEQ for each sample. The World Health Organization (WHO) publishes the TFs for the various dioxin and furan congeners. The TFs are relative to 2,3,7,8-TCDD, for which the WHO assigns a TF value of 1 and all other TFs are less than 1. Currently, the 2005 published WHO TFs are the accepted standards for use.

The results of the November 2009 discrete surface soil samples indicated that dioxins/furans were present in the surface soils within the drainage ditch at concentrations less than historically found on Site. Four samples were collected from the east ditch; three from the north side of Walck Road and one from the south side of Walck Road. The three samples collected from the east ditch north of Walck Road had total TEQ values of 85,400 picograms per gram (pg/g), 304 pg/g, and 780 pg/g, while the one sample collected from the east drainage ditch south of Walck Road had a TEQ value of 695 pg/g. The TEQ value of 85,400 pg/g was observed from the east ditch,

adjacent to the National Grid (Niagara Mohawk) ROW. TEQ values of 780 pg/g and 304 pg/g were observed in the sediments downstream from the National Grid (Niagara Mohawk) ROW sediment sample. See Figure 3 for the locations of the historical ditch sediment samples. It is worth noting that a review of the dioxin and furan data for these samples confirm the previously mentioned point that 2,3,7,8-TCDD is not the primary dioxin and furan congener at the Site. The 2,3,7,8-TCDD concentrations for the four samples were:

TEQ = 85,400 pg/g with 170 pg/g 2,3,7,8-TCDD
TEQ = 304 pg/g with 4.3 pg/g 2,3,7,8-TCDD
TEQ = 780 pg/g with 39 pg/g 2,3,7,8-TCDD
TEQ = 695 pg/g with 13 pg/g 2,3,7,8-TCDD

A review of historical investigation documents indicates that the 2,3,7,8-TCDD concentrations from the 2009 east ditch samples are comparable to historical 2,3,7,8-TCDD soil concentrations that remain buried on Site. Several historical reports were reviewed, including the following:

- "Report of Continuing Field Investigations Summer 1982, Section III Sampling and Analytical Chemistry" (Occidental Chemical Corporation, November 1982)
- "Remedial Alternatives Assessment for The Durez Site" (Dunn Geoscience Corporation, December 1986)
- Report of Continuing Field Investigations and Exposure Assessment – Section I Introduction, Conclusions, Exposure Assessment and Site Operations Plan" (Occidental Chemical Corporation, July 1984)

A review of the aforementioned reports indicates 2,3,7,8-TCDD concentration levels equivalent to or greater than the 2,3,7,8-TCDD concentration levels identified in the sediment samples collected from the eastern drainage ditch in 2009. Historical concentrations for 2,3,7,8-TCDD ranged from non-detect at 23 pg/g at location NP-20 to 5,500 pg/g at location NP-10. It is worth noting that an evaluation of total dioxin and furan content or TEQ values cannot be completed since in the early 1980s, the technology to reliably test for dioxin and furan congeners did not exist. Therefore, only 2,3,7,8-TCDD can be evaluated. It is assumed that ratios of dioxin and furan congeners to 2,3,7,8-TCDD would be similar in the 1980s to the ratios observed in the 2009 sediment samples. Excerpts of the relevant pages from the historical reports have been included in Appendix A.

3.0 SCOPE OF WORK

3.1 EASTERN DRAINAGE DITCH

As previously stated, the eastern drainage ditch is a common drainage ditch that lies between the eastern property line and the adjacent abandoned CSX rail line. It receives stormwater drainage for both the eastern portion of the Site (surface runoff) and the abandoned CSX rail line. Since the shutdown of the Plant in 1995, the ditch and adjacent rail line have been neglected, and vegetation such as brush and trees has overgrown the area. The drainage ditch is approximately 2,500 feet in length, extending from the northeast corner of the property southwesterly to Walck Road where it discharges via a 24-inch diameter pipe into the City's Walck Road storm sewer system. The ditch varies in width between 3 feet to as much as 12 feet. The ditch is an unlined dirt drainage ditch that is divided by a 36-inch diameter corrugated metal storm sewer pipe midway along its length (specifically there is approximately 1,020 feet of open ditch northeast of the storm pipe, approximately 820 feet of corrugated storm piping and another 660 feet of open ditch southwest of the corrugated piping). The corrugated metal sewer pipe is installed beneath the abandoned railway spurs that serviced the Plant in the past.

A recent topographic survey of the eastern drainage ditch revealed that the drainage ditch is uneven in its bottom elevation and is improperly sloped for drainage. In addition, trees and shrubs ranging in diameter from less than an inch to greater than 12 inches are growing within the ditch, impeding drainage. It was also verified, based on ground surface elevations, that surface runoff from the Site was capable of entering the ditch as well. Figures 4A and 4B present the plan view for the ditch showing ROWs, fence lines, trees, property lines, and miscellaneous ditch features. Figure 5 presents the topographic survey plan and profile for the eastern drainage ditch.

GSH proposes to complete six tasks for the eastern drainage ditch. The proposed improvements to the eastern drainage ditch have been designed to accomplish the following four objectives:

- Ensure that the ditch is properly sloped from north to south to allow drainage throughout its length
- Ensure that the ditch is protected from erosion which could introduce suspended solids from the drainage ditch into the City's Walck Road storm sewer system
- Ensure that the section of IT along the eastern boundary of the Site operates as designed

- Reduce and/or eliminate surface runoff from the Site into the ditch
- Decrease the likelihood of the reestablishment of trees and shrubs within the ditch areas

To accomplish these objectives, GSH proposes to complete the following tasks:

Task 1. Clear all debris (trees, shrubs, etc.) from the drainage ditch

Task 2. Excavate the drainage ditch to obtain the proper slope from the north end of the ditch to the south end of the ditch

Task 3. Remove the culvert currently installed in the ditch

Task 4. Line the excavated ditch with geosynthetic fabric and/or geogrid material

Task 5. Place 6 to 8 inches of No. 2 and No. 3 stone in the bottom of the drainage ditch to prevent erosion and to decrease the likelihood of the reestablishment of vegetation such as trees and shrubs

Task 6. Regrade the adjacent Site surface topography

Task 1 – Clear Debris

GSH proposes to clear all undergrowth (bushes, etc.) and trees from the drainage ditch area. The current overgrowth prohibits proper drainage of the ditch. In addition, during routine cleaning activities in 2011 for the IT, video inspection of the trench revealed the infiltration of root systems into the IT, which could cause damage to the IT and ultimately cause the IT to function improperly and groundwater containment at the Site to be compromised. To address this issue, GSH proposes to cut down to ground surface level all trees and to remove underbrush. Once the trees have been cut to grade, the remaining stump will be ground down to approximately 6 to 12 inches below grade. To limit disturbing the ground surface more than necessary, no tree stumps will be excavated. All trees and brush will be chipped on Site for reuse in the construction of the SSF wetland to be installed along the northern property line. In order to facilitate access to the ditch, the eastern property line fence will be removed, as needed, to gain access to the ditch. A temporary steel fence will be installed to maintain Site security during the construction activities. Where the trunk of a tree or vegetation has grown in such a manner as to encase the fence, the trunk will not be chipped to prevent damage to the equipment and will instead be stockpiled on Site. New fencing will be installed at the completion of the project, as necessary. Every effort will be made to salvage and reuse the existing fencing.

Tasks 2 and 3 – Excavate for Proper Slope and Remove Metal Culvert Piping

Once the ditch has been cleared of vegetation, it will be excavated to produce the proper drainage slope from the northeast to southwest. Figure 4 depicts the current grade for the ditch as well as the proposed final ditch grade. In order to facilitate installation of the proper drainage slope, the approximately 880 feet of metal 36-diameter culvert pipe will be removed and an open ditch constructed in its place.

Figure 6 depicts several cross sections along the ditch showing the current grade and the final grade of the drainage ditch. Figure 6 also depicts the final fabric and stone cover. Throughout the excavation activities, the existing slope (typically 2 on 1) associated with the abandoned CSX rail grade will be maintained. Any necessary soil excavations will be completed on the Site side of the ditch, to the extent practicable.

It is estimated that approximately 1,700 cubic yards of soil will be excavated to construct the proper drainage slope for the ditch. GSH proposes to reuse the drainage ditch soils on the interior of the Site to regrade low-lying areas that have subsided or are naturally low and collect (pond) Site surface runoff. Prior to placement of the excavated soil material in low-lying areas, the area will be demarcated with landscape fabric. Once the excavated soil materials from the eastern drainage ditch have been placed, the material will be covered with a 6-inch layer of topsoil and then hydro-seeded with a native prairie grass mix in support of GSH's Wildlife Habitat Council certification efforts for the Site. At no time will the excavated soils from the eastern drainage ditch be left uncovered or allowed to dry out, which could result in windborne dust. Once the regraded area has been hydro-seeded, the area will be surveyed, and the geographical location of the area will be added to a figure that notes areas at the Site of known impacted soils. The figure will be included in the Soil Management Plan for the Site. No excavated soils from the east drainage ditch will be used for the purposes of regrading at the property line. The hydro-seeding native prairie grass mixture will consist of a Sedge Meadow Seed mix and a Mesic to Dry Tallgrass Prairie Seed mix. Mix profile sheets are included in Appendix B.

Figure 7 illustrates the areas intended to receive excavated soil materials. If additional areas are needed, new locations will be discussed with the NYSDEC prior to being regraded. All regraded areas would be covered with topsoil as necessary prior to being reseeded.

Tasks 4 and 5 – Line Drainage Ditch with Geofabric and Stone

Upon completion of the excavation activities, the drainage ditch will be lined with a geotextile, such as Mirafi® fabric, and overlain by 6 to 8 inches of No. 2 and No. 3 armor stone. The geotextile and stone will be installed a minimum of 4 feet (from the centerline of the ditch) up the sidewall of the drainage ditch. Figure 6 depicts the typical cross section layout for the installation of the geotextile fabric and stone. The lining will assist with decreasing the likelihood of the reestablishment of trees and shrubs within the ditch area.

Task 6 – Regrade the Adjacent Site Surface Topography

Excavated soils generated from the construction of the SSF (discussed in Section 3.2) will be reused to regrade the surface topography of the Site adjacent to the eastern drainage ditch to prevent Site surface runoff from entering the eastern drainage ditch. No excavated soils from the east drainage ditch will be used for the purposes of regrading at the property line. It is estimated that approximately 1,660 cubic yards of soil will be necessary to backfill and regrade the property line adjacent to the eastern drainage ditch to prevent Site surface drainage from migrating off Site into the eastern ditch. Refer to Figures 5 and 6 for details regarding regrading of the edge of the eastern ditch along the Site property line.

3.2 NORTHERN DRAINAGE AREA

The northern portion of the Site is characterized by its predominantly flat topography, a drainage ditch, and mostly wooded area. The northern area is bisected by the 80-foot wide National Grid (formerly Niagara Mohawk) ROW, which runs north to south through the Site. In addition, there is a 30-foot wide National Fuel Gas ROW located along a portion of the northern property line. Refer to Figure 8 for the current Site conditions as determined by a 2011 topographic survey. There is also an unimproved drainage ditch that traverses a portion of the northern property area. The ditch crosses onto the Site at the north-northwest property line and meanders across from west to east along the northern property line. The current drainage ditch varies in depth, but is on average approximately 3 to 4 feet in depth and approximately 6 feet in width. Flow is from west to east emptying into the eastern drainage ditch. Surface runoff from the Site and off-Site locations to the north discharge into the northern drainage ditch. During the wet weather seasons (Spring and Fall), there is typically sufficient flow within the ditch for flow to discharge to the eastern drainage ditch where it ultimately has the potential to discharge to the City's Walck Road storm sewer system.

The primary objectives for improving drainage in the northern area of the Site are as follows:

- To manage the overland flow from off-Site sources to the north onto the northern portion of the Site
- To reduce and/or eliminate Site surface runoff to the drainage ditch
- To eliminate the visual perception by area residents of "contaminated runoff from the Site" leaving the Site
- To use open space in the northern area for habitat revitalization through replacement of trees and shrubbery removed along the eastern drainage ditch and during grub and clear activities for the construction of the SSF

A majority of the water that flows into the northern property area is received from the off-Site, undeveloped wooded area directly north of the Site. This off-Site flow, coupled with ponding along the drainage ditch, has led to the perception by area residents that runoff from a "contaminated Site" is leaving the Site via the northern drainage ditch.

To accomplish the objectives, GSH proposes to complete the following tasks:

Task 1. Clear all debris (trees, shrubs, etc.) from the area

Task 2. Excavate for the installation of a SSF wetland

Task 3. Install a SSF wetland

Task 4. Install new drainage piping through the National Grid ROW

Task 5. Regrade the adjacent Site surface topography to prevent Site surface runoff into the SSF wetland

Task 6. Backfill/abandon/incorporate the existing drainage

Task 7. Install replacement plantings in designated areas

The northern area of the property will be cleared of all trees and underbrush and then leveled. The remaining stumps will be excavated as necessary to facilitate the installation of the SSF wetland. Where excavation is not necessary, the stumps will be ground down to six to eight inches below grade. In addition, there are several monitoring wells in this area, which are used for the hydraulic monitoring. These wells will be maintained, however some upgrades, such as well extensions, may be necessary due to regrading activities.

An engineered SSF wetland will be installed (Figures 8 and 9). In a SSF wetland, the flow is designed to occur below the grade surface and thereby reduce the issues of standing water, which can lead to increased nuisance insects and possible odors. The installation of an engineered SSF wetland would involve the construction of two SSF cells and a discharge weir that would allow discharge from the wetland into the eastern drainage ditch. A slope of less than 1 percent would be utilized throughout the entire SSF wetland. The wetland will be constructed using a 30-mil poly liner, 20 mm and 30 mm washed gravel for the flow media, mulch/peat moss to provide insulating layer during cold months and a rooting zone for the wetland plant species, and native Typha root transplants to populate the SSF wetland. The proposed plant species would be either Typha angustifolia or Typha latifolia. Both species are cattails and represent emergent wetland plants that are native to the region. It is estimated that approximately 9,500 to 10,500 cubic yards of soil will be generated during the construction process. In addition, 750 to 1,000 cubic yards will be needed for regrading activities in the northern portion of the property.

Cell 1 would be the upstream SSF cell located on the western side of the National Grid ROW. Cell 1 would be approximately 30,000 square feet ranging in depth from at-grade on the western entrance to the cell to a depth of approximately 20 inches at the eastern end. Cell 1 would be approximately 250 feet long with a varying width ranging from 150 feet wide at the mouth to approximately 30 feet wide at the outlet. Cell 1 will be constructed in two zones, Zone 1 and Zone 2, represented by changes in stone bedding. Zone 1 is the western most zone, approximately 90 feet long and constructed with 30 mm washed gravel. Zone 2 is the next zone, approximately 160 feet long and constructed using 20 mm washed gravel. The outlet to Cell 1 is constructed with 80 mm rock/gravel.

Water would flow from west to east through Cell 1 and would enter Cell 2 through four 18-inch diameter corrugated high density polyethylene (HDPE) pipes. The four 18-inch diameter corrugated pipes will be installed through the National Grid ROW. The four pipes will be set in #2 run-of-crush (ROC) stone backfill with approximately 1 foot of stone along all sides of the piping. The piping will cover an area of approximately 11 feet wide by 170 feet in length. The inlet and outlet of the pipes will have 80 mm washed gravel.

Cell 2 would be located on the eastern side of the National Grid ROW. Cell 2 would be approximately 750 feet long by 80 feet wide with an overall footprint of approximately 60,000 square feet. Cell 2 would be approximately 24 inches in depth. Cell 2 will be divided into three sections by the installation of two gravel dividers. The gravel dividers will be 25 feet wide and constructed with 80 mm washed gravel. These

dividers will be installed to divide Cell 2 into three smaller cells, each constructed in the same manner. The exact layout of Cell 2 may change based on field conditions associated with the location of existing Site groundwater monitoring wells.

The constructed wetland has a limited volumetric capacity based on the void space in the washed gravel, the width, and the length of the wetland. During periods of high flow that would exceed the volumetric capacity, the SSF wetland would discharge into the eastern drainage ditch via an overflow weir. The overflow weir would be designed to maintain water levels within the wetland to a height no greater than the surface of the wetland (i.e., keep water levels below the surface).

Figures 8 and 9 present the design for the SSF wetland.

The soil excavated during the construction of the SSF wetland would be reused to backfill any remnants of the current drainage ditch, regrade low-lying areas of the Site, and install a 1-foot berm, sloping towards the south, along the northern property line above the National Fuel Gas ROW. This berm would prevent the off-Site runoff of Site surface water from the interior of the Site. In addition, the excavated materials from the SSF wetland would be used to regrade perimeter Site topography along the eastern drainage ditch to prevent Site surface runoff from entering the eastern ditch. Refer to Figure 7 for locations of reuse.

3.3 BENEFICIAL USE DETERMINATION

Under Title 6, New York Codes, Rules, Regulations, Part 360, Section 1.15 Beneficial Use (6NYCRR Part 360-1.15), the NYSDEC has established a number of exemptions or what are commonly referred to as predetermined beneficial use determinations (BUDs). It is based on these predetermined BUDs or exemptions outlined in 6NYCRR Part 360-1.15, that GSH intends to reuse an estimated 11,000 to 12,000 cubic yards of excavated soils generated from the construction of the SSF wetland and the improvements to the eastern drainage ditch. The Beneficial Use exemptions outlined in 6NYCRR Part 360-1.15(b)(7,8,9) identify both uncontaminated and nonhazardous contaminated soil from construction projects as being "no longer considered solid waste for the purposes of this Part when used as described in this subdivision:…" Those reuses are "…fill material, in place of soil native to the site of disposition;" and "…which is used as backfill for the same excavation or excavations containing similar contaminants at the same site…" In addition to identifying soils as being exempt, "recognizable, uncontaminated concrete and concrete products, asphalt pavement, brick…" are also

exempt for reuse without NYSDEC department approval when reused in the manners outlined in the exemption (i.e., when used as a substitute for conventional aggregate).

In support of the soil reuse activities, project drawings have been developed and are attached as Figures 4A, 4B, 5, 6, 7, 8, and 9. This Work Plan is being submitted to the NYSDEC for informational purposes based on the predetermined beneficial use exemptions outlined in 6NYCRR Part 360-1.15.

Approximately 11,000 to 12,000 cubic yards of soils are expected to be excavated during the implementation of this Work Plan and reused at the Site. All reused soils will be placed in areas of the Site that are within the Site containment area. The excavated soil will be placed in low-lying areas throughout the Site to prevent areas of standing water and installed along the property line to redirect surface runoff from the property back onto the property.

The excavated materials would be used on the Site to regrade areas of subsidence. Once the excavated soil materials have been used to regrade the low-lying areas, the material will be covered with a 6-inch layer of topsoil and then hydro-seeded. Figure 7 illustrates the areas intended to receive excavated soil materials. If additional areas are found to be needed during the construction activities, new locations will be discussed with the NYSDEC prior to being regraded. All regraded areas would be covered with topsoil as necessary prior to being reseeded with a native prairie grass mix.

3.3.1 ENVIRONMENTAL BENEFIT

Aside from the obvious economic benefits (to be discussed in Section 3.3.2) of reusing the excavated soil materials, there are also environmental benefits. Based on Site inspections, surface runoff from the Site into Site drainage ditches and the adjacent eastern drainage ditch has been identified with the potential to empty into the City's storm sewer system via the eastern drainage ditch. The regrading and drainage improvements will be a preventive measure to reduce and/or eliminate the potential for surface runoff from leaving the Site.

An estimated 11,000 to 12,000 cubic yards of excavated soils are expected to be generated from the drainage improvements and will be reused for regrading low-lying areas at the Site. GSH is recommending the reuse of all excavated materials from the eastern drainage ditch for regrading low-lying areas within the interior of the Site. This regrading will reduce and/or eliminate surface water runoff from the interior of the Site to surrounding off-Site properties.

Additionally, standing water found in the low-lying areas of the Site is also dissipating via percolation into the subsurface soils or through evaporation to the atmosphere. However, the Site has received several complaints over the years that these areas create a nuisance insect (i.e., mosquitoes, etc.) breeding area that negatively affects the quality of life for the surrounding property owners. The grading design for the low-lying areas would reduce the accumulation of runoff and allow the precipitation to better infiltrate the Site surface over a wider area. Additionally, the grading design for the low-lying areas calls for the planting of grass that would increase evapo-transpiration (uptake through roots and transpiration out from leaves), thereby reducing infiltration of surface water into the subsurface. Waters not lost to evaporation, and evapo-transpiration will be easily accommodated by the absorptive capacity of the additional soils as well as the existing soils.

In addition to providing an on-Site environmental benefit, the regrading of the low-lying areas of the Site utilizing the excavated soils would reduce the amount of excavated soil material requiring off-Site disposal. The reuse of the construction soils would promote the conservation of limited and valuable landfill space that could be better utilized for non-reusable materials. The reuse of construction soils would also reduce the amount of soil that would need to be imported to facilitate the regarding activities.

3.3.2 ECONOMIC BENEFIT

The economic benefit of reusing the construction excavation soils at the Site would be realized by OCC. Since the Site is a former Superfund Site and currently all solids and debris from the Site are disposed of as hazardous waste materials, it is reasonable to assume that if the excavated soils cannot be reused on Site in the manner previously described in Sections 3.1, 3.2, and 3.3.1, the soils would need to be disposed of as hazardous waste. Based on the current regional cost of approximately $350.00 per ton for transportation and disposal of hazardous solid waste, the cost to dispose of the excavated materials would be approximately $4.29 M to $4.68M for 11,000 to 12,000 cubic yards (estimated to be 16,500 to 18,000 tons) of soil.

OCC would also realize an additional cost savings since clean fill material to regrade the Site would not need to be purchased. The average transportation and per ton costs for fill material is approximately $25 per ton. Assuming the need for approximately 11,000 to 12,000 cubic yards (estimated 16,500 to 18,000 tons) of fill material to properly regrade the Site, the purchase cost of the material would be $412,500 to $450,000.

Combining these estimated costs results in a projected cost savings of approximately $4.7M to $5.13M.

3.4 HABITAT RECOVERY PROGRAM

In order to replace trees and shrubs that will be removed during the grub and clear activities for the construction of the SSF wetland and in the reconstruction of the eastern drainage ditch, GSH proposes to implement a habitat recovery program. The habitat recovery program proposes the installation of a variety of trees, shrubs, and native grasses in various areas within the northern and northwestern section of the Site that will provide year-round wildlife value (nutritional worth to foraging animals and birds) and natural habitat for native animals. No habitat recovery will occur in the eastern ditch area. In addition, the program will be comprised of representative plant species that are commonly found in the eastern Great Lakes and Northeastern United States old growth forests. It is expected that approximately 80-100 trees will be removed from the eastern drainage ditch and approximately 150-200 trees will be removed from the northern SSF wetland area. GSH proposes to replace at least 50 percent of the plants lost during the grub and clear activities with a similar number of beneficial trees, shrubs, and a constructed wetland in order to maintain a level of wildlife value and incorporate sustainable elements into this drainage improvement project. It should be noted that a majority of the existing tree species (Ash, Poplar, Elm, etc.) that are going to be removed represent species that provide limited wildlife value (cover and food source) and are susceptible to invasive pest and diseases such as the Emerald Ash Borer, the Elm Leaf Beatle, the Gypsy Moth and Dutch Elm Disease.

Approximately 4.8 acres will be grubbed and cleared in the northern SSF wetland area, and approximately 2.25 acres of land will be grubbed and cleared in the eastern drainage ditch. GSH is proposing to replant a total of approximately 4.9 acres, which will include 2.6 acres of land adjacent to the SSF wetland that will be used for the replanting of tree and shrub species and approximately 2.3 acres that will be used for the construction of the SSF wetland. The SSF wetland will provide a food source, cover area, and a source of nest building raw materials, while the forested areas will provide primarily cover, food, and nesting habitat. The proposed planting schedule includes Shagbark Hickory, Northern Red Oak, Sugar Maple, Basswood, American Hornbeam, Blue Spruce, Black Hills Spruce, Yellow Birch, Black Walnut, Alternateleaf Dogwood, Common Lilac, Arrowood Viburnum, Flowering Dogwood, Redosier Dogwood, American Holly, Pin Cherry, American Black Elderberry, Canadian Service Berry, and Nannyberry. In addition, the ground area will be reseeded with a native prairie grass mixture, specifically a Sedge Meadow Mix and a Mesic to Dry Tallgrass Prairie Seed

mix. These native grass mixtures include various sedges, rushes, asters, golden rod, clover, grasses, and rye. A copy of the plant profiles and native grass mix profiles are in Appendix B.

The tree plantings will be installed in the northern SSF area in the spring of 2013. Maintenance for 1-2 years after the plantings have been installed will include watering, inspection for invasive pest or disease, pruning, and fertilization of the plantings. During the summer months (June-August), weekly watering and inspection is anticipated and will be dependent upon weather conditions.

Wildlife within the area will benefit from the planting of oak, walnut, basswood, birch, maple, hornbeam, and hickory trees. Over time, these tree species will establish themselves and yield significant and diverse habitat and ground cover. The selected perennial tree plantings will flower annually and produce fruit, nuts, sap, or nectar that serve as high nutritional value for small mammals, birds, honeybees, and other local wildlife. The addition of various woody shrub plants that produce palatable fruit during the spring and summer will provide immediate sustenance to local wildlife through the selection of species with rapid growth rates.

The habitat recovery area and SSF wetland will be monitored weekly during the summer months (May-August), which will include inspection of tree, shrub, and wetland grass species. Inspections will include observing for mortality, scale, fungus, and invasion, particularly by the Emerald ash borer and Japanese beetle. Inspections will also include observing for foraging and wildlife establishment. Monitoring and inspection will occur on a monthly basis during the autumn, winter, and spring months (September-April). A varying degree of plant mortality is expected due to circumstances such as excessive grazing, unpredictable weather, etc. Plant mortality will be monitored, and individuals that have died will be considered for replacement.

Five tree and shrub replacement areas have been identified for plantings of various species adjacent to the SSF wetland in the northern area of the Site and along the northwestern property line (Figure 10). A summary of the areas and the species composition is included below:

- Area A (approximately 0.39 acre) is a perennial tree zone consisting of Shagbark Hickory (*Carya ovata*), Northern Red Oak (*Quercus rubra*), and Blue and Black Hills Spruce (*Picea pungens and Picea glauca var. densata,* respectively). Figure 11 shows the proposed layout for this area. Exact layout will be field determined based on Site conditions relative to power lines, monitoring wells, and the Site Interceptor trench.

- Area B (approximately 0.51 acre) is a mixed perennial tree and shrub zone consisting of Sugar Maple (*Acer saccharum*), Basswood (*Tilia americana*), American Hornbeam (*Carpinus caroliniana*), Alternateleaf Dogwood (*Corpus alternifolia*), Common Lilac (*Syringa vulgaris*), Arrowwood (*Vibernum dentatum*), American Black Elderberry (*Sambucus nigra*), Canadian Serviceberry (*Amelanchier canadensis*), and Blue and Black Hills Spruce (*Picea pungens and Picea glauca var. densata,* respectively). Figures 12A and 12B show the proposed layout for this area. Exact layout will be field determined based on Site conditions relative to power lines, monitoring wells, and the Site Interceptor trench.
- Area C (approximately 0.12 acre) is a perennial tree zone consisting of Yellow Birch (*Betula alleghniensis*), Sugar Maple (*Acer saccharum*), and Basswood (*Tilia americana*). Figure 13 shows the proposed layout for this area. Exact layout will be field determined based on Site conditions relative to power lines, monitoring wells, and the Site Interceptor trench.
- Area D (approximately 0.18 acre) is another perennial tree zone consisting of Black Walnut (*Juglans nigra*) and Blue and Black Hills Spruce (*Picea pungens and Picea glauca var. densata,* respectively). Figure 14 shows the proposed layout for this area. Exact layout will be field determined based on Site conditions relative to power lines, monitoring wells, and the Site Interceptor trench.
- Area E (approximately 0.59 acre) is another mixed perennial tree and shrub zone, consisting of Flowering Dogwood (*Cornus florida*), Redosier Dogwood (*Cornus sericea*), American Holly (*Ilex opacea*), Arrowwod (*Viburnum dentatum*), Common Lilac (*Syringia vulgaris*), American Black Elderberry (*Sambucus nigra*), Canadian Serviceberry (*Amelanchier Canadensis*), Nannyberry (*Viburnum lentago*), Blue and Black Hills Spruce (*Picea pungens and Picea glauca var. densata,* respectively), and Pin Cherry Trees (*Prunus pensylvanica*). Figure 15 shows the proposed layout for this area. Exact layout will be field determined based on Site conditions relative to power lines, monitoring wells, and the Site Interceptor trench.

In addition to the planting of new tree and shrub species, GSH proposes to install a series of Eastern Bluebird (*Sialia sialis*) (the State Bird of New York) boxes within Areas B and C.

Although the SSF wetland is designed to minimize nuisance insects such as mosquitoes, which are carriers of the West Nile Virus, there are natural seasonal wetlands adjacent to the proposed SSF wetland that provide natural habitat for populations of nuisance pests such as mosquitoes. As such, GSH also proposes to install bat boxes to encourage a bat population that will naturally assist in managing the nuisance pest populations.

3.5 REPORTING

A Drainage Improvement Summary Report will be prepared upon completion of the project. The report will document the construction activities completed for the installation of the SSF wetland and the east drainage ditch improvements, and summarize the volumes of beneficially used material and the locations where the soil was beneficially reused.

3.6 SCHEDULE

The schedule for implementation of this Work Plan provides approximate time frames for completion of the work beginning with the submittal of the Work Plan. The project schedule will be adjusted accordingly based on the actual approval date of this Work Plan. Currently, the implementation start is scheduled for July 2012, and the field activities are anticipated to take a minimum of 6 weeks to complete.

4.0 REFERENCES

- Partial Consent Judgment, State of New York vs. Occidental Chemical Company, April 1989
- Title 6, New York Codes, Rules, Regulations, Part 360, Section 1.15 Beneficial Use (6NYCRR Part 360-1.15)

FIGURES

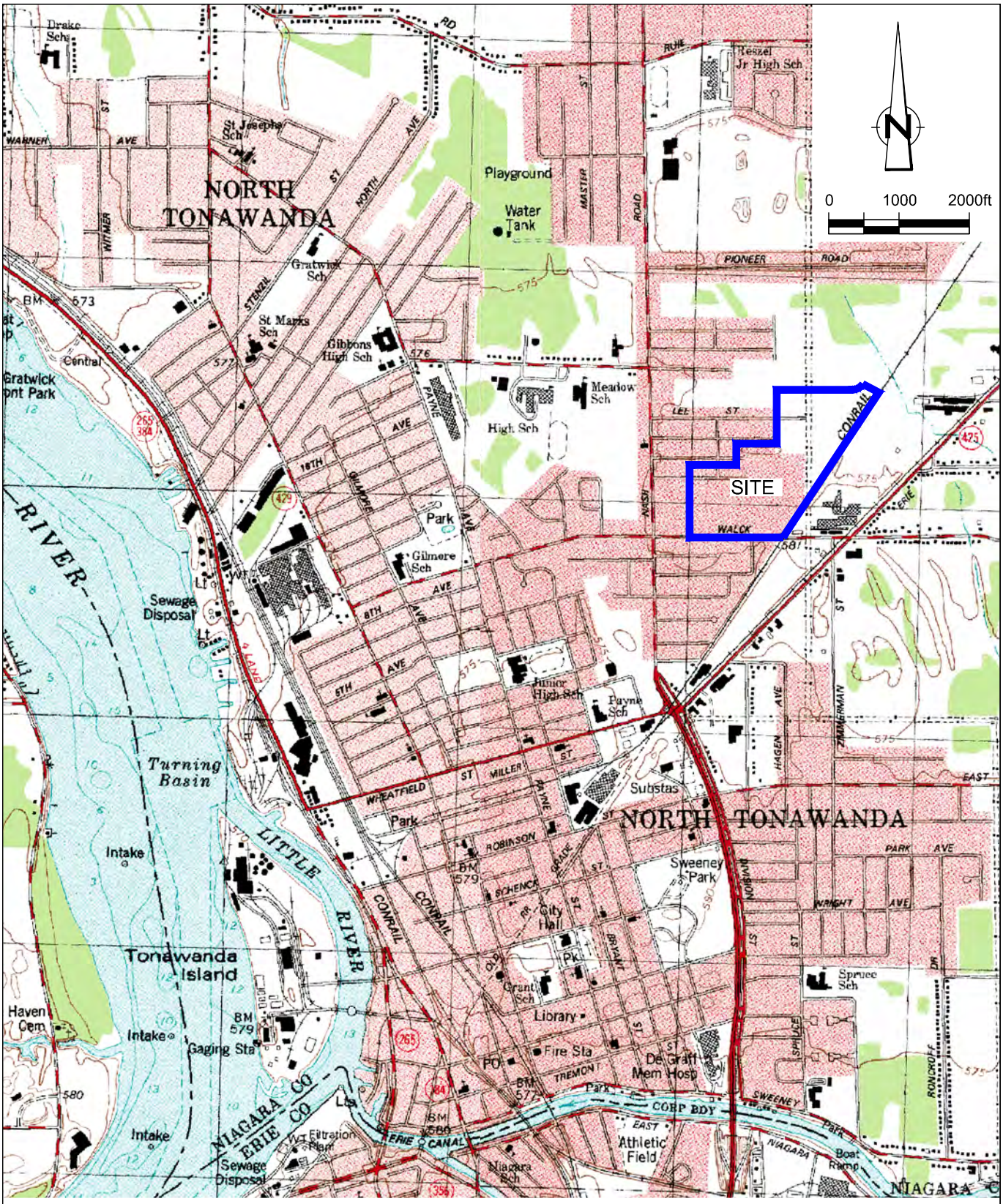

figure 1

SITE LOCATION MAP
DUREZ NORTH TONAWANDA SITE
North Tonawanda, New York

07405-00(032)GN-BU001 JUN 28/2012

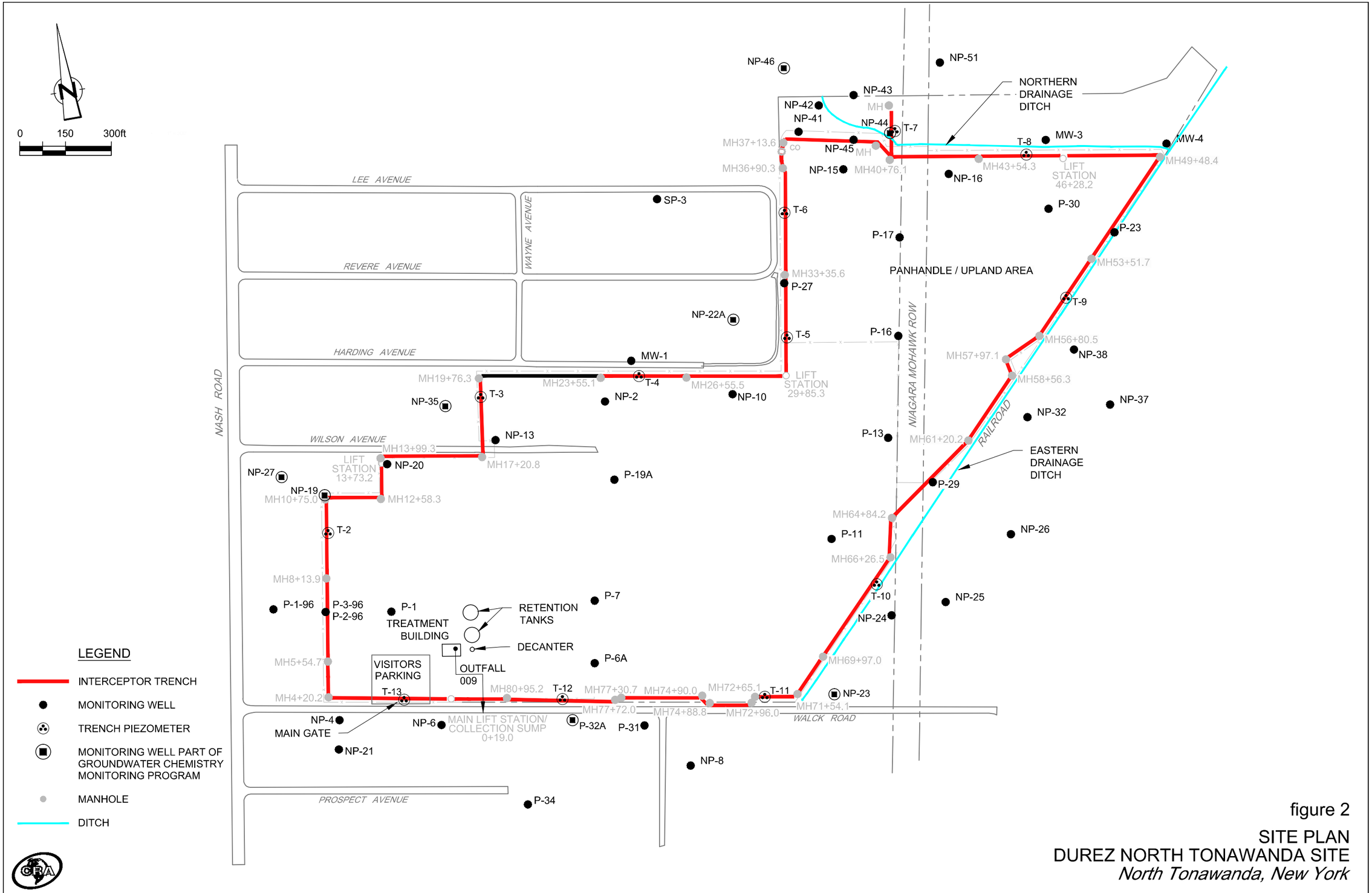

figure 2

SITE PLAN
DUREZ NORTH TONAWANDA SITE
North Tonawanda, New York

07405-00(032)GN-BU002 JUN 28/2012

NP-11	June 3, 1982	June 3, 1982
Sample Depth (ft)	2-4	6-8
Total TCDD (pg/g)	910	110
2,3,7,8-TCDD (pg/g)	670	72
Total TEQ (pg/g)	NA	NA

NP-3	May 27, 1982	May 27, 1982
Sample Depth (ft)	2-4	6-8
Total TCDD (pg/g)	6500	310
2,3,7,8-TCDD (pg/g)	690	ND @ 60
Total TEQ (pg/g)	NA	NA

006	November 25, 2009
Sample Depth (ft)	2-4
Total TCDD (pg/g)	5200
2,3,7,8-TCDD (pg/g)	170
Total TEQ (pg/g)	85400

007	November 25, 2009
Sample Depth (ft)	2-4
Total TCDD (pg/g)	210
2,3,7,8-TCDD (pg/g)	4
Total TEQ (pg/g)	304

008	November 25, 2009
Sample Depth (ft)	2-4
Total TCDD (pg/g)	3000
2,3,7,8-TCDD (pg/g)	39
Total TEQ (pg/g)	780

005	November 25, 2009
Sample Depth (ft)	2-4
Total TCDD (pg/g)	740
2,3,7,8-TCDD (pg/g)	13
Total TEQ (pg/g)	695

LEGEND

- Shallow Wells P-1 Thru P-30
- Shallow Wells P-31 Thru P-36
- New Shallow Piezometers NP-1 Thru NP-38
- Deep (Bedrock) Well Nos. 7,12,16,17
- Well Points To Sewer Bedding Nos. 7 - 20
- Sewer Lines
- Sewer Sampling Points
- BM 2 Datum 101.08'
- New York State Piezometer
- Shallow Wells WP-4, WP-5

DUNN GEOSCIENCE CORPORATION
5 Northway Lane North
Latham, N.Y. 12110

DUREZ PLASTICS DIVISION
NORTH TONAWANDA, NEW YORK

CHG. NO. | MADE BY D. Theodore Clark SCALE 1"=50'
W. O. NO. | TRACED BY M.T. Mckymik DATE Dec.
BLDG. NO. | CHECKED BY [illegible] APPROVED
PROJECT NO 348-2-2426
MAP NO. 8099

WELL & SEWER LOCATIONS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HISTORICAL 2,3,7,8-TCDD DETECTIONS
EAST DITCH AND ON-SITE LOCATIONS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: AUGUST 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: D. HOYT	Drawn By: S. PIKE
Scale: NTS	Project No: 07405-00	Report No: 032	Drawing No: figure 3

07405-00(032)GN-BU006 AUG 21/2012

LEGEND:

- FENCELINE
- NIAGARA MOHAWK ROW
- DITCH CENTERLINE
- RAILROAD ROW

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No	Revision	Date	Initial

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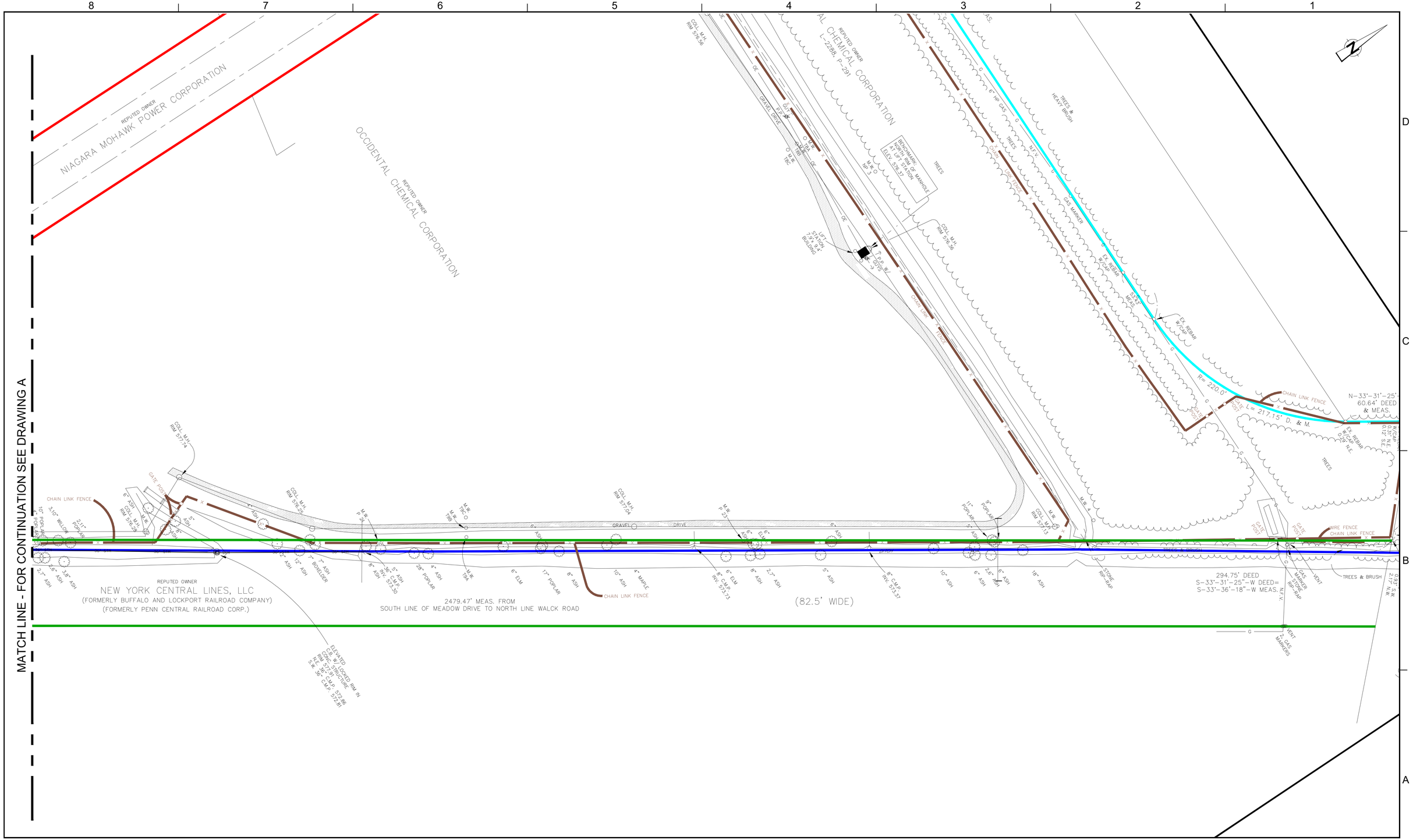
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

EAST DITCH SITE PLAN
SHEET 1 OF 2

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: 1" = 40'	Project No: 07405-00	Report No: 032	Drawing No: figure 4A

07405-00(032)GN-BU003 JUN 28/2012



MATCH LINE - FOR CONTINUATION SEE DRAWING A

LEGEND:

- FENCELINE
- NIAGARA MOHAWK ROW
- DITCH CENTERLINE
- RAILROAD ROW
- PROPERTY LINE

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No	Revision	Date	Initial

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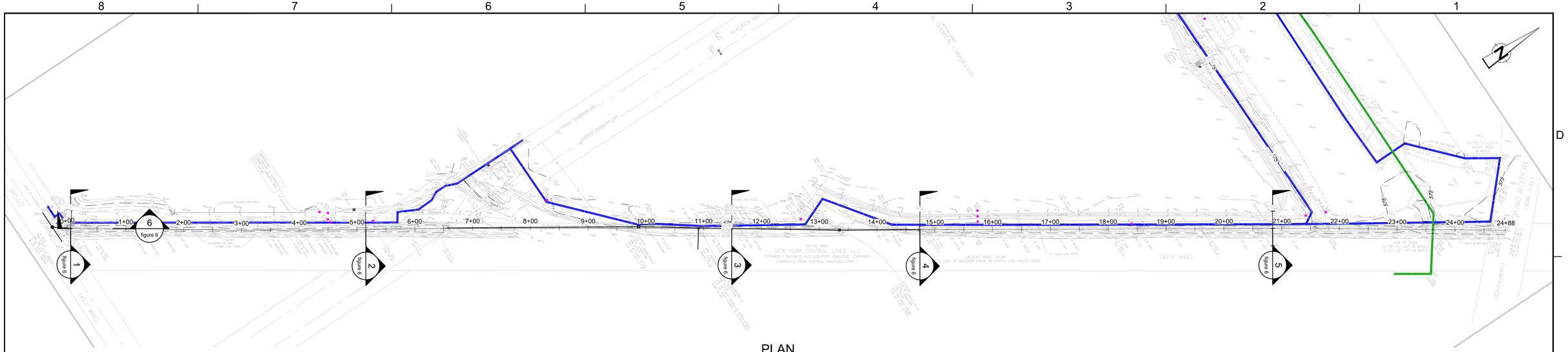
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

EAST DITCH - SITE PLAN
SHEET 2 OF 2

CONESTOGA-ROVERS & ASSOCIATES

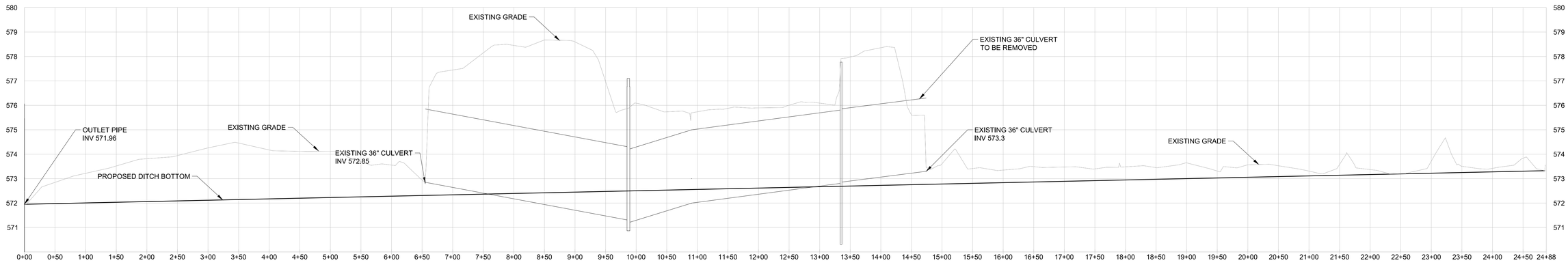
Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: 1" = 40'	Project No: 07405-00	Report No: 032	Drawing No: figure 4B

07405-00(032)GN-BU004 JUN 28/2012



PLAN

HORZ SCALE: 1" = 80'



PROFILE

HORZ SCALE: 1" = 80'
VERT SCALE: 1" = 2'

NOTES:

1. ALL VEGETATION (TREES, SHRUBS, ETC.) TO BE CUT AND CHIPPED (REUSED) ON SITE.
2. ALL TREE STUMPS TO BE GROUND DOWN IN PLACE TO SUFFICIENT DEPTH TO ALLOWS FOR INSTALLATION OF FABRIC AND STONE.
3. ALL EXCAVATED SOIL MATERIALS TO BE BENEFICIALLY REUSED ON-SITE TO IMPROVE DRAINAGE GRADES AND CORRECT AREAS OF SUBSIDENCE.
4. ALL EXCAVATED MATERIAL TO BE COVERED DAILY WITH TOPSOIL.
5. FINAL ELEVATIONS TO BE FIELD DETERMINED.

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

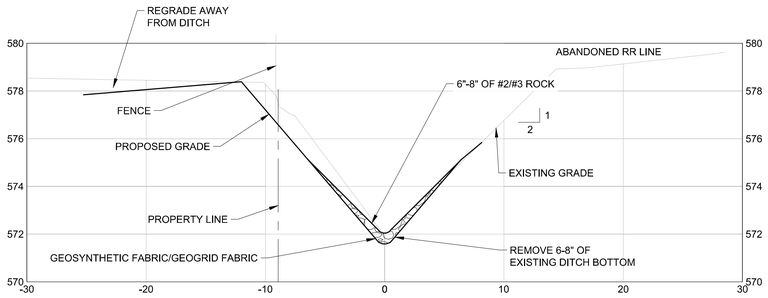
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

EAST DITCH DRAINAGE IMPROVEMENTS
PLAN AND PROFILE VIEWS

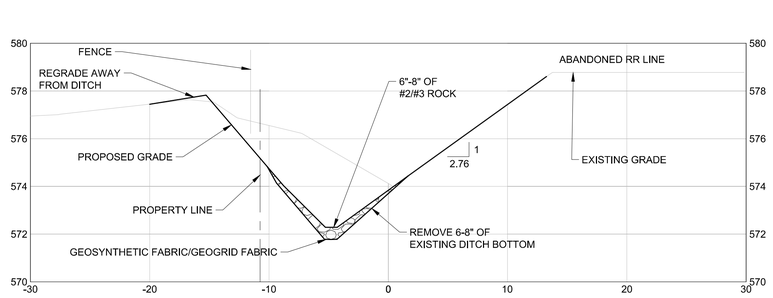
CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date:
			JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 5

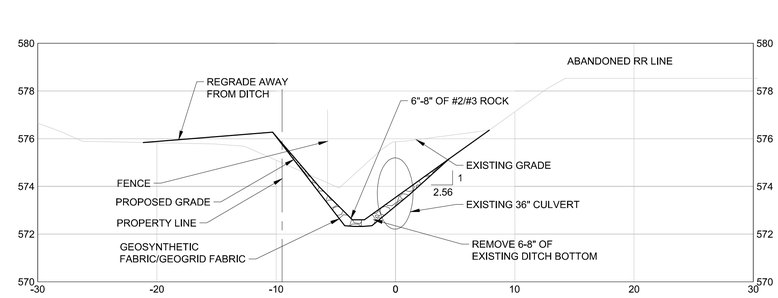
07405-00(032)CI-BU001 AUG 21/2012



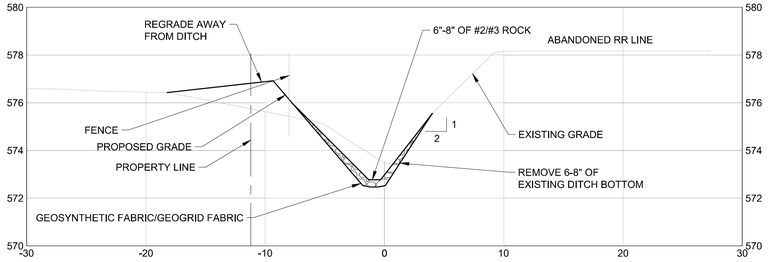
SECTION 1
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5



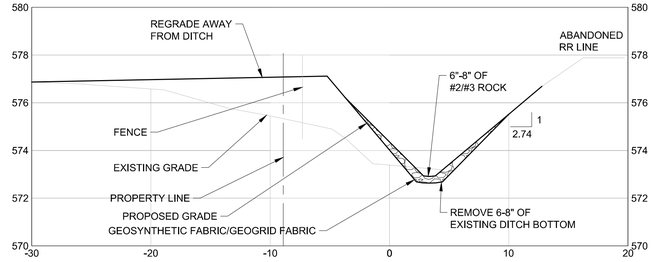
SECTION 2
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5



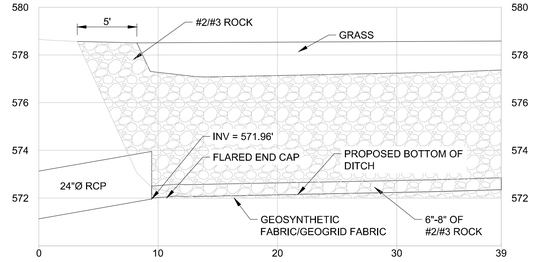
SECTION 3
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5



SECTION 4
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5



SECTION 5
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5



SECTION 6
HORZ SCALE: 1" = 6'
VERT SCALE: 1" = 3'
figure 5

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

EAST DITCH DRAINAGE IMPROVEMENTS
SECTION VIEW

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date:
			JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 6

07405-00(032)CI-BU002 AUG 21/2012

0 150 300ft

LEE AVENUE
REVERE AVENUE
HARDING AVENUE
WILSON AVENUE
PROSPECT AVENUE
WAYNE AVENUE
NASH ROAD
NIAGARA MOHAWK ROW
RAILROAD
WALCK ROAD

NP-46 NP-51 NP-43 NP-42 MH NP-41 NP-44 T-7 MW-3 MW-4 MH37+13.6 MH49+48.4 NP-45 MH T-8 MH36+90.3 NP-15 MH40+76.1 MH43+54.3 LIFT STATION 46+28.2 NP-16 P-30 SP-3 T-6 P-17 P-23 MH53+51.7 MH33+35.6 P-27 T-9 NP-22A T-5 P-16 MH56+80.5 MH57+91.1 NP-38 MW-1 MH19+76.3 MH23+55.1 T-4 MH26+55.5 LIFT STATION 29+85.3 MH58+56.3 NP-35 T-3 NP-2 NP-10 NP-37 NP-32 NP-13 P-13 MH61+20.2 MH13+99.3 MH17+20.8 NP-20 NP-27 P-19A P-29 NP-19 MH10+75.0 MH12+58.3 MH64+84.2 T-2 P-11 NP-26 MH66+26.5 MH8+13.9 T-10 P-1-96 P-3-96 P-2-96 P-1 TREATMENT BUILDING RETENTION TANKS P-7 NP-25 NP-24 DECANTER P-6A MH69+97.0 MH5+54.7 VISITORS PARKING OUTFALL 009 MH80+95.2 T-12 MH77+30.7 MH74+90.0 MH72+65.1 T-11 NP-23 MH4+20.2 T-13 MH77+72.0 MH74+88.8 MH72+96.0 MH71+54.1 NP-4 MAIN GATE NP-6 MAIN LIFT STATION/ COLLECTION SUMP 0+19.0 P-32A P-31 NP-21 NP-8 P-34

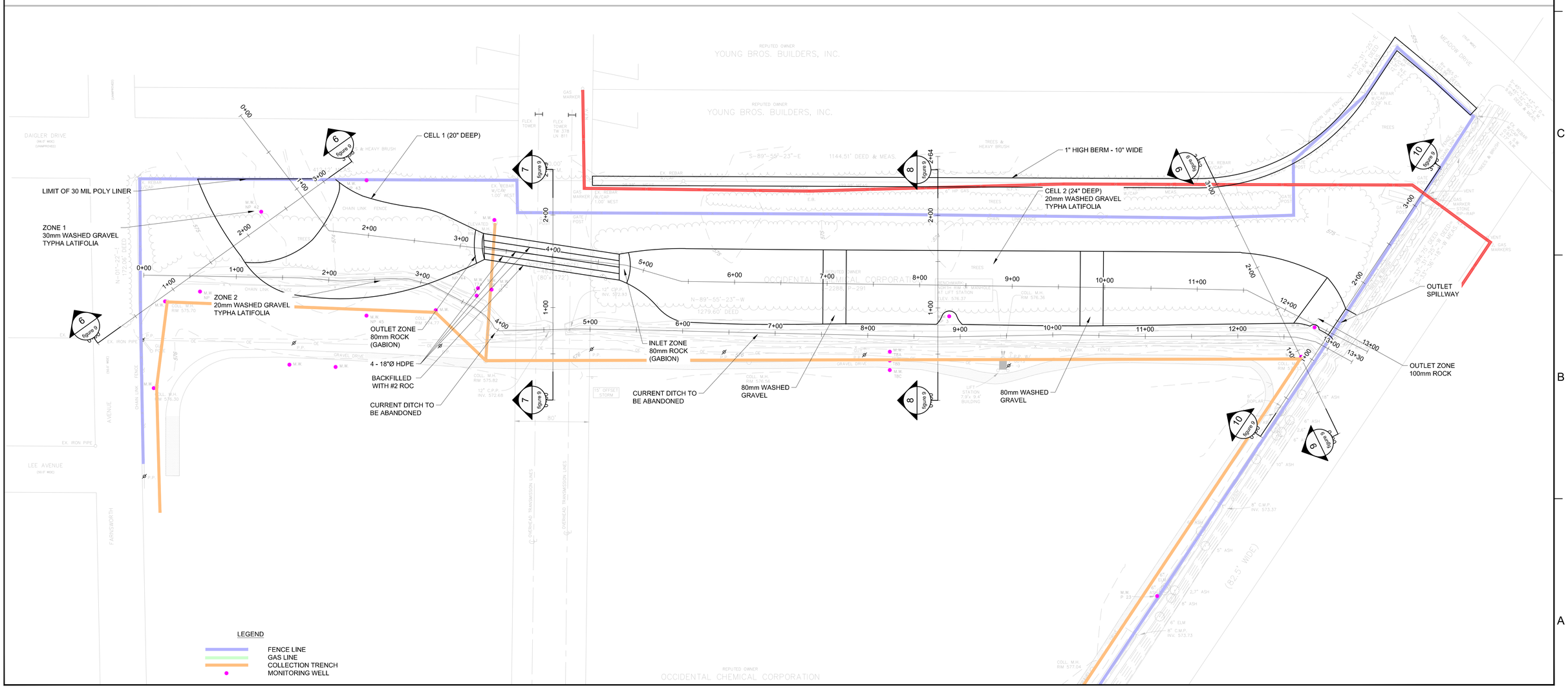
LEGEND

- INTERCEPTOR TRENCH
- MONITORING WELL
- TRENCH PIEZOMETER
- MONITORING WELL PART OF GROUNDWATER CHEMISTRY MONITORING PROGRAM
- MANHOLE
- AREA TO BE REGRADED

figure 7

REGRADING PLAN
DUREZ NORTH TONAWANDA SITE
North Tonawanda, New York

07405-00(032)GN-BU005 AUG 21/2012



NOTES:

1. ALL VEGETATION (TREES, SHRUBS, ETC.) TO BE CUT AND CHIPPED (REUSED) ON SITE.
2. ALL TREE STUMPS TO BE GROUND DOWN IN PLACE OR TAKEN TO A MANUFACTURER.
3. ALL EXCAVATED SOIL MATERIALS TO BE BENEFICIALLY REUSED ON-SITE TO IMPROVE DRAINAGE FEATURES.
4. CELLS 1 AND 2 TO BE COVERED (INSULATED) WITH MULCH PRODUCED ON SITE FROM CHIPPED VEGETATION REMOVED DURING GRUB AND CLEAR ACTIVITIES; MATERIAL TO BE IMPORTED AS NECESSARY TO RECONCILE SHORTAGES; IMPORTED MATERIAL TO BE DERIVED FROM VIRGINIA HARDWOODS (I.E. NO MATERIAL TO BE DERIVED FROM RECYCLED CONSTRUCTION DEBRIS).
5. VEGETATION FOR CELLS 1 AND 2 (TYPHIA LATIFOLIA) WILL BE FROM ROOT TRANSPLANTS.
6. FINAL ELEVATIONS AND DEPTHS TO BE FIELD DETERMINED.

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

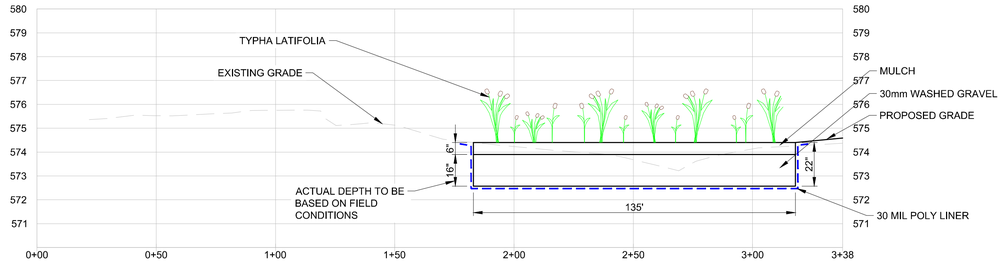
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

NORTH DITCH DRAINAGE IMPROVEMENTS
ENGINEERED WETLAND - PLAN VIEW

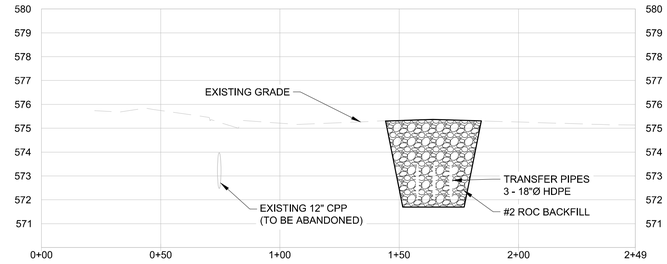
CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 8

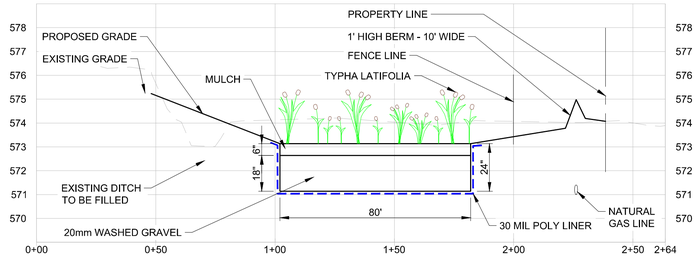
07405-00(032)CI-BU003 AUG 21/2012



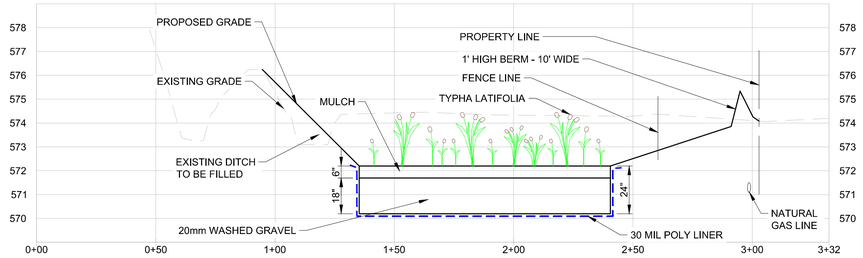
SECTION 6
HORZ SCALE: 1" = 30'
VERT SCALE: 1" = 3'
figure 8



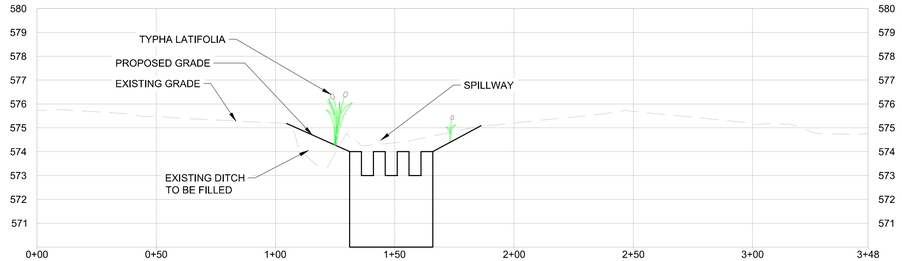
SECTION 7
HORZ SCALE: 1" = 30'
VERT SCALE: 1" = 3'
figure 8



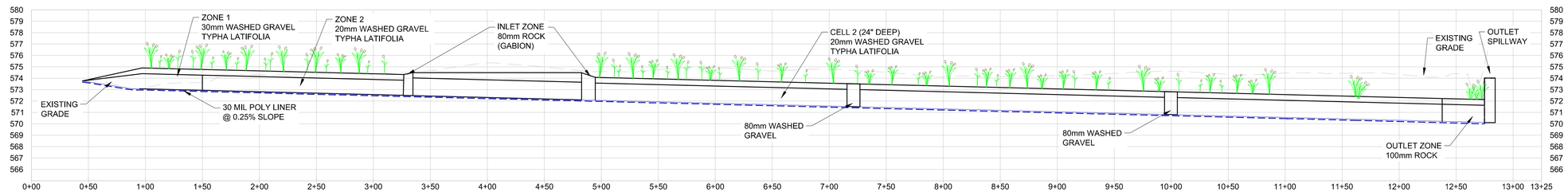
SECTION 8
HORZ SCALE: 1" = 30'
VERT SCALE: 1" = 3'
figure 8



SECTION 9
HORZ SCALE: 1" = 30'
VERT SCALE: 1" = 3'
figure 8



SECTION 10
HORZ SCALE: 1" = 30'
VERT SCALE: 1" = 3'
figure 8



PROFILE
HORZ SCALE: 1" = 50'
VERT SCALE: 1" = 5'

N

0 20 50ft

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

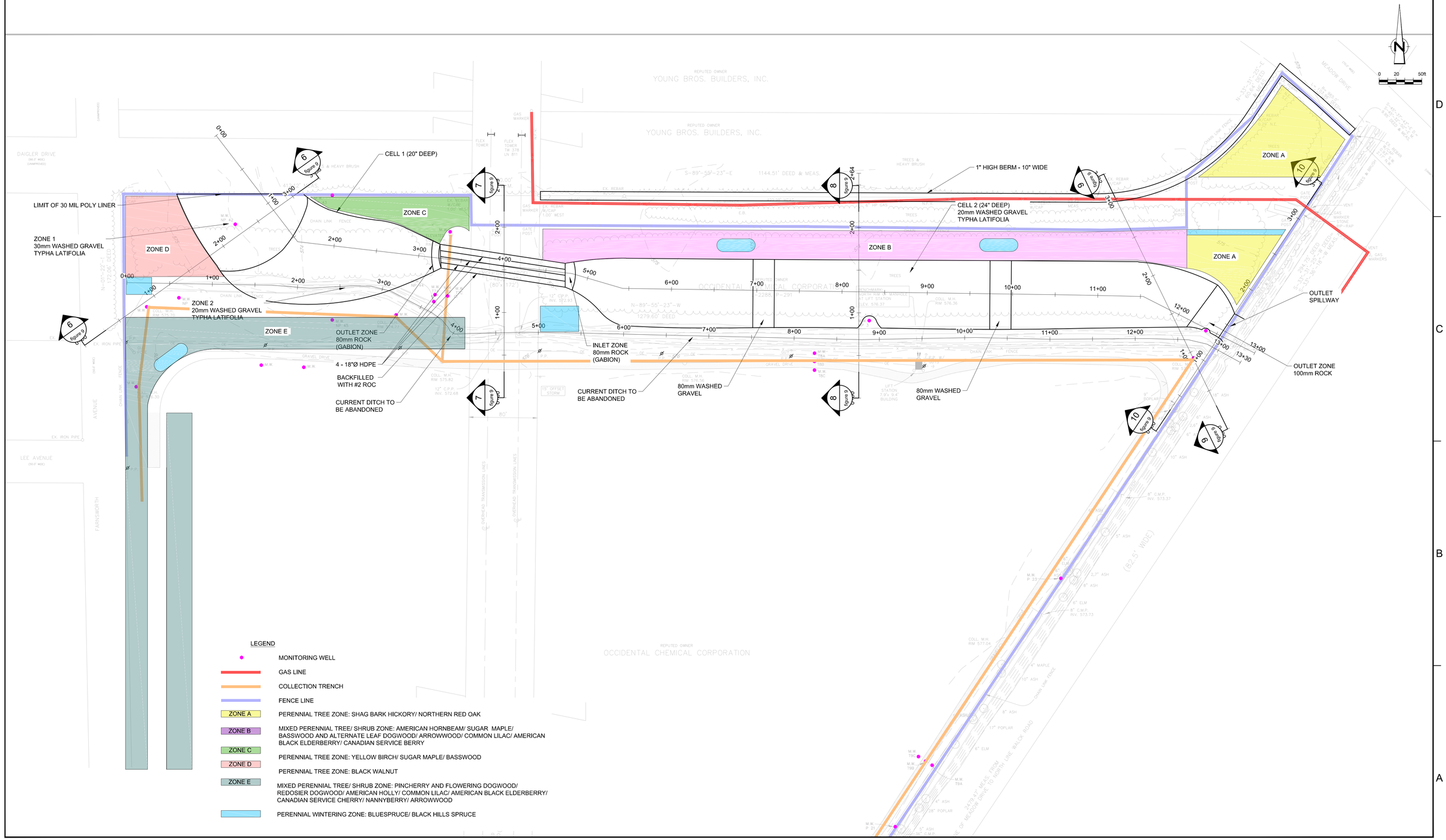
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

NORTH DITCH DRAINAGE IMPROVEMENTS
ENGINEERED WETLAND - SECTION VIEW

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: J. RABY	Designed By: S. PIKE	Drawn By: S. PIKE
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 9

07405-00(032)CI-BU004 JUN 28/2012



SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

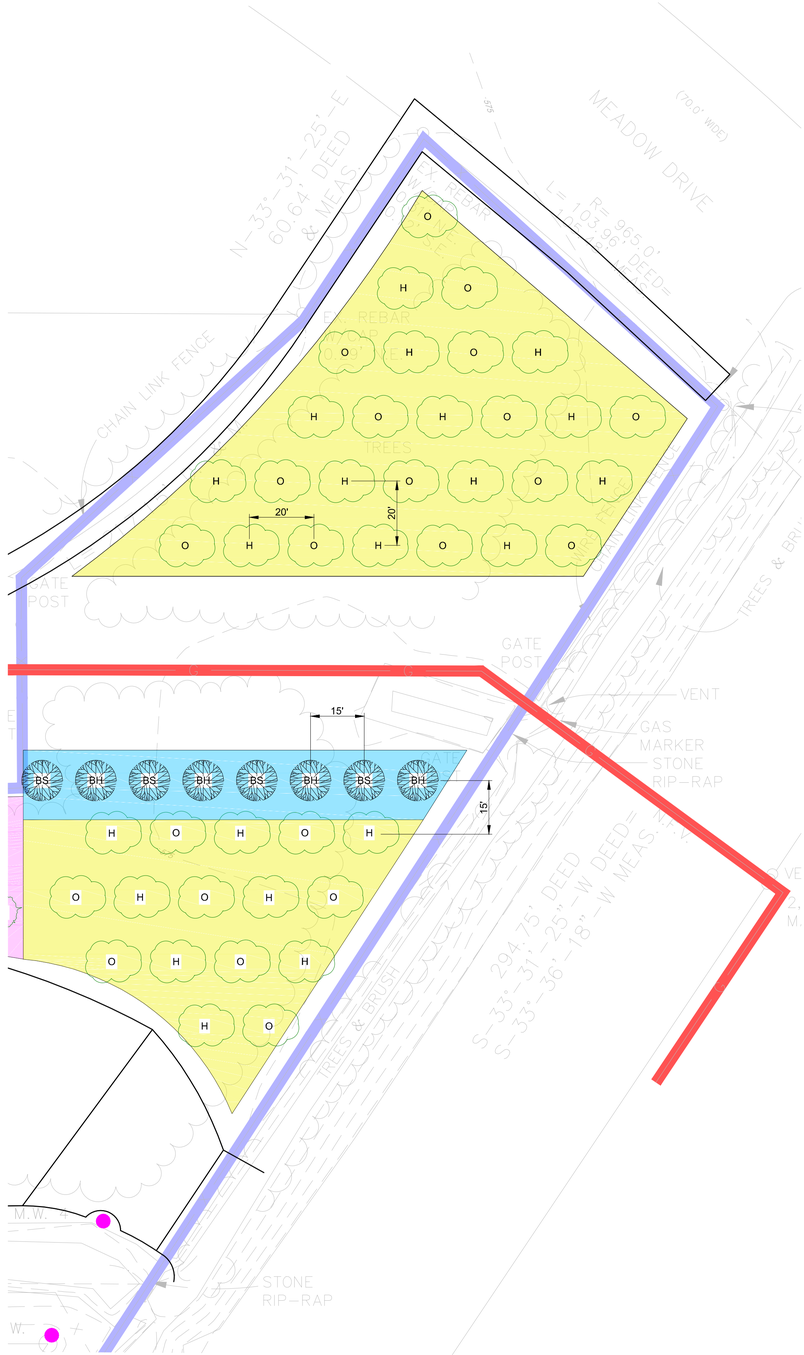
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
TREE AND SHRUB PLANTING ZONES

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: REVIEWED_BY	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 10

07405-00(032)CI-BU0011 AUG 21/2012



LEGEND

- MONITORING WELL
- GAS LINE
- COLLECTION TRENCH
- FENCE LINE
- ZONE A
- WINTERING ZONE
- H — SHAG BARK HICKORY
- O — NORTHERN RED OAK
- BS — BLUE SPRUCE
- BA — BLACK HILLS SPRUCE

NOTES:

1. TREES TO BE PLACED ON 20' CENTERS
2. PLANTING WILL BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES
3. WINTERING ZONE TREES TO BE PLACED ON 15' CENTERS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

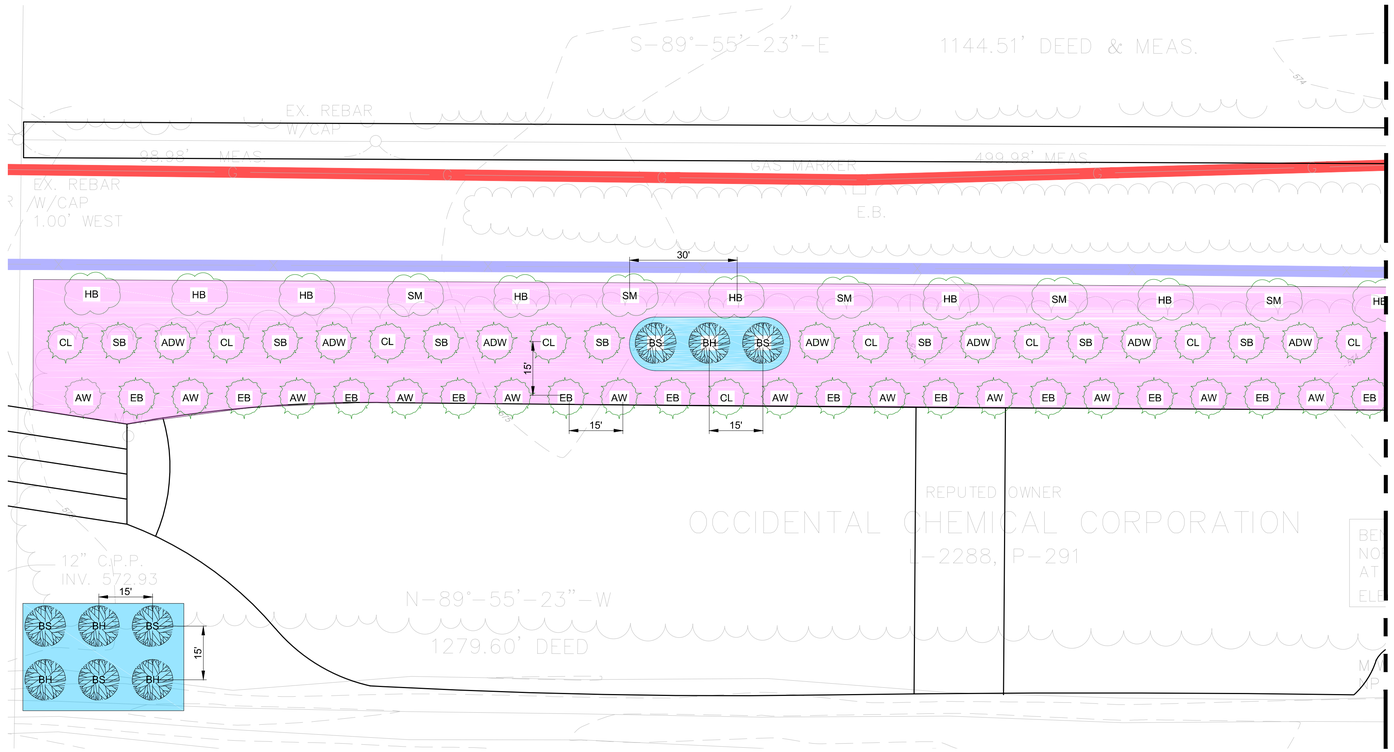
FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
ZONE A

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 11

07405-00(032)CI-BU0012 AUG 21/2012



LEGEND

- MONITORING WELL
- GAS LINE
- COLLECTION TRENCH
- FENCE LINE
- ZONE B
- WINTERING ZONE
- BS — BLUE SPRUCE
- BA — BLACK HILLS SPRUCE
- SM — SUGAR MAPLES
- HB — HORNBEAMS
- ADW — ALTERNATE LEAF DOGWOOD
- CL — COMMON LILAC
- AW — ARROWWOOD
- EB — AMERICAN BLACK ELDERBERRY
- SB — CANADIAN SERVICEBERRY

NOTES:

1. TREES TO BE PLACED ON 30' CENTERS
2. SHRUBS TO BE PLACED ON 15' CENTERS
3. PLANTINGS TO BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES.
4. WINTERING ZONE TREES TO BE PLACED ON 15' CENTERS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

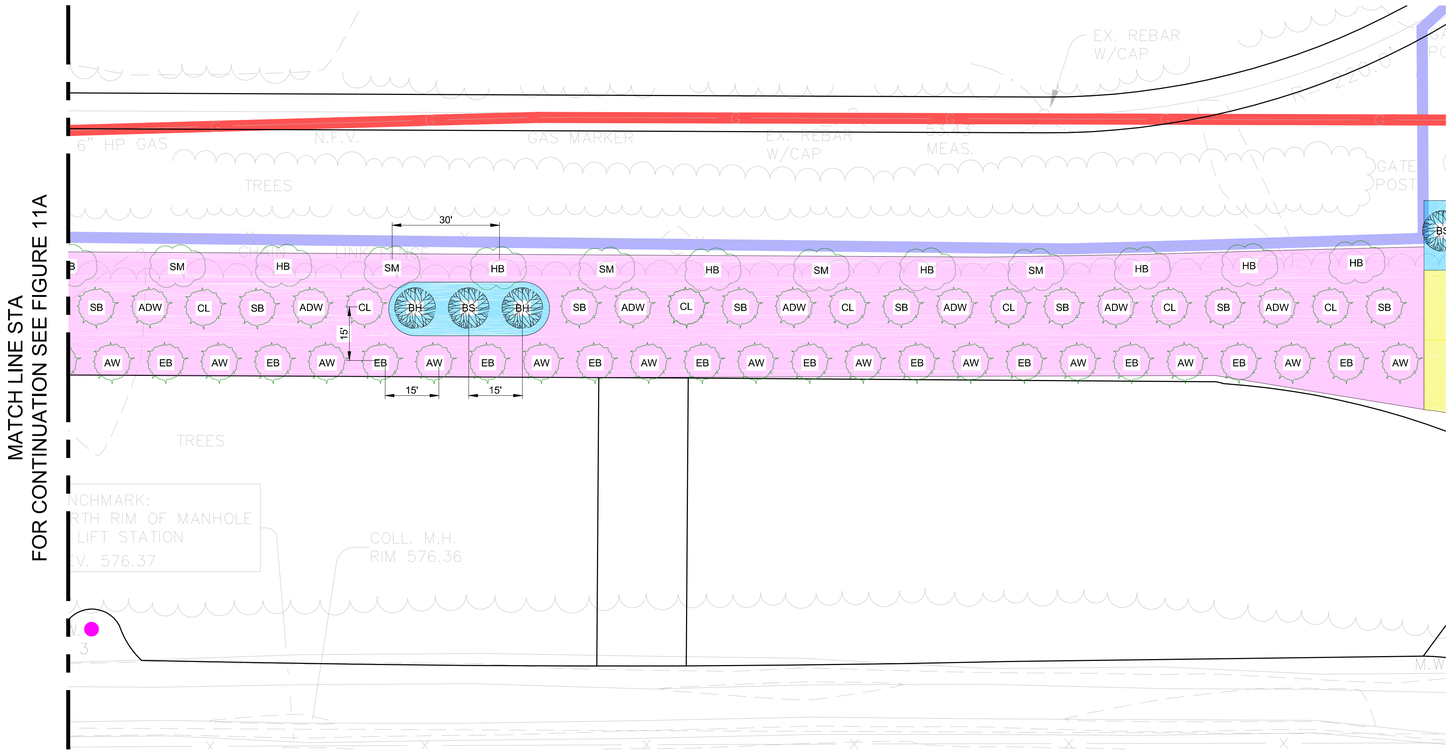
No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
ZONE B

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 12A



LEGEND

- MONITORING WELL
- GAS LINE
- COLLECTION TRENCH
- FENCE LINE
- ZONE B
- WINTERING ZONE
- BS — BLUE SPRUCE
- BA — BLACK HILLS SPRUCE
- SM — SUGAR MAPLES
- HB — HORNBEAMS
- ADW — ALTERNATE LEAF DOGWOOD
- CL — COMMON LILAC
- AW — ARROWWOOD
- EB — AMERICAN BLACK ELDERBERRY
- SB — CANADIAN SERVICEBERRY

NOTES:

1. TREES TO BE PLACED ON 30' CENTERS
2. SHRUBS TO BE PLACED ON 15' CENTERS
3. PLANTINGS TO BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES.
4. WINTERING ZONE TREES TO BE PLACED ON 15' CENTERS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

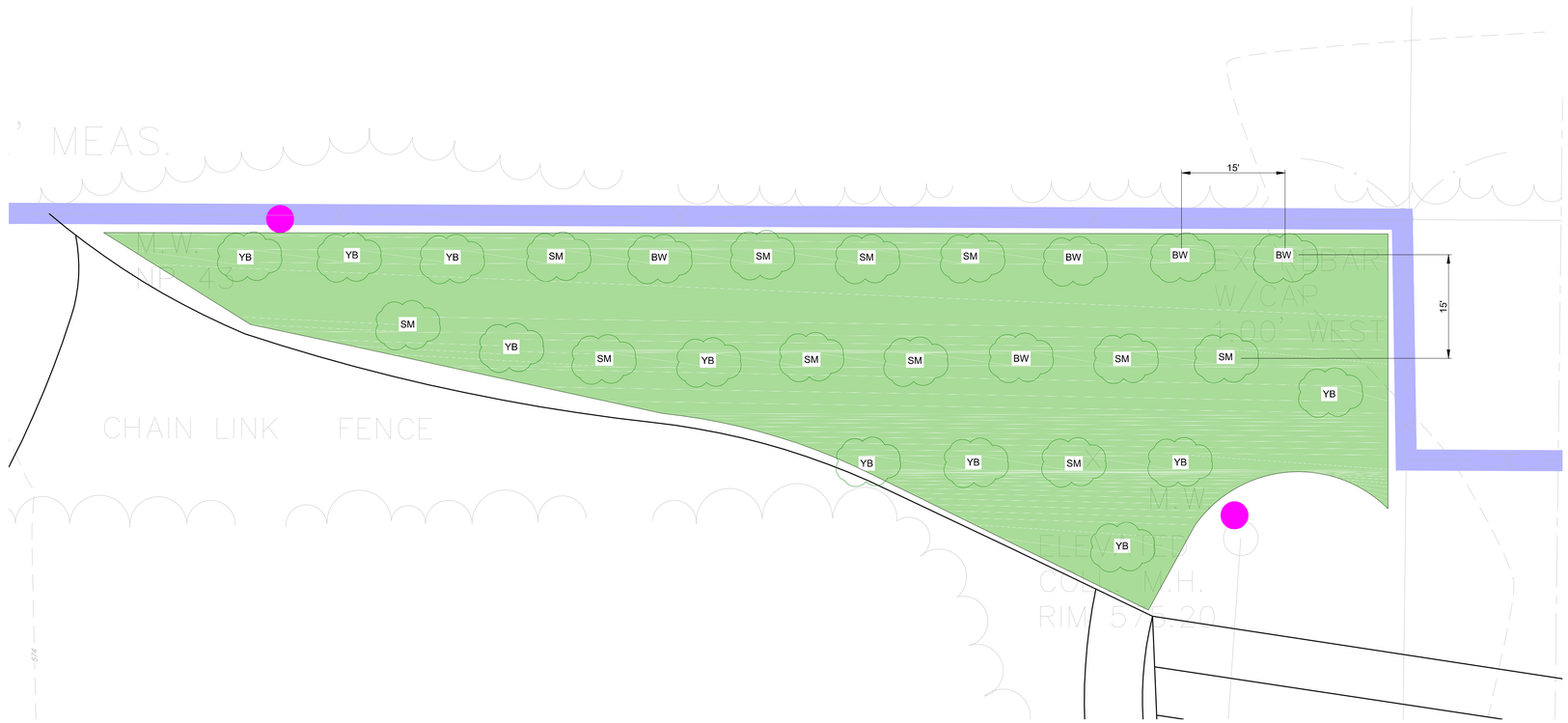
No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
ZONE B

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 12B



LEGEND

- MONITORING WELL
- GAS LINE
- COLLECTION TRENCH
- FENCE LINE
- ZONE C
- SM — SUGAR MAPLES
- YB — YELLOW BIRCH
- BW — BASSWOOD

NOTES:

1. TREES TO BE PLACED ON 15' CENTERS
2. PLANTINGS TO BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES.

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

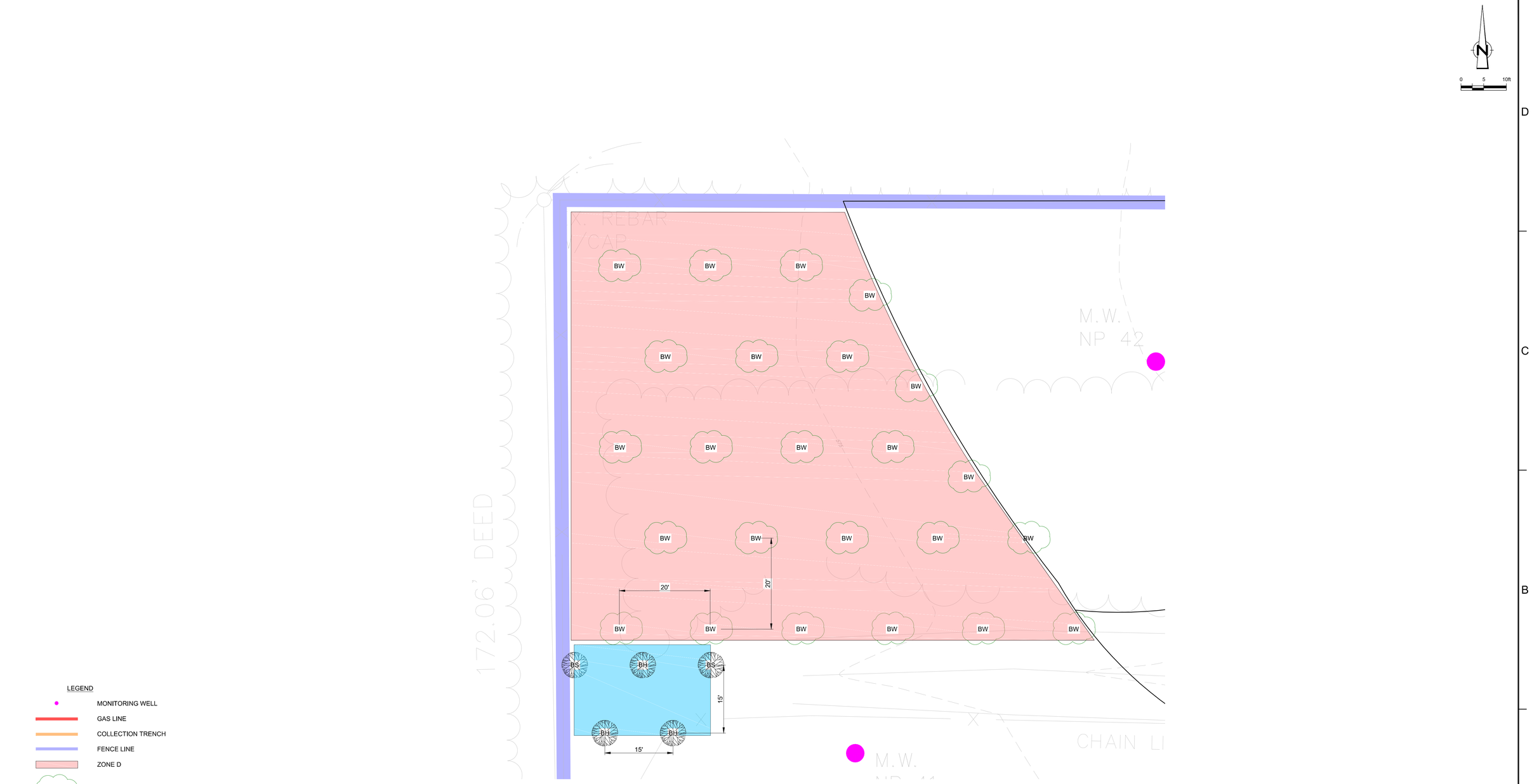
No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
ZONE C

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 13



NOTES:

1. TREES TO BE PLACED ON 20' CENTERS
2. PLANTINGS TO BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES.
3. WINTERING ZONE TREES TO BE PLACED ON 15' CENTERS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITAT RECOVERY PROGRAM
ZONE D

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 14

07405-00(032)GN-BU0012 AUG 21/2012

LEGEND

- MONITORING WELL
- GAS LINE
- COLLECTION TRENCH
- FENCE LINE
- ZONE E
- WINTERING ZONE
- BLUE SPRUCE
- BLACK HILLS SPRUCE
- PINCHERRY

- PC PINCHERRY
- AH AMERICAN HOLLY
- FDW FLOWERING DOGWOOD
- RDW REDOSIER DOGWOOD
- AW ARROWWOOD
- NB NANNYBERRY
- CL COMMON LILAC
- EB AMERICAN BLACK ELDERBERRY
- SB CANADIAN SERVICEBERRY

NOTES:

1. TREES TO BE PLACED ON 20' CENTERS
2. PLANTINGS TO BE INSTALLED AS 4' - 6' BARE ROOT WITH A MINIMUM OF 3 STAKES.
3. WINTERING ZONE TREES TO BE PLACED ON 15' CENTERS

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

FORMER DUREZ NORTH TONAWANDA SITE
NORTH TONAWANDA, NEW YORK

HABITATE RECOVERY PROGRAM
ZONE E

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JUNE 2012
Project Manager: D. HOYT	Reviewed By: S. PIKE	Designed By: L. PABST	Drawn By: J. ARTER
Scale: AS SHOWN	Project No: 07405-00	Report No: 032	Drawing No: figure 15

07405-00(032)CI-BU0012 AUG 21/2012

TABLES

TABLE 1

NUMBER OF PLANTINGS FOR EACH AREA
GLENN SPRINGS HOLDINGS, INC.
NORTH TONAWANDA NEW YORK

Species	*Common Name*	*Type*	*Characteristics*	*Area A*	*Area B*	*Area C*	*Area D*	*Area E*
				15,225 sf	19,145 sf	4,600 sf	10,200 sf	26,100 sf
				18' spacing	30' spacing trees 10' spacing shrubs	15' spacing	20' spacing	10' spacing
Betula alleghaniensis	Yellow Birch	Perennial Tree	Adapted to coarse, medium, and fine grained soils, 4-8 pH range, intermediate drought/hedge/salinity/shade tolerance, medium moisture use, high cold hardiness, medium fruit/seed abundance, slow growth rate, 30" minimum root depth, mature height at 75', minimum of 60 frost-free days, slow growth rate, ~30' spread			10		
Acer saccharum	Sugar Maple	Perennial Tree	Adapted to coarse and medium grained soils, 4-8 pH range, medium drought and shade tolerance, no salinity/hedge tolerance, medium moisture use, high cold tolerance, high fruit/seed abundance, slow growth rate, 40" minimum root depth, mature height at 100', minimum of 80 frost-free days, slow growth rate, ~40-50' spread		10	11		
Tilia Americana	Basswood	Perennial Tree	Adapted to coarse and medium grained soils, 4.5-7.5 pH range, low drought, no hedge/salinity, and medium shade tolerance, medium moisture use, high cold hardiness, high fruit/seed abundance, moderate growth rate, 30" minimum root depth, mature height at 100', minimum of 80 frost free days, moderate growth rate, ~35-50' spread			5		
Carya ovata	Shagbark Hickory	Perennial Tree	Adapted to coarse, medium, and fine grained soils, 4-7.3 pH range, medium drought/shade, low salinity, and no hedge tolerance, medium moisture use, high cold hardiness, medium fruit/seed abundance, slow growth rate, 48" minimum root depth, mature height at 75', minimum of 140 frost free days, slow growth rate, ~25' spread	21				
Quercus rubra	Northern Red Oak	Perennial Tree	Adapted to coarse, medium, and fine grained soils, 4.3-7.3 pH range, low drought, no hedge, and medium salinity/shade tolerance, medium moisture use, 36" minimum root depth, mature height 80', minimum of 100 frost free days, moderate growth rate, ~40' spread	22				
Juglans nigra	Black Walnut	Perennial Tree	Adapted to medium textured soils, 4.6-8.2 pH range, low drought, and no hedge/shade/salinity tolerance, high moisture use, 40" minimum root depth, mature height 100', minimum 170 frost-free days, rapid growth rate, ~ 40-50 spread				24	
Carpinus caroliniana	American Hornbeam	Perennial Tree	Adapted to coarse and medium grained soils, 4.0-7.4 pH range, low drought/hedge tolerance, shade tolerant, medium moisture use, 20" minimum root depth, mature height at 30', minimum of 80 frost-free days, slow growth rate, ~20-30' spread		15			

TABLE 1

NUMBER OF PLANTINGS FOR EACH AREA
GLENN SPRINGS HOLDINGS, INC.
NORTH TONAWANDA NEW YORK

Species	*Common Name*	*Type*	*Characteristics*	*Area A*	*Area B*	*Area C*	*Area D*	*Area E*
				15,225 sf	19,145 sf	4,600 sf	10,200 sf	26,100 sf
				18' spacing	30' spacing trees 10' spacing shrubs	15' spacing	20' spacing	10' spacing
Cornus alternifolia	Alternateleaf Dogwood	Perennial Woody Shrub	Adapted to medium grained soils, 4.8-7.3 pH range, low drought/hedge/salinity tolerance, tolerant of shade, medium moisture use, 20" minimum root depth, mature height at 25', minimum 120 frost free days, moderate growth rate		16			
Syringa vulgaris	Common Lilac	Perennial Woody Shrub	Adapted to coarse, medium, and fine grained soils, 5.8-7.8 pH range, medium drought/salinity/shade tolerance, high hedge tolerance, medium moisture use, 14" minimum root depth, mature height at 20', minimum 110 frost free days, moderate growth rate		17			28
Cornus Florida	Flowering Dogwood	Perennial Woody Shrub	Adapted coarse and medium grained soils, 4.8-7.7 pH range, low drought/salinity/hedge tolerance, intolerant of shade, low moisture use, 18" minimum root depth, mature height at 30', minimum 160 frost free days, moderate growth rate					30
Cornus sericea	Redosier Dogwood	Perennial Woody Shrub	Adapted to coarse, medium, and fine grained soils, 4.8-7.5 pH range, low hedge/drought/salinity tolerance, high anaerobic tolerance, no shade tolerance, high moisture use, 20" minimum root depth, mature height at 12', minimum 90 frost-free days, moderate growth rate					30
Viburnum dentatum	Arrowwood	Perennial Woody Shrub	Adapted to coarse, medium, and fine grained soils, 4.5-7.3 pH range, low drought/salinity tolerance, medium hedge tolerance, and intermediate shade tolerance, medium moisture use, 20" minimum root depth, mature height at 8', minimum 160 frost free days, moderate		25			30
Prunus pensylvanica	Pin Cherry	Perennial Woody Shrub	Adapted to coarse, medium, and fine grained soils, 4.3-7.3 pH range, low drought/salinity/hedge tolerance, shade intolerant, medium moisture use, 20" minimum root depth, mature height at 30', minimum 90 frost-free days, rapid growth rate					20
Ilex opaca	American Holly	Perennial Woody Shrub	Adapted to coarse and medium textured soils, 4.5-7.0 pH range, medium drought/hedge/salinity tolerance, shade tolerant, medium moisture use, 30" minimum root depth, mature height at 40', minimum 140 frost-free days, slow growth rate					30

TABLE 1

NUMBER OF PLANTINGS FOR EACH AREA
GLENN SPRINGS HOLDINGS, INC.
NORTH TONAWANDA NEW YORK

Species	*Common Name*	*Type*	*Characteristics*	*Area A*	*Area B*	*Area C*	*Area D*	*Area E*
				15,225 sf	19,145 sf	4,600 sf	10,200 sf	26,100 sf
				18' spacing	30' spacing trees 10' spacing shrubs	15' spacing	20' spacing	10' spacing
Sambucus nigra	Common Elderberry	Perennial Woody Shrub	Adapted to medium grained soils, 5.0-8.9 pH range, medium drought, hedge tolerance, intolerant of shade, medium moisture use, 16" minimum root depth, mature height at 7', minimum 100 frost free days, rapid growth rate		25			30
Amelanchier canadensis	Canadian Serviceberry	Perennial Woody Shrub	Adapted to fine, medium and coarse grained soils, 5.5-7.5 pH range, low drought tolerance, medium hedge and shade tolerance, medium moisture use, 20" minimum root depth, mature height at 23', minimum 110 frost-free days, moderate growth rate		17			30
Viburnum lentago	Nannyberry	Perennial Woody Shrub	Adapted fine and medium textured soils, 5-7 pH range, low drought and hedge tolerance, shade tolerant, medium moisture use, 14" minimum root depth, mature height at 28', minimum 128 frost-free days, slow growth rate					28
Picea pungens	Blue Spruce	Perennial Tree	Adapted coarse and medium textured soils, 5.5-7.8 pH range, medium drought, low hedge tolerance, intermediate shade tolerance, medium moisture use, 18" minimum root depth, mature height at 100', minimum 120 frost free days, slow growth rate, ~20' spread	4	4		2	7
Picea glauca var. densata	Black Hills Spruce	Perennial Tree	Adapted coarse and medium textured soils, 4-7.5 pH range, medium drought, tolerance intermediate shade tolerance, medium moisture use, 18" minimum root depth, mature height at 100', minimum 120 frost-free days, slow growth rate, ~20' spread	4	4		3	3

APPENDIX A

EXCERPTS FROM HISTORICAL REPORTS – 2,3,7,8-TCDD DETECTIONS

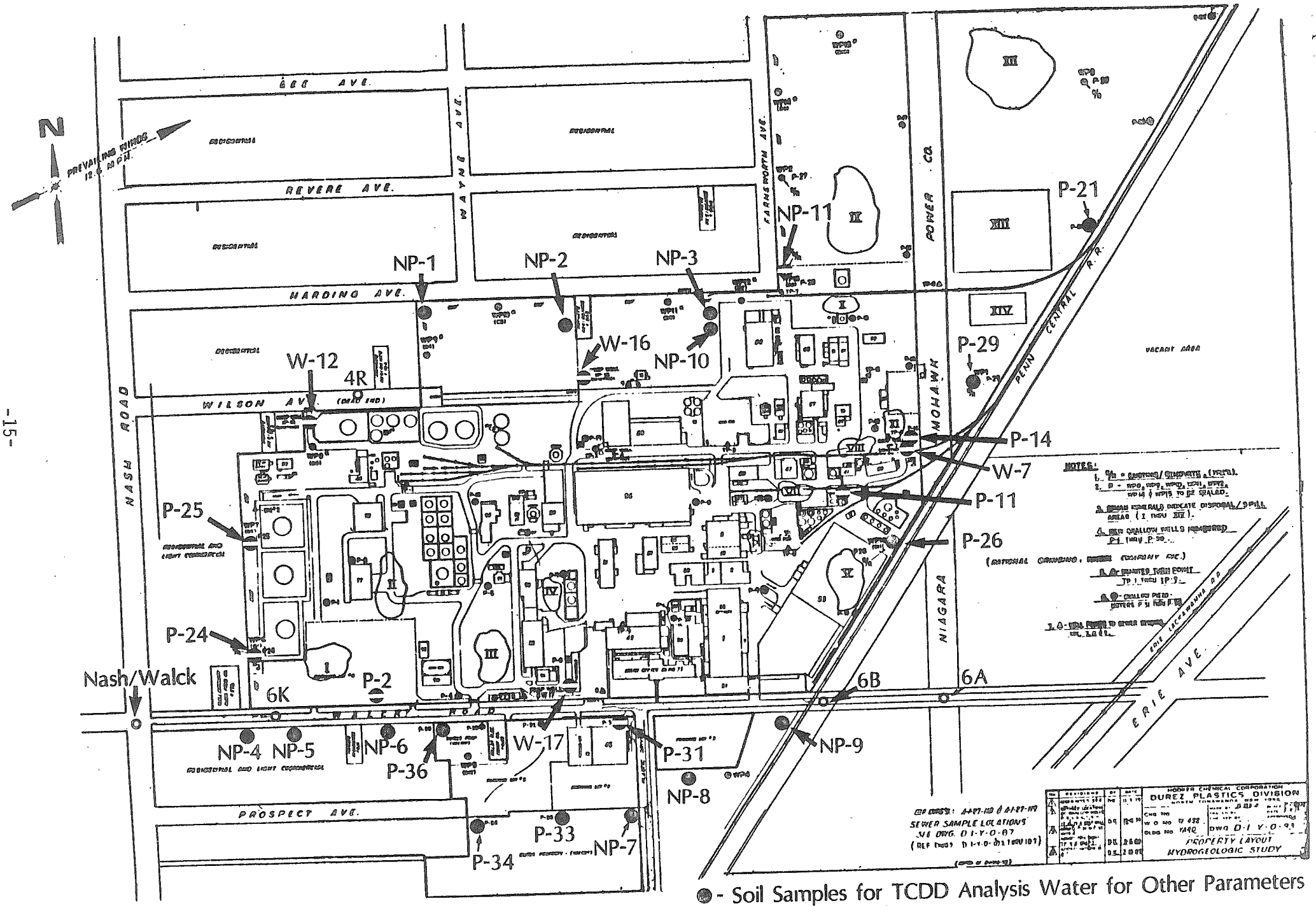
OCCIDENTAL CHEMICAL CORPORATION

Durez Division
North Tonawanda, N.Y.

REPORT OF CONTINUING FIELD INVESTIGATIONS
Summer 1982

SECTION III
Sampling and Analytical Chemistry

November 1982



● - Soil Samples for TCDD Analysis Water for Other Parameters

⊖ - Water for Other Parameters

CIRCLES - Sewer Samples for TCDD and Other Parameters

FIGURE 1.1 - Sample Sites

TABLE 1B.1

SOIL SAMPLING - FIELD NOTES

Site Description	Site No.	Date	Time	Portion Number	Depth (Feet)	Bottle Number	Comments
N-W Corner (Harding) of plant - Heavy growth of grass	NP-1	5/26	15:35	S-3	4-6	00128	
			15:50	S-4	6-8	00127	S-4 was separated with a top gravel layer going into bottle 00138.
			15:50	S-4	6-8	00138	
At the edge of concrete pad surface of slag or crushed stone	NP-3	5/27	13:17	S-4	6-8	00143	
			13:26	S-5	8-10	00131	Abnormal sample - refer to text.
			13:43	S-6	10-12	00144	Sandy lens in clay layer - refer to text.
Adjacent to NP-3	NP-10	5/28					Placement of second piezometer for hydrogeological reasons not for soil sampling.
Adjacent to old piezometer in tall grass and weeds	P-21	5/28	11:40	S-2	2-4	00152	
			11:50	S-3	4-6	00133	
Adjacent to old piezometer into gravel or slag	P-26	5/28	-	S-3	4-6	00132	Pine odor in soil
			14:50	S-4	6-8	00134	Same odor as S-3 - Both portions covered with black slimey liquid
A few feet from south edge of parking lot #3 in weeds with some grass	NP-8	6/1	09:05	S-2	2-4	00043	
			09:07	S-3	4-6	00052	
			09:13	S-4	6-8	00105	
Near camera tower in thick grass	NP-7		12:50	S-2	2-4	00125	
			12:56	S-3	4-6	00107	
			13:01	S-4	6-8	00108	
In unpaved driveway or parking area - surface is somewhat stoney	NP-9	6/1	15:15	S-2	2-4	00153	Disputed sample - refer to text.
			15:20	S-3	4-6	00145	
			15:30	S-4	6-8	00146	Only 2" discard - refer to text.

TABLE 1B.1

SOIL SAMPLING - FIELD NOTES (CONT)

Site Description	Site No.	Date	Time	Portion Number	Depth (Feet)	Bottle Number	Comments
At interface of paved and unpaved parking areas	NP-4	6/2	09:20	S-3	4-6	00148	
			09:32	S-4	6-8	00151	
Asphalt paving at corner of commercial garage	NP-6	6/2	13:19	S-2	3-5	00139	First foot was asphalt crushed stone base.
			13:27	S-3	5-7	00124	
			-	S-4	7-9	00123	No discard, kept entire 4" above clay.
Grass and weeds adjacent to P-36	P-36	6/2	15:50	S-2	2-4	00129	
			15:55	S-3	4-6	00044	
			16:11	S-4	6-8	00106	
Tall grass and weeds	NP-2	6/3	09:41	S-2	2-4	00130	
			09:48	S-3	4-6	00140	
			09:56	S-4	6-8	00141	
Tall grass and weeds adjacent to broken piezometer P-28	NP-11	6/3	13:35	S-2	2-4	00040	
			-	S-3	4-6	00041	
			13:50	S-4	6-8	00042	
Swampy grassy area adjacent to P-29	P-29	6/4	09:20	S-1	0-2	00051	
			09:35	S-2	2-4	00053	
			10:02	S-3	4-6	00142	Small portion on top of clay -no discard.
Lawn adjacent to P-34	P-34	6/4	11:40	S-3	4-6	00046	
			11:50	S-4	6-8	00047	Note text.
Edge of lawn at 603 Walck, a private residence	NP-5	6/4	14:35	S-3	4-6	00050	
			14:48	S-4	6-8	00049	Note text.
Lawn adjacent to P-33	P-33	6/4	17:54	S-2	2-4	00054	
			18:00	S-3	4-6	00055	
			18:07	S-4	6-8	00056	

4th Sample Bottle #
(Not to be Analyzed)
Prog. Duke
Site NP-1 (Site S-5)
Sample Descrip Soil (Site S-5)
Date 5/26/82
Time 4:05 pm
Taken By Eddy/Mead
This Sample will not be logged in the Chain of Custody

5/27/82

Piezometer installation at site NP-1 was completed by approx 10:15 AM. The next scheduled site to be sampled was NP-2. Because of the wet ground it was believed that the drilling rig may have difficulty get back to NP-2

It was decided that NP-2 be skipped for the time being and NP-3 be sampled next. Preparation for sampling at NP-3 began at 11:10 a m

Drilling began at 11:34

NP-3 First Sample

Bottle # 00135
Program - Duke
Site NP-3
Sample Descript: Soil (S-3)
B-5-6-7-7 Depth 4-6 ft
Date 5/27/82 Time 11:56
Taken by Eddy/Mead

6 NP-3 2nd SAMPLE

BOTTLE # 00143
PROGRAM DURE2
SITE NP-3
SAMPLE DESCRIPTION: SOIL (S-4)
B-8-9-10-12 Depth 6-8 ft
DATE 5/27/82 TIME 1:17 pm
TAKEN BY EDDY/MEAD

NP-3 3RD SAMPLE

BOTTLE # 00131
PROGRAM DURE2
SITE NP-3
SAMPLE DESCRIPTION SOIL (S-5)
B-7E-12-16-22 Depth 8-10 ft
Top 6" layer
DATE 5/27/82 TIME 1:26 pm
TAKEN BY EDDY/MEAD
NOTE - This sample is the top 6" of S-5 core - this portion would normally be discarded following protocol guidelines

however, since the portion was of a gravelly composition it was decided ~~not~~ that it would be saved. The section S-5 (denoted S-5# by Logger was below saturated zone and was discarded

NP-3 4th SAMPLE

BOTTLE # ~~00131~~ 00144
PROGRAM DURE2
SITE NP-3
SAMPLE DESCRIPTION SOIL S-6
B-8-11-13-18 Depth 10-12 ft
DATE 5/27/82 TIME 1:43 pm
TAKEN BY EDDY/MEAD

NOTE - This sample was a 1/4 ft (3") ~~samp~~ sandy section of core just below the top 6" discard section
- The rest of the core was all clay. Geologist believes the section may just be an isolated sand pocket in the clay layer - 1 1/2 ft below saturated zone

7

54
55
56

8

NP-3 - (5-7) ~~confirmed~~ confirmed the end of the saturated zone had been passed - no more samples will be taken

NOTE: Since there is a sand layer or pocket at approx 11½ ft depth and the main saturated zone down to 7½ to 8 ft, the NP-3 site will have the well point installed at 11½ ft depth.

A second boring will be made approx 2 ft away from NP-3 and the well point at this site will be set at 7½ ft.

Installation of Piezometer (11½ ft well pt.) at NP-3 completed at 4:15 pm

EVALUATION

9

181 NP-2
2nd Sample

Bottle # 00140
Program DURE2
Site NP-2
Sample Description Soil (S-3)
B-4-5-5-8 Depth 4-6 ft
Date 6/3/82 Time 9:48
Taken By: EDDY/MEAD

NP-2 3rd SAMPLE

Bottle # 00141
Program: DURE2
Site NP-2
Sample Description: Soil (S-4)
B-13-15-20-16 Depth 6-8 ft
Date 6/3/82 Time: 9:58 AM
Taken By: EDDY/MEAD

Wellpoint of piezometer at NP-2 to be set at 8 ft

Piezometer installation at NP-2 completed by 11:25 am

NP-11 (site of old piezometer P-28)

Note - P-28 was a old piezometer installation that had been damaged (well pipe crushed - probably run over by vehicle.) A new piezometer is to be installed at the location. Rick Mead consulted with Gene Kuclarski Gene advised calling new piezometer NP-11 and taking soil boring before well is established

Soil boring at site NP-11 began at 1:15 pm

NP-11 - 1ST SAMPLE

BOTTLE # 00040
PROGRAM DUREZ
SITE: NP-11
SAMPLE DESCRIPTION: SOIL (S-2)
B-6-9-10-13 DEPTH 2-4 ft
DATE: 6/3/82 TIME: 1:35pm
TAKEN BY: EDDY/MEAD

NP-11 2nd SAMPLE

BOTTLE # 00041
PROGRAM: DUREZ
SITE NP-11
SAMPLE DESCRIPTION SOIL (S-3)
DATE: 6/3/82 TIME
TAKEN BY EDDY/MEAD

B-9-11-13-15 DEPTH 4-6 ft

NP-11 3rd SAMPLE

BOTTLE # 00042
PROGRAM DUREZ
SITE NP-11
SAMPLE DESCRIPTION SOIL (S-4)
B-16-19-16-19 DEPTH 6-8 ft
DATE 6/3/82 TIME: 1:50pm
TAKEN BY EDDY/MEAD

Well point for Piezometer at NP-11 was set at 7½ ft

SAMPLING TEAM ON 6/3/82 CONSISTED OF
JOE GENOVESE & DRILLER
JIM LAMM
BOB EDDY
RON MEAD
JERRY PIETRZAK & DEG GEOLOGISTS
JACK KRASZEWSKI

3.0 RESULTS - TCDD

3.1 INTRODUCTION

Tetrachlorodibenzo-p-dioxins (TCDD) were investigated in Durez soils, sewer water and filters. The analyses were performed by high resolution gas chromatography/high resolution mass spectrometry. Incomplete TCDD isomer separation was achieved. Positive responses were reported in two ways: as total TCDD and as 2,3,7,8-TCDD and co-eluting isomers. Detection limits for water and for water equivalent from filters were 2 ng/L. Detection limits for soils varied and the method of calculation is explained in Appendix 3A. The detection limit values ranged from 48 pg/g to 260 pg/g.

Water samples were prepared for analysis by a modification of G. Junk's technique using XAD-2 resin. The soil samples and the filters were Soxhlet extracted. All three procedures used modified Dow column chromatography. A detailed description of the preparation and analysis methods is given in Appendix 3A. A complete package of the raw data generated for one of the soil samples, together with standards and calibration information, is presented in Appendix 3B.

3.2 Results

3.2.1 Soil

The results of the Durez soil analyses are found in Table 3.1. The values reported are corrected for recovery. The data is based on the dry weight of the soil. The moisture content of each sample is given in Table 3.10. Sixteen(16) soil samples were analyzed.

3.2.2 Water

The results for the storm sewer water analyses are found in Table 3.2. The detection limit is 2 ng/L for all samples. Six water samples were analyzed.

3.2.3 Filters

Data from the analysis of filters and filter cake is found in Table 3.3. The detection limit is 2 ng/L in the water passed through the filter. The six filters analyzed were sampled in conjunction with the six water samples.

3.3 Review of Data

3.3.1 Standards - Data Correction

Standards obtained from KOR Isotopes were corrected with a primary standard from Dow Chemical, Midland, Michigan. This primary standard was used to correct KOR standards analyzed after August 25.

By analyzing the August 25th standards vs. the primary standard, a correction factor of three was obtained. The KOR standards were three times higher than the Dow standard. Any data generated prior to August 25th was not checked with the primary standard. To remedy this, positive responding extracts were rerun. Correlation between the two sets of raw, uncorrected data was good. This is shown in Table 3.4. The only exception was NP-11 for 2,3,7,8 and co-eluting isomers. This was probably due to integration difficulties, see section 3.3.3.4. The values given in Table 3.1 represent the average of the numbers in Table 3.4 with the correction factor of three applied. In the case of not detected results, all values were amended by the factor of three. Where two detection limits were generated for the same extract, the lower value was used.

Sample NP-10, extract 7-21-SS-4, was not available for re-analysis because the original extract went dry and the reserved aliquot extract contained no internal standard. Because of the response similarities in Table 3.4, the primary standard correction was applied to the original analytical result.

3.3.2 Total TCDD Variation

There appears to be a difference in the total TCDD from subsample to subsample in the same sample. This is illustrated by sample NP-8, Figures 3.4 and 3.5. From a preliminary study, it seems that the TCDD isomers' recoveries may vary from the alumina column. Further work is in progress to confirm this.

Differences in isomer recoveries have been reported previously by Dow[1]. The differences observed during our preliminary study and those reported by Dow are not large enough to account for the observed difference in NP-8. At this time we do not have an explanation except that the subsamples contained differing amounts of the TCDD isomers.

3.3.3 Soils

The data in Table 3.1 have been corrected for recovery. An internal standard, $^{13}C_{12}$-2,3,7,8-TCDD, was added to all samples prior to preparation and was used to correct the final numbers for losses during workup. The results are based on the dry weight of the soil. The moisture content of each sample is found in Table 3.10. Each extract was analyzed in duplicate. The data reported in Table 3.1 are the average of the two injections. Where replicate samples were prepared, each result is listed. In some cases, analysis of an extract was repeated at a later time. These values are also included to show the reproducibility of the GC/MS system. The key is the C.S. workup number which was assigend to each sample aliquot prepared.

3.3.3.1 Raw Data From a Soil Sample

A complete set of raw data generated for soil sample, NP-8, extraction number, 8-30-SS-1, is presented in Appendix 3B. This includes instrument calibration and standards data.

3.3.3.2 Chromatograms - Positive Results

Reconstructed ion chromatograms (RIC) and mass maps are presented in Figures 3.1 - 3.10 for soil samples with a positive TCDD response. The bottom portion, or RIC, is equivalent to a gas chromatogram and represents the sum of the three ions monitored. The upper portion follows the three individual masses. All figures show m/e 334 from the internal standard. In all figures, the acquisition was started two minutes after injection.

3.3.3.3 Method Validation

Results of the method validation study for soil analysis are presented in Table 3.5. Chromatograms are found in Figures, 3.11-3.14. Sample P-33 was chosen for this experiment. Details are given in Appendix 3A, section 3A.1. The recovery data is valid since it is based on the native 2,3,7,8-TCDD added prior to preparation and does not involve the uncertainty explained in section 3.4.1 of this report.

There are two possible explanations for the single discrepancy. One

is a nonhomogeneous sample. The other is contamination from the laboratory. The outlying aliquot is the only one to contain non-2,3,7,8-TCDD isomers. A further study is in progress with four more portions of soil from the P-33 sample. Results will be released upon completion.

3.3.4 Discussion of Specific Samples

Three separate portions of sample NP-3 were prepared and analyzed. Three widely varying results were obtained. The RICs in Figures 3.6, 3.7 and 3.8, for the three positive extracts are similar, except for intensities. This suggests a nonhomogeneous sample. Figure 3.8 represents a split portion of the same soil aliquot in Figure 3.6. A slight spill occurred with extract 7-20-SS-2. Recovery data is acceptable for that sample.

It should be noted in Figures 3.6 to 3.8 that the retention time for the m/e 320, m/e 322 response in the 2,3,7,8 isomer area is shifted slightly from the internal standard. Therefore, the TCDD present may be co-eluting isomers rather than 2,3,7,8.

The NP-4 extract, 7-22-SS-2, was pink in color. All other extracts were colorless.

Comparison of Figures 3.4 and 3.5, showing two separate extracts of NP-8, illustrates the variation in TCDD isomer recovery for that sample discussed in section 3.3.2.

Quantitation of the 2,3,7,8 and co-eluting isomers in both NP-11 sample extracts was achieved by summing the m/e 322 scans in the internal standard retention time window. This was done because of an isomer overlap problem due to inadequate GC resolution.

The aliquot of sample P-26 that was analyzed was not part of the composite split with the NYSDEC. However, the sample used was taken from the remaining soil from P-26, labelled S-3. Due to difficulties in preparation, the original composite sample was not analyzed.

3.3.4 Water

The data in Table 3.2 have been corrected for recovery. An internal standard, $^{13}C_{12}$-2,3,7,8-TCDD, was added to all samples prior to preparation and was used to correct the final data for losses during

workup. Each extract was analyzed by GC/MS in duplicate. The data reported in Table 3.2 are the average of the two injections. One duplicate sample was prepared and the result is listed. In one case, analysis of an extract was repeated at a later time. This value is also included to show the reproducibility of the GC/MS system. The above cases can be distinguished by the CS workup number which was assigned to each sample aliquot prepared.

3.3.4.1 Positive Sample Chromatogram

A Reconstructed Ion Chromatogram (RIC) and a mass map are shown in Figure 3.15 for the water sample from 4R, Wilson Street storm sewer. This sample showed a positive response for TCDD. It can be seen that no 2,3,7,8 or co-eluting isomers were found. Earlier eluting isomers are present.

A second one liter portion of this water did not show a positive response for TCDD.

3.3.5 Filters

Each extract was analyzed in duplicate. The results reported in Table 3.3 are the average of two injections. One duplicate sample was prepared and the result is listed.

The sample, 6B-Walck, involved two filters; one being changed at some point during the filtration. In this case, one quarter of each filter was placed in the Soxhlet thimble for extraction.

One-half of the filter from sample 6K-Walck was analyzed. Calculations were adjusted accordingly.

3.3.5.1 Replicate Filter Analysis

No positive TCDD responses were found. This includes the 4R-Wilson Street sample where a positive response was obtained in the water. Two quarters of this filter were analyzed separately and both were negative for TCDD.

3.4 Quality Assurance

3.4.1 General Comments

The specifics of the quality assurance protocol for the samples reported here is found in Appendix 3A, section 3A.4.

Recovery data for each sample follows. This data is based on the $^{13}C_{12}$-2,3,7,8-TCDD added to each sample prior to workup. It should be regarded as an approximate number because it is calculated on an external standard basis. The absolute intensity of standard responses varies in the GC/MS system, making these numbers an estimate. All other TCDD data generated is based on a $^{12}C/^{13}C$ ratio which does not fluctuate and yields precise results. Information to support the ratio stability is presented in section 3.4.5.

3.4.2 Soils - Recovery Data

Approximate recovery data for all soil samples analyzed is given in Table 3.6.

3.4.3 Water - Recovery Data

Approximate recovery data for all water samples analyzed is given in Table 3.7.

3.4.4 Filters - Recovery Data

Approximate recovery data for all filters analyzed is given in Table 3.8.

3.4.5 Instrument Stability Data

Data is presented in Table 3.9 for a set of 2,3,7,8-TCDD standards analyzed over one month. This shows good reproducibility and indicates that the GC/MS system was stable in its response over at least a month's time period. The curves were based on $^{12}C/^{13}C$ ratios. The same standard set was analyzed each time. The ion source was removed, cleaned and reinstalled during this time period. The fused silica capillary column was replaced at the same time as the source cleaning.

3.5 Durez Raschig Tar Sample

A Durez Raschig Tar was qualitatively analyzed for TCDD. The RIC and mass map are found in Figure 3.16.

3.6 Changes in May, 1982 Proposed Protocol

The methods used in the generation of the data reported here are slightly different from those reported in the May, 1982 protocol. The changes are as follows:

1). The primary standard used was from Dow Chemical, not from Professor Andrew Kende at the University of Rochester. The standard from Dow was obtained during the course of the program. The Dow standard was felt to be better for external comparison purposes.

2). The validation study was not performed at the detection limit and the 10 L portion of the protocol was not done. The methodology for the 10 L study has not been developed. Review of the original protocol showed that spiking at the detection limit would not be valid statistically.

3). There were minor modifications to the column conditioning temperatures and times for silica gel and alumina to improve the quality of both materials.

4). There were changes in the soil preparation procedure. Methanol was added prior to extraction. No iso-octane was added. These gave improvements in recovery data.

5). In the sediment cake workup, no iso-octane was added. Improvements in recovery data were observed.

REFERENCE

1). Lamparski, L. L. and Nestrick, T. J., "Determination of Tetra-, Hexa-, Hepta-, and Octachlorodibenzo-p-dioxin Isomers in Particulate Samples at Parts Per Trillion Levels", Anal. Chem., 52, 2045-2054 (1980).

TABLE 3.1

Durez Soils TCDD Analysis

pg/g (ppt)

Sample ID	C.S. Workup #	Total TCDD	2,3,7,8 + co-eluters
NP-1	7-18-SS-3	ND_{260}	ND_{260}
NP-2	7-20-SS-1	ND_{78}	ND_{78}
NP-3	7-20-SS-2	6500	690
	7-20-SS2D	4500	390
	7-21-SS-4	290	not determined*
	7-21-SS-4	310	ND_{60}
	8-17-SS-3	ND_{93}	ND_{93}
	8-17-SS-3	ND_{230}	ND_{230}
Np-4	7-22-SS-1	160	ND_{96}
	7-22-SS-2	470	ND_{51}
NP-5	7-21-SS-2	ND_{57}	ND_{57}
NP-6	7-21-SS-3	ND_{90}	ND_{90}
	7-21-SS-3	ND_{93}	ND_{93}
NP-7	8-4-SS-1	190	ND_{110}
NP-8	8-4-SS-2	1300	ND_{96}
	8-30-SS-1	1100	ND_{60}
NP-9	8-4-SS-3	ND_{60}	ND_{60}
NP-11	8-5-SS-1	910	670
	8-26-SS-3	110	72
P-21	8-5-SS-2	ND_{90}	ND_{90}
P-26	8-23-SS-1(S-3)	ND_{48}	ND_{48}
P-29	7-22-SS-4	ND_{78}	ND_{78}
P-33	8-5-SS-3	ND_{90}	ND_{90}
P-34	8-8-SS-2	ND_{90}	ND_{90}
	8-8-SS-2	ND_{60}	ND_{60}
	8-8-SS-2	ND_{93}	ND_{93}
P-36	8-23-SS-2	ND_{99}	ND_{99}

ND_X = not detected at or above X pg/g.

* - data was accidently lost in the laboratory.

TABLE 3.4

Positive TCDD Responses *

pg/g

Sample	CS #	Original Total TCDD	Rerun+ Total TCDD	Original 2,3,7,8 + co-eluters	Rerun 2,3,7,8 + co-eluters
NP-3	7-20-SS-2	2400	2000	260	200
NP-4	7-22-SS-1	40	67	ND_{25}	ND_{32}
NP-4	7-22-SS-2	170	140	ND_{25}	ND_{17}
NP-7	8-4-SS-1	56	71	ND_{37}	ND_{32}
NP-8	8-4-SS-2	440	440	ND_{37}	ND_{32}
NP-8	8-30-SS-1	390	360	ND_{33}	ND_{20}
NP-11	8-5-SS-1	340	270	324	121

* - Not corrected for primary standard.

+ - See section 3.3.1 for an explanation.

Durez-16

OCCIDENTAL CHEMICAL CORPORATION

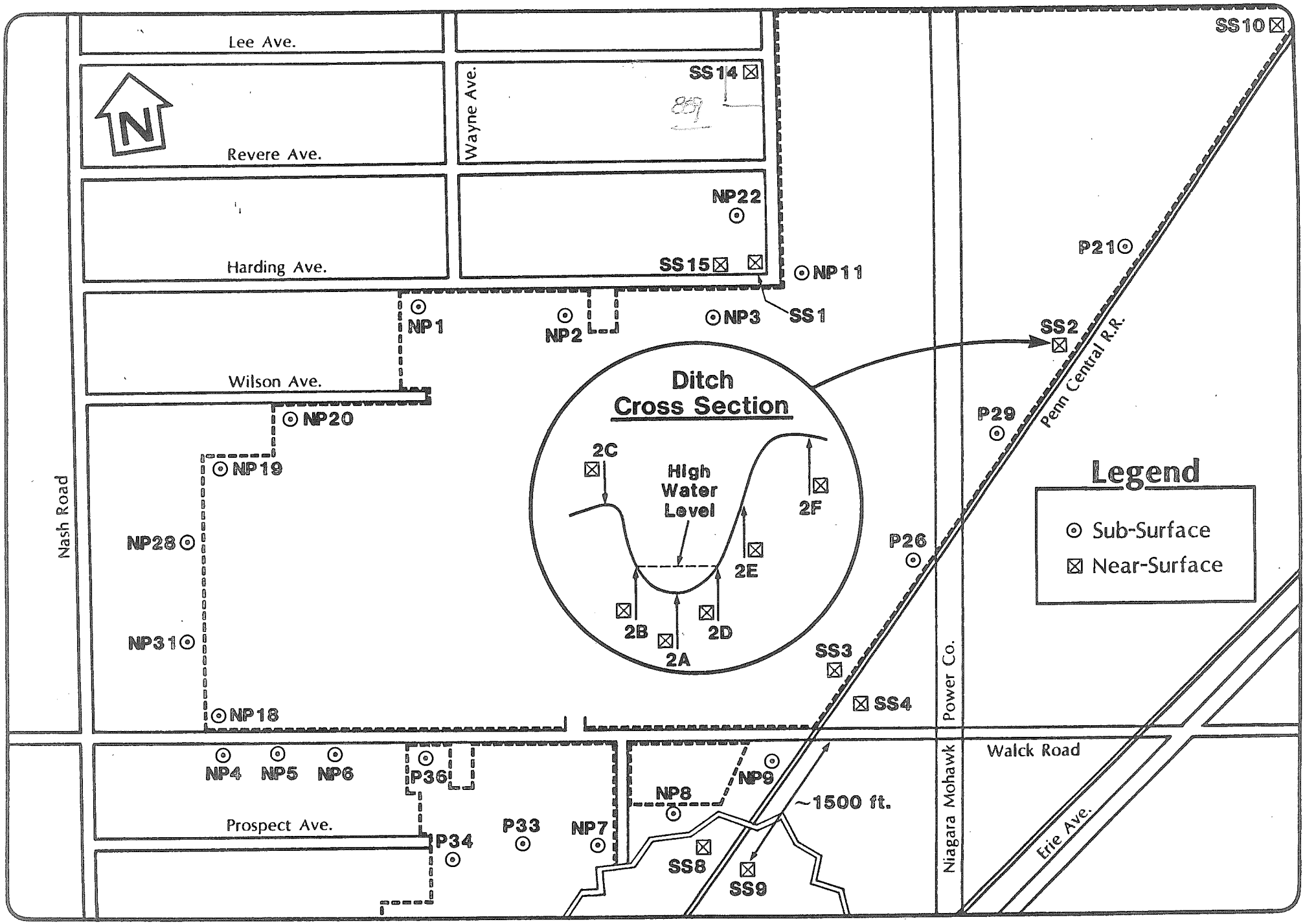
Durez Division
North Tonawanda, N.Y.

REPORT OF CONTINUING FIELD INVESTIGATIONS AND EXPOSURE ASSESSMENT

SECTION I

Introduction, Conclusions, Exposure Assessment and Site Operations Plan

July 1984



TCDD Soil Sample Sites

Figure 3.2

TABLE 3.2

TCDD DATA SUMMARY

Near Surface Soils (ng/g or ppb)

DB-1 Column

Sample	Total TCDD	2,3,7,8 & Co-eluters
SS-1	0.89	0.10
SS-2	8.0	0.84
SS-2B	4.3	1.0
SS-2C	0.92	0.15
SS-2D	4.3	0.83
SS-2E	0.2	0.07
SS-2F	0.34	0.06
SS-4	0.29	0.06
SS-10	5.5	0.64
SS-15	1.1	0.09
SS-15 (Dup.)	0.55	0.08

CPS-2 Column

Sample	Total TCDD	2,3,7,8
SS-2A	19	0.29
SS-2B	29	0.84
SS-3	3.7	0.18
SS-8	1.2	0.05
SS-9	0.26	0.07
SS-14	0.51	0.03
SS-15	2.5	0.20

TABLE 3.2 (Cont'd.)

Subsurface Soils (ng/g or ppb)

Sample	Total TCDD	2,3,7,8 & Co-eluters
NP-16	$ND_{0.029}$	$ND_{0.029}$
NP-19	$ND_{0.036}$	$ND_{0.024}$
NP-20	$ND_{0.023}$	$ND_{0.023}$
NP-22	$ND_{0.035}$	$ND_{0.035}$
NP-28	$ND_{0.024}$	$ND_{0.024}$
NP-31	$ND_{0.023}$	$ND_{0.023}$
NP-1	$ND_{0.026}$	$ND_{0.026}$
NP-2	$ND_{0.078}$	$ND_{0.078}$
NP-3	$ND_{6.5}$	$ND_{0.69}$
	4.5	0.39
	0.29	Not determined
	0.31	$ND_{0.06}$
	$ND_{0.093}$	$ND_{0.093}$
	$ND_{0.023}$	$ND_{0.023}$
NP-4	0.16	$ND_{0.096}$
	0.47	$ND_{0.051}$
NP-5	$ND_{0.57}$	$ND_{0.057}$
NP-6	$ND_{0.09}$	$ND_{0.090}$
	$ND_{0.093}$	$ND_{0.093}$
NP-7	0.19	$ND_{0.11}$
NP-8	1.3	$ND_{0.096}$
	1.1	$ND_{0.06}$
NP-9	$ND_{0.06}$	$ND_{0.06}$
NP-11	0.91	0.67
	0.11	0.072

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North Tonawanda, N.Y.

Remedial Alternatives Assessment for The Durez Site

Prepared by

Dunn Geoscience Corporation

December 1986

TABLE 2.2

BORING INSTALLATION SUMMARY

SYMBOL IDENTIFICATION	WELL NOS.	INSTALLATION DATES (REFERENCE)*
Shallow Wells	P-1 thru P-30	Dec. 1979 - Jan. 1980 (RECRA 80)
Shallow Wells	P-31 thru P-36	Nov. 1981 (EMPIRE 81)
	P-3S, P-11S, P-15S, P-18S	Dec. 1982 (CONT INV 83)
	P-6A, P-7S, P-8S	Apr. 1983 (CONT INV 83)
Shallow Piezometers	NP-1 thru NP-11	May - June 1982 (SUMR 82)
	NP-12 thru NP-23	Dec. 1982 (CONT INV 83)
	NP-24 thru NP-29	Feb. 1983 (CONT INV 83)
	NP-30 thru NP-36	Apr. 1983 (CONT INV 83)
	NP-37 thru NP-38	Sept. 1983 (CONT INV 83)
	NP-39 thru NP-40	Jan. 1984 (PAN 86)
	NP-41 thru NP-45	Apr. 1985 (PAN 86)
	NP-46 thru NP-51	Sept. 1985 (PAN 86)
Deep (Bedrock) Wells	Nos. W-7, W-12, W-16 (renovated)	Jan. - Feb. 1980 (RECRA 80)
	No. W-17	Jan. 1980 (RECRA 80)
Well Points to Sewer Bedding	Nos. 7 thru 9	Nov. 1981 (EMPIRE 81)
	Nos. 10 thru 20	Aug. - Sept. 1983 (CONT INV 83)
New York State Piezometers	SP-1	Nov. 1982
	SP-2 thru SP-7	Oct. 1983
Sewer Bedding Wells	SB-1 thru SB-3	Oct. 1983
Shallow Wells	WP-4, WP-5	Jan. 1979
Durez Borings	DB-1 thru DB-7	June 1984 (CLAY INTG 84)

*References are described in the ENVIRONMENTAL CHEMICAL AND HYDROGEOLOGIC ANALYSES/DATA INDEX found in Appendix A.

TABLE 2.3

SUMMARY OF WATER SAMPLING AND ANALYSIS

SYMBOL IDENTIFICATION	WELL NOS.	SAMPLE COLLECTION DATES (REFERENCE)*
Shallow Wells	P-1 thru P-30	April & June 1980 (RECRA 80); June & July 1982 (SUMR 82); June & July 1983 (CONT INV 83); February 1984 (CONT INV 84)
Shallow Wells	P-31 thru P-36	July 1982 (SUMR 82); July 1983 (CONT INV 83); February 1984 (CONT INV 84)
Shallow Piezometers	NP-1 thru NP-11	June & July 1982 (SUMR 82); June & July 1983 (CONT INV 83); February 1984 (CONT INV 84)
	NP-12 thru NP-23	June & July 1983 (CONT INV 83); February 1984 (CONT INV 84); May 1985 (PAN 86)
	NP-24 thru NP-29	June & July 1983 (CONT INV 83)
	NP-30 thru NP-36	June & July 1983 (CONT INV 83); February 1984 (CONT INV 84)
	NP-37 thru NP-38	
	NP-39 thru NP-40	May & December 1985 (PAN 86)
	NP-41 thru NP-45	May & December 1985 (PAN 86)
	NP-46 thru NP-51	December 1985 (PAN 86)
Deep (Bedrock) Wells	Nos. W-7, W-12, W-16	April & June 1980 (RECRA 80); July 1982 (SUMR 82); July 1983 (CONT INV 83); January-July 1985 (CONT INV 85)
	No. W-17	April & June 1980 (RECRA 80); July 1982 (SUMR 82); July 1983 (CONT INV 83); January-July 1985 (CONT INV 85)

Only eight wells contained quantities of organic compounds significantly above the detection limit. Quantities close to the detection limit were detected in only four other wells (CONT INV 83). Gas chromatography/mass spectrometry (GC/MS) confirmation of the identity of the organic compounds observed by GC was performed for many of the well water samples. In several cases, GC identifications of chlorophenols were not confirmed by GC/MS.

Because a localized depression in the clay surface in the area of monitoring well P-6 collected a non-aqueous phase liquid (NAPL) by gravity flow, P-6 was pumped on a periodic basis to remove this fluid for off-site disposal.

The supplementary sampling of Panhandle waters (CONT INV 84) showed that the same organic compounds found in NP-15 in 1983 were still present in 1984 and in roughly similar concentrations (Table 4). None of the other wells in the vicinity of NP-15 showed the presence of any of the compounds found in NP-15.

Studies (Tables 5 and 6) indicate that some organics have been detected in sites north of monitoring well NP-15 both on and off the plant property (PAN 86). These studies also determined the extent of the migration north of the Panhandle.

Soil Borings

The purpose of all soil borings, regardless of whether or not they were converted to groundwater monitoring wells, was to provide a description of the geologic stratigraphy underlying the site. Table 2.2 lists the appropriate sources where boring logs can be found. In several instances, soil was collected from borings in Shelby tubes for permeability testing or in split-spoon samplers for visual observation and/or chemical

analysis. A contour map for the top of the glaciolacustrine clay is shown in Figure 2.3. The surface of the sand and gravel layer at the site is shown in Figure 2.4 and the thickness of this layer is shown in Figure 2.5.

In addition to the extensive split-spoon sampling program during the RECRA 1980 study, undisturbed Shelby tube samples were collected to define the permeability in the glaciolacustrine clay stratum underlying the entire site. Based on tube conditions and recoveries, samples from borings P-8 and P-18 (both recovered in the 13 to 15 foot interval below grade) were tested for permeability and index properties. Permeability results were 1.6 x 10^{-8} and 2.4 x 10^{-8} centimeters per second, respectively (RECRA 80).

During the OCC 1982 studies (Table 2), 16 locations in the overburden soil were sampled and analyzed for tetrachlorodibenzo-p-dioxins (TCDD). Of these, 2,3,7,8-TCDD was detected at two locations. At both locations the results were below 1 ug/l (ppb).

Three soil borings off plant property and three soil borings on plant property were analyzed for TCDD (Table 3) during the OCC 1983 investigation. TCDD was not detected in the off plant borings. One on plant boring (NP-19) showed 0.036 ng/g (ppb) TCDD. Study of the isomer pattern showed that two TCDD isomers (1,3,6,8- and 1,3,7,9-TCDD) were present in the sample. 2,3,7,8-TCDD was not detected in any of these six borings (CONT INV 83).

fractures above, adjacent to and below the open portion of the rock well. Therefore, the average of the last four months' results should represent the general characteristics of the bedrock groundwater in the vicinity of the pumping well (SOP 86).

2.2 Panhandle

2.2.1 Surface Water

To determine if surface water on the Panhandle is a route of chemical migration during times of heavy rain or rapidly melting snow, five surface water sites (A-F; C was not sampled) on and adjacent to the Panhandle were sampled during June, 1984. Figure 2.6 shows these sampling locations. Details of the sampling plan and analytical results are found in SOP 86.

Results of these analyses indicate that surface water on, and adjacent to, the area is not contaminated and therefore, significant concentrations of organic chemicals do not leave the site dissolved in surface water (SOP 86).

2.2.2 Surface Soil

During August, 1983, OCC collected soil samples to determine the presence of chemicals in Panhandle surface soil. Near-surface soil samples were collected from a drainage ditch between the Penn Central railroad line and the eastern edge of the site and analyzed for TCDD, chlorophenols and chlorobenzenes (CONT INV 84). Figure 2.7 shows the sampling locations.

The sixteen near-surface soil samples analyzed (Table 13) for various parameters during the OCC August 1983 study showed that chlorophenols were found only at sites SS2 and SS2A. No chlorobenzenes were found at sites SS8, 9, 14 and 15; the other

sites had various amounts of some or all of the chlorobenzenes tested. The highest concentrations were found near site SS2 with the concentrations generally decreasing with increasing distance from the SS2 area (CONT INV 84).

The highest concentrations of chlorinated organic compounds found in soil samples taken from the ditch (Figure 2.7) near the railroad were found in the bottom of the ditch at SS-2 and -2A. The concentrations decrease as the distance from this location increases both along the bottom of the ditch and up its side walls. The concentrations at site SS-2F (near the railroad tracks) are, however, higher than at sites SS-2C and SS-2E, both of which are closer to the bottom of the ditch (CONT INV 84).

Fifteen samples were analyzed for 2,3,7,8- TCDD and coeluting compounds (Table 14). None exceeded the 1 ppb (ng/g) level of concern for soil in residential areas established by the U.S. Government Centers for Disease Control.

During June 1984 seven surface soil samples from the Panhandle area were collected and analyzed (SOP 86). Figure 2.8 shows the sampling locations. Results for these seven surface soils (Table 15) analyzed during the Panhandle study found no presence of chlorophenols, but all samples were found to contain low levels of chlorobenzenes (SOP 86).

2.2.3 Non-Vegetated Areas

During November 1984, non-vegetated areas representing limited areas located in the central region of the Panhandle (SOP 86) as shown in Figure 2.9 were found and mapped. Sixty sites were located where vegetative cover was missing or disturbed. These sixty sites were classified into eight groups (Table 16b) based on the types of materials observed. A total of eleven samples (Table 16b) was selected with State concurrence to represent the materials present on the surface (SOP 86).

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		NP1	NP2	NP3	NP4	NP5
WATER	o-Chlorophenol	DRY	ND10	a	ND10	DRY
	p-Chlorophenol		ND10		ND10	
	2,4,5-Trichlorophenol		ND10		ND10	
	2,4,6-Trichlorophenol		ND10		ND10	
	Benzene		ND1		ND1	
	Toluene		ND1		ND1	
	Monochlorobenzene		ND1		ND1	
	o-Chlorotoluene		ND1		ND1	
	o-Dichlorobenzene		ND1		ND1	
	p-Dichlorobenzene		ND1		ND1	
	1,2,3 & 1,2,4-Trichlorobenzene		ND1		ND1	
	TOC, mg/L		60		51	
	Chloride, mg/L		510		270	
	TDS		1700		850	
	Phenols		ND100		ND100	
	pH, units		6.40		7.00	
	Conductivity, umhos/cm		2500		1525	
SOIL	% Moisture	13.8	16.0		17.0	16.8
	Total TCDD* (pg/g)	ND260	ND78		160, 470	ND57
	2,3,7,8-TCDD* (pg/g) (+co-eluting isomers)	ND260	ND78		ND96, ND51	ND57

Results are expressed as ug/L except where noted.
* Multiple values represent sub-sample analyses.
a - NP3 is a soil boring adjacent to NP10. For clarity, the soil results are presented under NP10.
NDx = Not detected at or above x ug/L for water or pg/g for soil.
TOC samples were not purged due to concern over loss of volatile organics.

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		NP6	NP7	NP8	NP9
WATER	o-Chlorophenol	ND10	ND10, ND10	ND10	ND10
	p-Chlorophenol	ND10	ND10, ND10	ND10	ND10
	2,4,5-Trichlorophenol	ND10	ND10, ND10	ND10	ND10
	2,4,6-Trichlorophenol	ND10	19, ND10	ND10	ND10
	Benzene	ND1	ND1	ND1	ND1
	Toluene	ND1	ND1	ND1	ND1
	Monochlorobenzene	ND1	ND1	ND1	ND1
	o-Chlorotoluene	ND1	ND1	ND1	ND1
	o-Dichlorobenzene	ND1	ND1	ND1	ND1
	p-Dichlorobenzene	ND1	ND1	ND1	ND1
	1,2,3 & 1,2,4-Trichlorobenzene	ND1	ND1	ND1	ND1
	TOC, mg/L	55	85	60	106
	Chloride, mg/L	42	500	110	340
	TDS, mg/L	500	1400	1000	2400
	Phenols	ND100	ND100	ND100	ND100
	pH, units	7.05	6.80	7.00	6.70
	Conductivity, umhos/cm	880	3000	1310	2700
SOIL	% Moisture	16.0	17.0	16.0	15.0
	Total TCDD** (pg/g)	ND90	190	1300, 1100	ND60
	2,3,7,8-TCDD** (pg/g) (+co-eluting isomers)	ND90	ND110	ND96, ND60	ND60

Results are expressed as ug/L except where noted.
* Resampled and analyzed by GC and GC/MS.
**Multiple values represent sub-sample analyses.
NDx = Not detected at or above x ug/L for water or pg/g for soil.
TOC samples were not purged due to concern over loss of volatile organics.
See Figure 2.1 for well locations.

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		NP10	NP11	P2	P11
WATER	o-Chlorophenol	ND10	ND10	ND10	59
	p-Chlorophenol	ND10	ND10	ND10	81
	2,4,5-Trichlorophenol	ND10	ND10	ND10	ND10
	2,4,6-Trichlorophenol	ND10	ND10	ND10	10
	Benzene	ND1	ND1	ND1	18
	Toluene	ND1	ND1	ND1	290
	Monochlorobenzene	ND1	ND1	ND1	740
	o-Chlorotoluene	ND1	ND1	ND1	ND1
	o-Dichlorobenzene	ND1	ND1	ND1	160
	p-Dichlorobenzene	ND1	ND1	2	200
	1,2,3, & 1,2,4-Trichlorobenzene	ND1	ND1	ND1	28
	TOC, mg/L	44	110	82	108
	Chloride, mg/L	2000	17	2400	24
	TDS, mg/L	3900	800	4400	350
	Phenols	ND100	ND100	ND100	49500
	pH, units	7.30	6.65	6.60	6.35
	Conductivity	6500	1075	7500	525
SOIL	% Moisture	15.6	14.8	-	-
	Total TCDD* (pg/g)	5500, 300, ND93	910, 110	-	-
	2,3,7,8-TCDD (pg/g) (+co-eluting isomers)	ND60	670, 72	-	-

Results are expressed as ug/L except where noted.
NDx = Not detected at or above x ug/L for water or pg/g for soil.
TOC samples were not purged due to concern over loss of volatile organics.
* Multiple values represent average results of sub-samples analyses
- Analysis not performed.
See Figure 2.1 for well locations.

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		P14	P21	P24	P25
WATER	o-Chlorophenol	ND10, ND10*	DRY	ND10, ND10*	ND10, ND10*
	p-Chlorophenol	ND10, ND10*		27, 44*	ND10, ND10*
	2,4,5-Trichlorophenol	ND10, ND10*		ND10, ND10*	ND10, ND10*
	2,4,6-Trichlorophenol	12, ND10*		22, ND10*	19, ND10*
	Benzene	ND1		26	ND1
	Toluene	ND1		ND1	ND1
	Monochlorobenzene	4		105	ND1
	o-Chlorotoluene	2		ND1	ND1
	o-Dichlorobenzene	25		ND1	ND1
	p-Dichlorobenzene	ND1		2	ND1
	1,2,3, & 1,2,4-Trichlorobenzene	4		ND1	ND1
	TOC, mg/L	22		73	90
	Chloride, mg/L	70		4	17
	TDS, mg/L	350		600	700
	Phenols	ND100		260	ND100
	pH, units	6.20		7.00	7.20
	Conductivity, umhos/cm	600		900	1050
SOIL	% Moisture	-	18.2	-	-
	Total TCDD (pg/g)	-	ND90	-	-
	2,3,7,8-TCDD (pg/g) (co-eluting isomers)	-	ND90	-	-

*Resampled and analyzed by GC and GC/MS.
Results are expressed as ug/L except where noted.
NDx + Not detected at or above x ug/L for water and pg/g for soil.
TOC samples were not purged due to concern over loss of volatile organics.
- Analysis not performed.
See Figure 2.1 for well locations.

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		P26	P29	P31	P33
WATER	o-Chlorophenol	17	b	b	c
	p-Chlorophenol	8800	b	b	c
	2,4,5-Trichlorophenol	130	b	b	c
	2,4,6-Trichlorophenol	330	b	b	c
	Benzene	100	ND1	ND1	ND1
	Toluene	4200	ND1	ND1	ND1
	Monochlorobenzene	1200	ND1	ND1	ND1
	o-Chlorotoluene	27	ND1	ND1	ND1
	o-Dichlorobenzene	ND1	ND1	ND1	ND1
	p-Dichlorobenzene	150	ND1	ND1	ND1
	1,2,3, & 1,2,4-Trichlorobenzene	410	ND1	ND1	ND1
	TOC, mg/L	162	b	b	79
	Chloride, mg/L	57	12	140	62
	TDS, mg/L	650	450	1200	750
	Phenols	15600	b	b	ND100
	pH, units	6.70	7.05	6.85	6.80
	Conductivity, umhos/cm	900	650	1850	1280
SOIL	% Moisture	14.2	18.0	-	15.8
	Total TCDD (pg/g)	ND48	ND78	-	ND90
	2,3,7,8-TCDD (pg/g) (co-eluting isomers)	ND48	ND78	-	ND90

Results are expressed as ug/L except were noted.
NDx = Not detected at or above x ug/L for water or pg/g for soil.
b = Partial sample only.
c = Sample lost due to lab accident.
- Anaylsis not performed.
See Figure 2.1 for well locations.

TABLE 2

Summary of Chemical Analyses
Unconsolidated Deposit Groundwater and Soil
Summer 1982

		P34	P36
WATER	o-Chlorophenol	ND10	DRY
	p-Chlorophenol	ND10	
	2,4,5-Trichlorophenol	ND10	
	2,4,6-Trichlorophenol	ND10	
	Benzene	ND1	
	Toluene	ND1	
	Monochlorobenzene	ND1	
	o-Chlorotoluene	ND1	
	o-Dichlorobenzene	ND1	
	p-Dichlorobenzene	ND1	
	1,2,3, & 1,2,4-Trichlorobenzene	ND1	
	TOC, mg/L	67	
	Chloride, mg/L	6	
	TDS, mg/L	500	
	Phenols	ND100	
	pH, units	6.80	
	Conductivity, umhos/cm	900	
SOIL	% Moisture	15.4	15.6
	Total TCDD* (pg/g)	ND90, ND60, ND93	ND99
	2,3,7,8-TCDD* (pg/g) (co-eluting isomers)	ND90, ND60, ND93	ND99

Results are expressed as ug/L except where noted.
NDx = Not detected at or above x ug/L for water or pg/g for soil.
* Multiple values represent sub-sample analyses.
See Figure 2.1 for well locations.

Table 14
TCDD Data Summary
Near Surface Soils
August 1983

DB-1 Column

Sample	Total TCDD	2,3,7,8, & Co-eluters
SS-1	0.89	0.10
SS-2	8.0	0.84
SS-2B	4.3	1.0
SS-2C	0.92	0.15
SS-2D	4.3	0.83
SS-2E	0.2	0.07
SS-2F	0.34	0.06
SS-4	0.29	0.06
SS-10	5.5	0.64
SS-15	1.1	0.09
SS-15 (Dup.)	0.55	0.08

CPS-2 Column

Sample	Total TCDD	2,3,7,8
SS-2A	19	0.29
SS-2B	29	0.84
SS-3	3.7	0.18
SS-8	1.2	0.05
SS-9	0.26	0.07
SS-14	0.51	0.03
SS-15	2.5	0.20

* ng/g = ppb
See Figure 2.7 for sample locations.

Symbol	Identification	Well Nos.			Installation Dates
●	Shallow Wells	P-1	thru	P-30	Dec. 1979 - Jan. 1980
⊙	Shallow Wells	P-31	thru	P-36	Nov. 1981
⊗	New Shallow Piezometers	NP-1	thru	NP- 11	May - June 1982
		NP-12	thru	NP- 23	Dec. 1982
		NP-24	thru	NP- 29	Feb. 1983
		NP-30	thru	NP- 36	Apr. 1983
		NP-37	thru	NP- 38	Sept.1983
		NP-39	thru	NP- 40	Jan. 1984
		NP-41	thru	NP- 45	Apr. 1985
		NP-46	thru	NP- 51	Sept.1985
▣	Deep (Bedrock) Wells	Nos W-7, W-12, W-16 (renovated)			Jan. - Feb. 1980
		No W-17			Jan. 1980
⚠	Well Points to Sewer Bedding	Nos. 7 thru 9			Nov. 1981
		Nos. 10 thru 20			Aug. - Sept. 1983
⊗	New York State Piezometers	SP-1			Nov. 1982
		SP-2	thru	SP-7	Oct. 1983
	Sewer Bedding Wells	SB-1	thru	SB-3	Oct. 1983
⊙	Shallow Wells	WP-4 , WP-5			Jan. 1979
▽	Durez Borings	DB-1	thru	DB-7	June 1984
○	Sewer Sampling Points	Nash / Walck, 4R, 6A, 6B, 6K			July 1982

Meadow Drive Extension

Storm Sewer

Sanitary Sewer

Lee Avenue

Revere Avenue

Harding Avenue

Wilson Avenue

Prospect Avenue

Nash Road

Walck Road

Wayne Avenue

Farnsworth Avenue

CORPORATION POWER

MOHAWK CENTRAL

NIAGARA LACKAWANNA RAILROAD

PENN CENTRAL RAILROAD

ERIE Erie Avenue

SCALE IN FEET

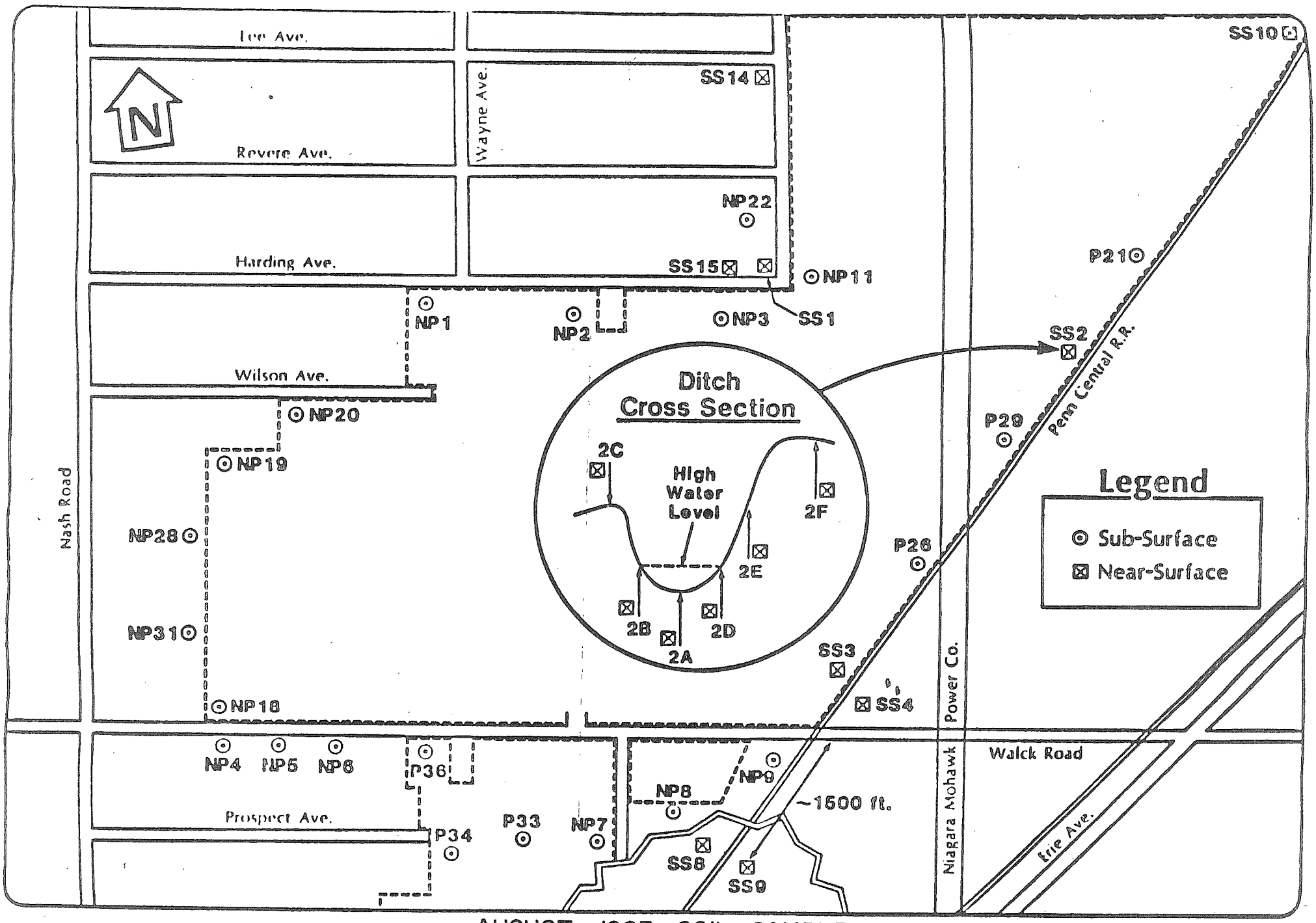
0 100 200 300 400

Geographic North

FIGURE 2.1

DUNN GEOSCIENCE CORPORATION
5 Northway Lane North
Latham, N.Y. 12110

GROUNDWATER MONITORING AND SAMPLING LOCATIONS
DUREZ PLASTICS DIVISION
TOWN OF NO. TONAWANDA - NIAGARA COUNTY, N.Y.



AUGUST 1983 SOIL SAMPLE SITES
PANHANDLE AREA
FIGURE 27

Note: See Tables 13 & 14 for Sample Data

APPENDIX B

PLANT PROFILE SHEETS

Fact Sheet ST-74
November 1993

Amelanchier canadensis
Shadblow Serviceberry[1]

Edward F. Gilman and Dennis G. Watson[2]

INTRODUCTION

Downy Serviceberry is an upright, twiggy, multi-stemmed large shrub, eventually reaching 20 to 25 feet in height with a spread of 15 to 20 feet (Fig. 1). This North American native is usually the first to be noticed in the forest or garden at springtime, the pure white, glistening flowers some of the earliest to appear among the many other dull brown, leafless, and still-slumbering trees. The small white flowers are produced in dense, erect, two to three-inch-long racemes, opening up to a delicate display before the attractive reddish-purple buds unfold into small, rounded leaves. These leaves are covered with a fine, soft grey fuzz when young, giving the plant its common name, but will mature into smooth, dark green leaves later. Following the blooms are many small, luscious, dark red/purple, sweet and juicy, apple-shaped fruits, often well-hidden by the dark green leaves, and which would be popular with people were they not so quickly consumed by birds and other wildlife who seem to find their flavor irresistible.

GENERAL INFORMATION

Scientific name: *Amelanchier canadensis*
Pronunciation: am-meh-LANG-kee-er kan-uh-DEN-sis
Common name(s): Shadblow Serviceberry, Downy Serviceberry
Family: *Rosaceae*
USDA hardiness zones: 4 through 7 (Fig. 2)
Origin: native to North America
Uses: container or above-ground planter; near a deck or patio; specimen

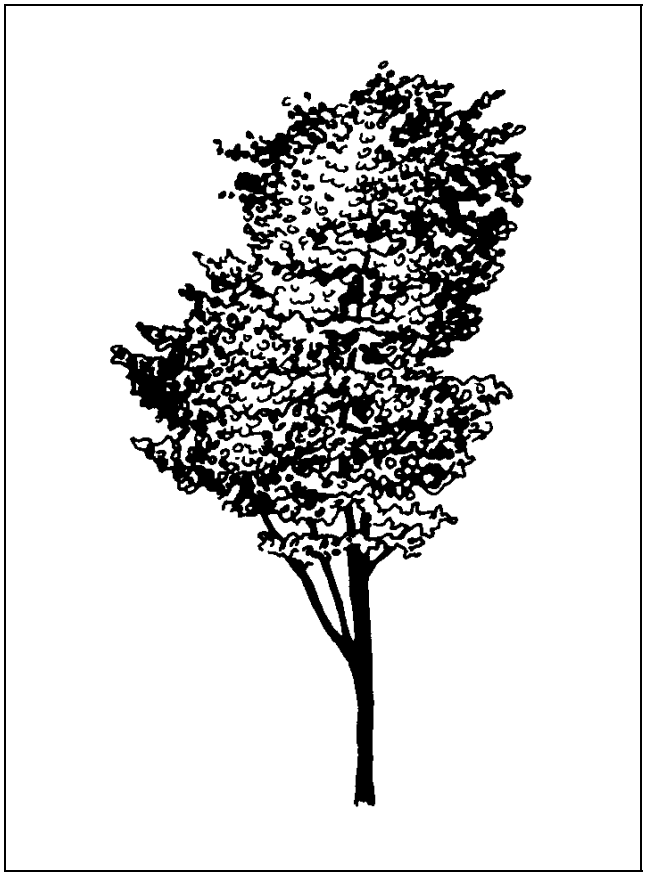


Figure 1. Young Shadblow Serviceberry.

Availability: somewhat available, may have to go out of the region to find the tree

1. This document is adapted from Fact Sheet ST-74, a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: November 1993.

2. Edward F. Gilman, associate professor, Environmental Horticulture Department; Dennis G. Watson, associate professor, Agricultural Engineering Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

Figure 2. Shaded area represents potential planting range.

DESCRIPTION

Height: 20 to 25 feet
Spread: 15 to 20 feet
Crown uniformity: symmetrical canopy with a regular (or smooth) outline, and individuals have more or less identical crown forms
Crown shape: upright
Crown density: open
Growth rate: medium
Texture: fine

Foliage

Leaf arrangement: alternate (Fig. 3)
Leaf type: simple
Leaf margin: serrate
Leaf shape: elliptic (oval); oblong
Leaf venation: banchidodrome; pinnate
Leaf type and persistence: deciduous
Leaf blade length: 2 to 4 inches; less than 2 inches
Leaf color: green
Fall color: orange; red; yellow
Fall characteristic: showy

Flower

Flower color: white
Flower characteristics: spring flowering; very showy

Fruit

Fruit shape: round
Fruit length: < .5 inch
Fruit covering: fleshy
Fruit color: purple; red
Fruit characteristics: attracts birds; attracts squirrels and other mammals; suited for human consumption; no significant litter problem; showy

Trunk and Branches

Trunk/bark/branches: bark is thin and easily damaged from mechanical impact; droop as the tree grows, and will require pruning for vehicular or pedestrian clearance beneath the canopy; routinely grown with, or trainable to be grown with, multiple trunks; not particularly showy; tree wants to grow with several trunks but can be trained to grow with a single trunk; no thorns

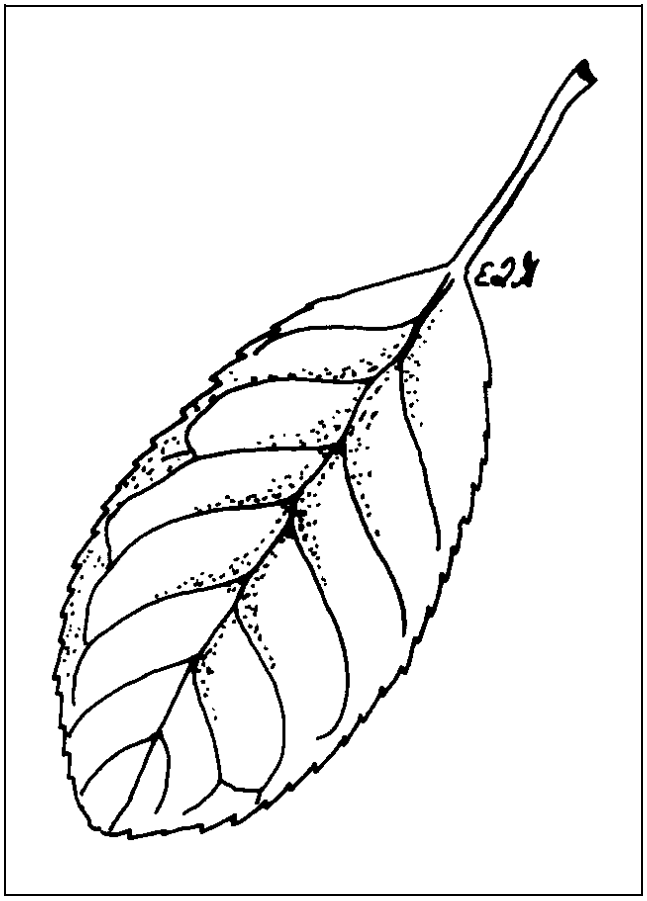


Figure 3. Foliage of Shadblow Serviceberry.

Pruning requirement: needs little pruning to develop a strong structure
Breakage: resistant
Current year twig color: brown
Current year twig thickness: thin

Culture

Light requirement: tree grows in part shade/part sun; tree grows in full sun
Soil tolerances: clay; loam; sand; acidic; well-drained
Drought tolerance: moderate
Aerosol salt tolerance: moderate
Soil salt tolerance: moderate

Other

Roots: surface roots are usually not a problem
Winter interest: no special winter interest
Outstanding tree: not particularly outstanding
Invasive potential: little, if any, potential at this time
Pest resistance: long-term health usually not affected by pests

USE AND MANAGEMENT

When the shortened days of autumn arrive, Downy Serviceberry is alive with a variety of colorful hues, from yellow and gold, to orange and deep red. Downy Serviceberry is ideal for planting in the naturalized garden where it can be allowed to spread by its naturally-suckering habit, or is striking when placed in the mixed shrubbery border where its brilliant white blooms and fall color stand out nicely against a background of evergreen shrubs. The light shade cast by the open crown makes the tree well-suited for planting as a specimen near the deck or patio.

With a native habitat of wet bogs and swamps, Downy Serviceberry should be grown in full sun or light shade on moist, well-drained, acid soil. Plants will rarely require any pruning or fertilizing, except if thinning of the multiple stems is desired to ‘clean up’ the bottom of the plant.

Propagation is by seeds after cold-stratification.

Pests and Diseases

No pests or diseases are of major concern.

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

SUGAR MAPLE

Acer saccharum Marsh.

Plant Symbol = ACSA3

Contributed By: USDA NRCS National Plant Data Center & the Biota of North America Program

A.E. Hoyle
U.S. Forest Service
@ Hunt Institute

Alternate common names
Hard maple, head maple, sugartree, bird's-eye maple

Uses
Sugar maple is the only tree today used for commercial syrup production, as its sap has twice the sugar content of other maple species. The sap, mostly collected in the spring, is concentrated by boiling or reverse osmosis, with about 35-40 liters of sap making 1 liter of syrup. A single tree may produce 5-60 liters of sap per year. Nights below freezing and days at higher than 5°C are needed to ensure good sap flow. Sugar maple was the premier source of sweetener, along with honey, to Native Americans and early European settlers. Native Americans also used sugar maple sap for sugar and candies, as a beverage, fresh or fermented into beer, and soured into vinegar and used to cook meat.

Sugar maple is widely planted as an ornamental or shade tree and many cultivars have been selected, based on variation in growth habit/crown shape, mature height, fall color, leaf shape, and temperature tolerance. The leaves go from green to brilliant yellow, orange, and red in autumn, although there is much variation in fall color within the species. Orange and reds seem to be more intense in New England types, while yellows are more pronounced further west. Interior leaves may be yellow, while outer exposed leaves turn orange-red. The species is best suited to larger sites where soil compaction is not a concern. It also is sometimes used in shelterbelt plantings and has potential value for rehabilitation of disturbed sites.

Sugar maple is an important timber tree valued for its hard, heavy, and strong wood, commonly used to make furniture, paneling, flooring, and veneer. It is also used for gunstocks, tool handles, plywood dies, cutting blocks, woodenware, novelty products, sporting goods, bowling pins, and musical instruments.

White-tailed deer, moose, and snowshoe hare commonly browse sugar maple. Red squirrel, gray squirrel, and flying squirrels feed on the seeds, buds, twigs, and leaves. Porcupines consume the bark and can girdle the upper stem. Songbirds, woodpeckers, and cavity nesters nest in sugar maple. Although the flowers appear to be wind-pollinated, the early-produced pollen may be important to the biology of bees and other pollen-dependent insects because many insects, especially bees, visit the flowers.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description
General: Maple Family (Aceraceae). A native tree with a dense, spreading crown, to 25-37(-40) m in height; bark light gray to gray-brown, rough, deeply furrowed, and darker with age. The leaves are deciduous, opposite, long-petioled, blades 5-11 cm long and about as wide, with 5 shallow, blunt or short-pointed lobes, edges coarsely toothed, dark green and glabrous above, whitish and more or less hairy below, turning intensely red, orange, or yellow in fall. The flowers are small, greenish-yellow, in long-stalked, drooping clusters or racemes, each cluster with 8 to 14 flowers. Most trees are either male or female (the species is essentially dioecious), but both kinds of flowers occur on some trees (technically monoecious), sometimes segregated on different branches. The fruits are winged nutlets (samaras) in a pair, 2-2.5 cm long, clustered on long

stalks, red to red-brown. The common name refers to the use of the species for making sugar and syrup.

Variation within the species: Closely similar forms of sugar maple have been recognized at various taxonomic ranks – from varieties to subspecies and species. Three of them are now generally recognized as species, but the differences are technical and it is difficult to be sure of the correct identifications of trees sold as "sugar maple" in the southeastern US. Duncan and Duncan (1988) gives a good summary of the distribution and morphology of these species.

- Florida maple (*A. barbatum*, including *A. floridanum*): primarily a species of the Gulf and southeast Atlantic coastal plain, from Texas to North Carolina and Virginia, and up the Mississippi valley as far as Missouri and Illinois.

- chalk maple (*A. leucoderme*): similar in distribution to Florida maple, but not extending into Virginia or up the Mississippi valley.

- black maple (*A. nigrum*): similar in distribution to „true' sugar maple, but somewhat more restricted.

Norway maple (*Acer platanoides*), an introduced European species, is often planted and looks similar to sugar maple, but Norway maple has broader leaves with drooping lobes, and sap from a broken petiole is milky.

Distribution: Sugar maple is widespread in mixed hardwood forests of the eastern United States. It grows from Nova Scotia and New Brunswick westward to Ontario and Manitoba, North Dakota and South Dakota, southward into eastern Kansas into Oklahoma, and southward in the east through New England to Georgia. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Sugar maple most commonly occurs in rich, mesic woods but also grows in drier upland woods. It often grows in canyons, ravines, valleys, stream terraces, and streambanks, but it is occasionally found on dry rocky hillsides, at 500-1700 meters elevation. It is a dominant or codominant in many northern hardwood and mixed mesophytic forests. Common codominants include beech (*Fagus grandifolia*), birch (*Betula* spp.), American basswood (*Tilia americana*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and yellow poplar (*Liriodendron tulifera*), but it also grows with various other hardwood species as well as conifers such as pine, spruce, fir, and eastern hemlock.

In the absence of disturbance, forests of jack pine, eastern white pine, eastern hemlock, yellow birch, or red pine are replaced by sugar maple and American basswood. Because repeated disturbance by fire was common in eastern deciduous forests in pre-settlement times, succession to sugar maple-American basswood stands may have taken as long as 650 years in some locations. Increases in sugar maple during the past 50 years in central and Great Lakes hardwood forests have been attributed to fire suppression.

This species flowers in April-June, with fruiting occurring in June-October. Fruits ripen about 12-16 weeks after flowering and begin to fall about 2 weeks after ripening. Leaves generally drop just after seeds have fallen. At the southern edge of the species' range, dead leaves tend to remain on the trees through much of the winter.

Establishment
Minimum seed-bearing age for sugar maple is 30-40 years; maximum seed production is reached after about 60 years of age. Seed is abundantly produced each year but peaks occur mostly from 2-5 years. Seeds are dispersed in fall and germinate in spring. Germination occurs on moist mineral soil or in the litter layer, at an optimal temperature of about 1° C. Seeds can remain viable for up to 5 years but few persist in the seed bank for more than one year. Sugar maple seeds require moist stratification at temperatures slightly above freezing for 35-90 days.

Sugar maple is shade-tolerant but seedlings in dense young stands may survive for only 5 years; those in older stands commonly persist for many years. Such a bank of abundant seedlings and saplings can remain suppressed until gaps are created by windfall or other disturbances, where they typically respond vigorously and rapidly to release. Sugar maples can live for up to 500 years.

Stump sprouting and root sprouting are moderately common means of vegetative reproduction after mechanical disturbance in natural conditions, especially in the northern part of its range, and layering occasionally occurs.

Management
Sugar maples are not particularly good street trees, because they are intolerant of compacted soil, high heat, air pollution, and road salt commonly found in urban environments. They are susceptible to stem

and root injury, and verticillum wilt may occur when grown in heavy, poorly drained soils. "Maple decline," periodic die-backs of relatively large trees in the Northeast, has been attributed to acid rain and other air pollutants, particularly in the last two decades, but its exact causes are not understood.

Even light ground fires may damage the thin bark of sugar maple. Hot fires can kill an entire stand and existing regeneration. The trees sprout poorly after fire. Although communities with sugar maple are relatively resistant to ground fires, a fire hazard may occur in dry years during October, after the leaves have fallen.

Seed can propagate sugar maple; early spring plantings generally produce the best results. Nurserymen usually rely on budding or grafting or sometimes use air layering or rooting of stem cuttings. Use stem tips 35-55 centimeters long taken in mid June with fully elongated bottom leaves; rooting occurs in 4-6 weeks under mist in a 2:1:1 mixture of sandy loam, vermiculite, and peat moss.

Cultivars, Improved and Selected Materials (and area of origin)

This species is readily available through local nurseries.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

YELLOW BIRCH

Betula alleghaniensis Britt.

Plant Symbol = BEAL2

Contributed By: USDA NRCS National Plant Data Center & Biota of North America Program

R. Mohlenbrock
USDA, NRCS, Wetland Science Institute
@ PLANTS

Alternate common names
Gray birch, silver birch, swamp birch

Uses
The wood of yellow birch is heavy, strong, close-grained, even-textured, and shows a wide color variation, from reddish brown to creamy white. It is used for furniture, cabinetry, charcoal, pulp, interior finish, veneer, tool handles, boxes, woodenware, and interior doors. The wood can be stained and takes a high polish. Yellow birch is one of the principal hardwoods used in the distillation of wood alcohol, acetate of lime, charcoal, tar, and oils.

Deer consume large numbers of yellow birch seedlings in summer and prefer green leaves and woody stems in fall. Moose, white-tailed deer, and snowshoe hare also browse yellow birch. The seeds are eaten by various songbird species, and ruffed grouse feed on seeds, catkins, and buds. Red squirrel cut and store mature catkins and eat the seeds. Beaver and porcupine chew the bark.

The sap of yellow birch can be tapped for use as edible syrup. Tea is sometimes made from the twigs and/or inner bark.

Yellow birch sees limited use in landscape plantings, partly because it may be relatively hard to locate at local nurseries. It is a good lawn tree, providing relatively light shade, and it has showy bark and fall foliage colors. It also is a good edge tree for naturalized areas. Although yellow birch grows best in full sun, cherry birch is better suited to hotter or drier sites.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Birch Family (Betulaceae). These are native trees mostly 15-20(-30) m tall, with straight trunks and variable crowns; mature bark smooth and shiny, usually separating into thin layers, giving a shaggy appearance; lenticels dark, horizontally; twigs with odor and taste of wintergreen, usually with small resinous glands. Leaves are deciduous, alternate, simple, narrowly ovate to broadly oblong, 6-10 cm long, base rounded to cuneate or cordate, margins sharply doubly toothed, apex acuminate, usually softly hairy beneath along major veins and in vein axils, often with scattered, minute, resinous glands. Male (pollen) and female (seed) flowers are in catkins, borne separately, but on the same tree. Seed catkins are erect, ovoid, 1.5-3 cm long, generally remaining intact after release of fruits in late fall, scales 3-lobed, sparsely to moderately hairy; pollen catkins elongate and hanging. Seeds (nutlets) have wings narrower than body. The common name pertains to the yellow color of the bark and fall leaves.

Variation within the species. Two varieties have been recognized (see Fernald 1950; Braun 1961); var. *macrolepis* differs from typical variety *alleghaniensis* in its larger fruiting catkin scales (8-13 mm long vs. 5-8 mm), with more elongated basal portion. Erdmann (1990) and Furlow (1993) regard the species as variable but without formally recognized varieties.

Yellow birch is closely similar to cherry birch (*Betula lenta*). Cherry birch differs in its light grayish brown bark that remains close (vs. dark, freely exfoliating bark), leaves with fine, sharp teeth (vs. coarse teeth), and catkin scales without hairs (vs. hairy scales). The twigs and inner bark of cherry

birch have a stronger wintergreen odor. Yellow birch forms natural hybrids with paper birch (*B. papyrifera*) and with bog birch (*B. pumila*).

Distribution
Yellow birch ranges from Newfoundland, Nova Scotia, New Brunswick, and Anticosti Island west through southern Ontario to extreme southeastern Manitoba; south to Minnesota and northeastern Iowa; east to northern Illinois, Ohio, Pennsylvania to northern New Jersey and New England; and south in the Appalachian Mountains to eastern Tennessee and northeastern Georgia. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment
Adaptation: Yellow birch is a characteristic tree of the northern Appalachians and the hemlock hardwoods forest of the Great Lakes region, at elevations of mostly 0-500 meters but up to 1050 meters. In the Appalachians and the Adirondacks, yellow birch reaches its maximum importance in the transition zone between low elevation deciduous forest and montane spruce-fir forests. Yellow birch occurs on moist, well-drained soils of various types of uplands and mountain ravines and along stream banks and in swampy woods. It may also grow where drainage is restricted, but growth may be correspondingly poor. Flowering: April-May, beginning before leafing; fruiting: July-August.

General: Yellow birch reproduces primarily by seed, normally first at about 40 years but optimally at about 70 years – trees under 20 years sometimes produce seed. Good seed crops are produced at intervals of 1-4 years, usually with little seed produced in intervening years. Viability under natural conditions decreases around the second year.

Seeds germinate and grow best on moist mineral soil enriched with humus, but those in undisturbed stands usually germinate on mossy logs, decayed wood, in cracks in boulders, and on wind thrown tree hummocks. Seedlings cannot pierce compacted hardwood litter. Scarification of seedbeds improves seedling establishment, but organic matter should be left mixed in with the mineral soil. Seed dormancy is broken (under artificial conditions) by stratification or by exposure of wet seed to cool-white fluorescent light. Seeds can be stored 2-4 years or longer without losing viability.

Gap conditions are conducive to yellow birch seedling establishment, and seedling survival is better on disturbed microsites. Mortality of seedlings is usually very high. Seedlings surviving their first year survive to sapling and larger stages only where there is sufficient light, although some shade improves seedling survival.

Yellow birch has been termed “a persistent successional species.” Its presence in mid- to late-successional stands depends on local disturbance; it cannot reproduce under a closed canopy and requires soil disturbance and light for seedling survival. Older trees do not sprout. In northern hardwood ecosystems, yellow birch reaches maximum importance levels within 15 years of disturbance, and those levels are maintained for at least 100 years. In many old-growth stands, yellow birch usually decreases in importance as the stand ages, but the species is often a component of old growth types and sometimes occurs as a major component of climax stands, perhaps through a combination of longevity and micro-succession. Yellow birch often reaches 150 years; the average age in old growth woods may be 200-250 years. Maximum age is over 300 years.

Management
Heavy or repeated browsing of yellow birch by deer and moose kills small yellow birch and may prevent regeneration. Heavy feeding by porcupine and yellow-bellied sapsucker reduces growth, lowers wood quality, and is sometimes fatal.

Heavy cuts in older stands may be followed by top dieback and mortality. Recently isolated trees, in particular, are subject to wind throw on shallow soils and susceptible to winter sunscald. All are sensitive to high soil temperatures. Harvest of yellow birch timber should coincide with good seed years, because the trees regenerate primarily by germination, and openings for regeneration should be provided.

Yellow birch can be grown from seed relatively easily. Artificial propagation can be done through greenwood cuttings and by grafting.

Cultivars, Improved and Selected Materials (and area of origin)
The species may be hard to locate in local nurseries, but it can be ordered.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under ”United States Government”. The Natural Resources Conservation Service will be listed under the subheading “Department of Agriculture.”

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Scientific Name
Cornus alternifolia

NC STATE UNIVERSITY

Trees
Plant Fact Sheets
Consumer Hort

Common Name
Alternate-leaved dogwood; Pagoda dogwood

- **Hardiness Zones:** 3-7
- **Habit:** Deciduous
- **Growth Rate:** Slow to moderate
- **Site Requirements:** Sun to partial shade; range of soil types but prefers moist, well drained soil
- **Texture:** Medium
- **Form:** Spreading, horizontal branches; branches parallel to the ground creating a layered look
- **Height:** 15 to 25'
- **Width:** 15 to 30'
- **Leaf:** 2 to 5" alternate leaves; maroon to reddish purple fall color
- **Flower/Fruit:** Clusters of greenish white flowers in late summer; fragrant; purplish black berries on red stems
- **Comments:** Disease resistance; fibrous, spreading root system; keep root zone cool
- **Cultivars:** Argentea
- **Additional Image:**

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

AMERICAN HORNBEAM

Carpinus caroliniana Walt.

Plant Symbol = CACA18

Contributed By: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Ironwood, musclewood, muscle beech, blue beech, water beech

Uses
The wood of *Carpinus* is of minor economic importance because of the small size of the trees. It is whitish, extremely hard, and heavy and has been used for making mallet heads, tool handles, levers, and other small, hard, wooden objects. The wood is not subject to cracking or splitting and was used by American pioneers for bowls and dishes.

American hornbeam is planted in landscapes and naturalized areas. It prefers deep, fertile, moist, acidic soil and grows best in partial shade, but will grow in full sun. Its chief liabilities in cultivation are a relatively slow growth rate and difficulty in transplantation. It is not drought-tolerant.

Seeds, buds, or catkins are eaten by a number of songbirds, ruffed grouse, ring-necked pheasants, bobwhite, turkey, fox, and gray squirrels. Cottontails, beaver, and white-tailed deer eat the leaves, twigs, and larger stems. Beaver heavily uses American hornbeam, because it is readily available in typical beaver habitat.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Birch Family (Betulaceae). American hornbeam is a native, large shrub or small tree with a wide-spreading, flat-topped crown, the stems slender, dark brown, hairy; bark gray, thin, usually smooth, with smooth, longitudinal fluting (resembling a flexed muscle). Its leaves are deciduous, simple, alternate, ovate to elliptic, 3-12 cm long, with doubly-serrate edges, dark green, turning yellow to orange or red in the fall, glabrous above, slightly to moderately pubescent beneath, especially on major veins, with or without conspicuous dark glands. The flowers are unisexual, in catkins, the male (staminate) catkins 2-6 cm long, female (pistillate) catkins 1-2.5 cm long, both types on the same plant (the species monoecious). Fruits are a nutlet 4-6 mm long, subtended by a 3-winged, narrow, leaf-like bract, numerous nutlets held together in pendulous chain-like clusters 2.5-12 cm long, changing from green to brown in September-October. The common name, beam, is an Old English word for tree, with horn suggesting an analogy of the hard, close-grained wood to the tough material of horns.

Variation within the species: the two subspecies are distinguished by morphology and geography. They hybridize or intergrade where their ranges overlap in a broad band running from the Carolinas south to northern Georgia and westward to Missouri, Arkansas, and southeastern Oklahoma. Plants with

intermediate features are also found throughout the highlands of Missouri and Arkansas.

1. Leaf blades narrowly ovate to oblong-ovate, 3-8.5(-12) cm long, acute to obtuse at the tip; secondary teeth blunt and small; lower surfaces without small dark glands; southern Atlantic and Gulf of Mexico coastal plains and also extends northward in the Mississippi Embayment. ..... subsp. *caroliniana*

2. Leaf blades ovate to elliptic, mostly 8-12 cm long, usually abruptly narrowing at the tip, sometimes long and gradually tapered; secondary teeth sharp-tipped, often almost as large as primary teeth; lower surfaces covered with tiny, dark glands; Appalachians and interior forested northeastern North America. ..... subsp. *virginiana* (Marsh.) Furlow

Trees of temperate forests in the mountains of Mexico and Central America, formerly considered to be part of *Carpinus caroliniana*, are now treated as *C. tropicalis* (J.D. Smith) Lundell spp. *tropicalis* and *C. tropicalis* ssp. *mexicana* Furlow.

Distribution: Widespread in the eastern United States --- from central Maine west to southwestern Quebec, southeastern Ontario, northern Michigan, and northern Minnesota, south to central Iowa and eastern Texas, east to central Florida. Absent from the lowermost Gulf Coastal Plain and the Mississippi embayment south of Missouri).

Adaptation

American hornbeam occurs primarily as an understory species in bottomland mixed-hardwood forests. Best sites are in the transition between mesic and wet areas -- near lakes and swamps, on well-drained terraces of rivers, terraces or steep slopes of minor streams with some gradient, coves, ravine bottoms, and rises in lowlands. These sites generally have abundant soil moisture but sufficient drainage to prevent saturation and poor aeration during the growing season, although trees may be abundant on sites flooded for up to about 20% of the growing season. American hornbeam occurs less commonly in upland hardwood forests and may range from 300-900 meters elevation in the Appalachian and Adirondack Mountains. In the northeastern US, it may be an early migrant and form pure stands in moist old fields; it may be a minor seral component of sapling-size tree-shrub communities along the mid-Atlantic coast. Flowering: March-May; fruiting: August-October.

Establishment

American hornbeam begins to produce seeds at about 15 years and peaks at 25 to 50 years, probably ceasing at about 75 years. Large seed crops are produced at 3-5-year intervals. Seeds are mainly dispersed by birds. Seed establishment will occur on leaf litter in deep shade. Flooding, drought, damping off, proximity to a conspecific adult, and herbivory are important causes of mortality for first-year seedlings. Reproduction also may occur by sprouts from the root crown and by root sprouts, although the latter apparently is not common.

American hornbeam is best suited to establishment in bottomlands that have already been stabilized by pioneer species. It is shade-tolerant and persists in the understory of late seral and climax communities. Shade tolerance declines with age and American hornbeam is likely to become dominant, with other subcanopy species, at some sites after overstory removal.

Management

Because of its thin bark, American hornbeam is probably either top-killed or completely killed by most fires. It occurs mostly in communities that rarely experience fire. It sprouts after top-kill by fire and repeated fires at a closely spaced interval will quickly eliminate the species. The wood rots very rapidly and dying trees usually disappear naturally within a decade.

Cultivars, Improved and Selected Materials (and area of origin)

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

AMERICAN HORNBEAM

Carpinus caroliniana Walt.

Plant Symbol = CACA18

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
ironwood, musclewood, muscle beech, blue beech, water beech

Uses
The wood of *Carpinus* is of minor economic importance because of the small size of the trees. It is whitish, extremely hard, and heavy and has been used for making mallet heads, tool handles, levers, and other small, hard, wooden objects. The wood is not subject to cracking or splitting and was used by American pioneers for bowls and dishes.

American hornbeam is planted in landscapes and naturalized areas. It prefers deep, fertile, moist, acidic soil and grows best in partial shade, but will grow in full sun. Its chief liabilities in cultivation are a relatively slow growth rate and difficulty in transplantation. It is not drought-tolerant.

Seeds, buds, or catkins are eaten by a number of songbirds, ruffed grouse, ring-necked pheasants, bobwhite, turkey, fox, and gray squirrels. Cottontails, beaver, and white-tailed deer eat the leaves, twigs, and larger stems. American hornbeam is heavily used by beaver, because it is readily available in typical beaver habitat.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
American hornbeam is a native, large shrub or small tree with a wide-spreading, flat-topped crown, the stems are slender, dark brown, hairy; bark gray, thin, usually smooth, with smooth, longitudinal fluting (resembling a flexed muscle). Its leaves are deciduous, arranged alternately along stems, egg-shaped to elliptical in outline, ¾ to 4¾ inches long, with doubly-serrate edges. They are glabrous above, slightly to moderately pubescent beneath, especially on major veins, with or without conspicuous dark glands. During the growing season, leaves are dark green but turn yellow to orange or red in the fall. The flowers are unisexual, in catkins. The male catkins are 1 to 2½ inches long, female catkins are somewhat shorter. Both types occur on the same plant). Fruits are nutlets surrounded by a 3-winged, narrow, leaf-like bract. Numerous nutlets are held together in pendulous chain-like clusters, changing from green to brown in September-October.

Adaptation and Distribution
American hornbeam occurs primarily as an understory species in bottomland mixed-hardwood forests. Best sites are in the transition between mesic and wet areas -- near lakes and swamps, on well-drained terraces of rivers, terraces or steep slopes of minor streams with some gradient, coves, ravine bottoms, and rises in lowlands. These sites generally have abundant soil moisture but sufficient drainage to prevent saturation and poor aeration during the

growing season, although trees may also grow on sites flooded for up to about 20% of the growing season.

American hornbeam is distributed throughout most of the eastern United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment
American hornbeam is planted in landscapes and naturalized areas. It prefers deep, fertile, moist, acidic soil and grows best in partial shade, but will grow in full sun. Its chief liabilities in cultivation are a relatively slow growth rate and difficulty in transplantation. It is not drought-tolerant.

American hornbeam begins to produce seeds at about 15 years and peaks at 25 to 50 years, probably ceasing at about 75 years. Large seed crops are produced at 3-5-year intervals. Seeds are mainly dispersed by birds. Seed establishment will occur on leaf litter in deep shade. Flooding, drought, damping off, proximity to an adult of the same species, and herbivory are important causes of mortality for first-year seedlings. Reproduction also may occur by sprouts from the root crown and by root sprouts, although the latter apparently is not common.

American hornbeam is best suited to establishment in bottomlands that have already been stabilized by pioneer species. It is shade-tolerant and persists in the understory of mature plant communities. Shade tolerance declines with age and American hornbeam is likely to become dominant, with other subcanopy species, at some sites after overstory removal.

Management
Because of its thin bark, American hornbeam is probably either top-killed or completely killed by most fires. It occurs mostly in communities that rarely experience fire. It sprouts after top-kill by fire and repeated fires at a closely spaced interval will quickly eliminate the species. The wood rots very rapidly and dying trees usually disappear naturally within a decade.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

FLOWERING DOGWOOD

Cornus florida L.

Plant Symbol = COFL2

Contributed by: USDA NRCS National Plant Data Center

C.W. Cook. 2003.

Alternate Names

American boxwood, arrowwood, *Benthamia florida*, boxwood, cornel, cornelian tree, *Cornus candidissima, Cornus florida* forma *pendula, Cornus florida* forma *pluribracteata, Cornus florida* forma *xanthocarpa, Cornus florida* var. *pendula, Cornus florida* var. *rosea, Cornus florida* var. *rubra, Cynoxylon floridum*, dogwood, eastern flowering dogwood, white cornel, white dogwood.

WARNING: The fruit of flowering dogwood is poisonous to humans.

Uses

Ethnobotanic: Flowering dogwood root bark was used by Native Americans as a fever reducer, skin astringent, an antidiarrheal agent, and as a pain reliever for headaches, sores, and muscle inflammations. It was also used to counteract the effects of many poisons and as a general tonic for unspecified ailments. The bark was used for headache and backache relief, as a throat aid for hoarseness, and as an infusion for childhood diseases like worms and measles. Flowers were infused to

reduce fever and relieve colic pains. Compound infusions of several plant parts were used as blood purifiers and as medicine for blood diseases like malaria.

Ornamental: The showy blossoms and attractive fall foliage make flowering dogwood a valuable ornamental species. It is commonly used in landscape and street plantings. As a garden tree, it is used for shade around patios, as a shrub border or backdrop species, or as single specimens in the lawn. It is best suited for plantings receiving less than full-day sun.

Restoration: Flowering dogwood is a *soil improver* because its leaf litter decomposes more rapidly than most other species. For this reason flowering dogwood has been planted on abandoned strip mines and used for urban forestry projects.

Wildlife: Flowering dogwood is a valuable food plant for wildlife because high calcium and fat contents make it palatable. Many bird types including songbirds, forest edge species, and upland game birds (e.g. wild turkey) consume the seeds. The eastern chipmunk, white-footed mouse, gray fox, gray squirrel, black bear, beaver, white-tailed deer, and skunk readily consume flowering dogwood seeds as well. Beaver, rabbits, and deer browse the leaves and sprouts of the plant. Flowering dogwood also provides shelter and habitat for many wildlife species.

Wood production: The wood of flowering dogwood has been harvested for the manufacture of tool handles, charcoal, wheel cogs, hayforks, and pulleys. It is occasionally used to make specialty items like golf club heads, roller skate wheels, knitting needles, and spools. The wood is hard, strong, and shock resistant, making it suitable for wood products that need to withstand rough use.

Legal Status

Flowering dogwood is endangered in Maine, exploitably vulnerable in New York, and threatened in Vermont. Please consult the PLANTS Web site (http://plants.usda.gov) and your State Department of Natural Resources for this plant's current status (e.g.

threatened or endangered species, state noxious status, and wetland indicator values).

Description
General: Dogwood Family (Cornaceae). Flowering dogwood is a deciduous multi-branched shrub or small tree, characterized by a rounded crown and horizontal branches that spread wider than its height. Flowering dogwood is typically 5 to 15 m tall. The bark on mature trees is broken into small square blocks that give the stem an "alligator" appearance. Leaves are opposite, simple, medium-green in color, 7.6 to 15 cm long, and less than 7 cm wide. The veins follow the elliptic curve of the leaf (arcuate). Autumn foliage turns red or purple. The flowers are yellow, very small, and clustered into inflorescences that are surrounded by 4 large white (pink) bracts. Each bract has a rounded notch on the outer edge. The fruit are yellow to red berrylike drupes that contain one to two cream-colored, ellipsoid seeds. Flowers appear between March and June, with or before the leaves, and persist for 2 to 4 weeks. Fruits ripen in September and October.

Key characteristics of flowering dogwood are its opposite leaves with arcuate venation, large showy flowers (bracts), onion-shaped terminal flower buds, and alligator bark on mature trees.

Distribution: Flowering dogwood is native to the northeastern and southeastern United States. It occurs from Maine, south to Florida and west to eastern Texas, Missouri, Illinois, and southern Michigan. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site (http://plants.usda.gov).

Habitat: Flowering dogwood is an important understory species in the eastern deciduous and southern coniferous forests. It is also found on floodplains, slopes, bluffs, ravines, gum swamps, along fencerows, and in old-field communities. It is mentioned in 22 of the 90 Society of American Foresters forest cover types including jack pine, beech-sugar maple, eastern hemlock, oak-hickory, and prairie.

Adaptation
The USDA hardiness zones for flowering dogwood is 5 to 9. Flowering dogwood trees grow best in course to medium textured, well-drained soils with a pH range of 6 to 7. They are sensitive to rapidly changing soil temperature and are most abundant in temperature-consistent woodland soils. Although they are tolerant of seasonal dry periods, they are not tolerant of severe drought or heavy, saturated soils. The inability to grow on extremely dry sites is attributed to their shallow root system.

Flowering dogwood is an indicator of rich soil (mesic sites), but smaller trees will occur on more xeric sites. Trees growing in the mesic sites are more susceptible to dogwood anthracnose (see Pests and Potential Problems). In the future, flowering dogwood may only be found on poor, dry sites.

Partial or broken shade is best, but flowering dogwood can tolerate full sun. It does best with some shade in the south and full sun in the north. Shaded trees are less dense, grow more quickly and taller, and have poor flowering and fall color. Trees exposed to more sun are stouter, bushier, and produce more flowers.

Flowering dogwood is not tolerant of stresses such as heat, drought, pollution, or salt. These stresses make flowering dogwood more susceptible to disease, pests, and other problems.

Establishment
Flowering dogwood is intolerant of extended drought periods, especially during the first year after planting. Daily watering is necessary for the first few weeks following planting. After one month, watering should be reduced to two times per week and continue for one year. Establishment takes 6 to 12 months for each inch of trunk diameter. Larger trees benefit from irrigation during the second year.

Management
Flowering dogwood is moderately resistant to herbicides although direct application of Garlon has killed the plant. Mechanically cutting stems results in smaller resprouts. Midsummer-cut regeneration is typically smaller and shorter than regeneration from winter-cut.

Plants commonly resprout from the root crown after aboveground vegetation is damaged or destroyed by fire. The aboveground portions of flowering dogwood are readily damaged by fire because the thin bark allows fatal levels of heat to reach the cambium very quickly. Post-fire recovery is generally more rapid after surface fires than after crown fires.

Extreme soil moisture and flooding is detrimental to the survival of flowering dogwood. The tree can be uprooted in saturated soil. Excess water also leaves this plant susceptible to pests and diseases.

Established trees in partial or deep shade need irrigation only in times of drought. Those in full sun will need regular irrigation throughout their lives.

Pests and Potential Problems

Dogwood borer larvae move through openings in the bark and feed on the trunks of flowering dogwood. If the cambium is destroyed, branches or the entire tree will die. Leaves will turn red and drop early, and bark will slough off around holes on the trunk or branches. An advantageous point of entry for larvae is through wounds. For this reason, avoid hitting the trunk with lawn mowers or string trimmers to prevent infestation. Insecticides are preventative, but will not control an existing infestation.

Twig borers will kill the tips of young twigs, but rarely kill an entire tree because they are usually present in small numbers. Twig borers tunnel through the pith and deposit ambrosia fungi as a food source for larvae. This infestation causes wilted leaves at the end of branches, and can be controlled by pruning infected twigs below the discolored pith area.

Larvae of the dogwood club-gall midge cause twigs to swell at the base of flowering dogwood leaves. An early symptom of club gall is a wilted, deformed leaf. The twig beyond the gall may die, but galls can be pruned and destroyed. In early fall, larvae drop from the gall to over winter on the ground. A light infestation is not harmful, but a heavy infestation will stunt the growth of the tree.

Flowering dogwood is threatened by dogwood blight caused by the dogwood anthracnose fungus. Tan and purple colored leaf spots develop in the lower canopy and progress up the tree. Infection spreads into the shoots, main branches, and trunk causing cankers to form. Multiple cankers can girdle the trunk and kill the tree. Diseased trees produce shoots that also become infected on the lower trunk and leaves. Stressful environmental conditions like drought or acid rain may weaken trees, predisposing them to dogwood blight. Dogwood blight can be controlled if the disease is detected before branch dieback begins. Prune and remove all dead twigs, dead limbs, and new shoots, and rake and remove fallen leaves. Remove crowding vegetation and thin the canopy to promote air circulation. Avoid nitrogen fertilizer. Fungicides can prevent infestations of new leaves and flowers.

Spot anthracnose attacks flowering dogwood leaves, stems, flowers, and buds. Spots are usually very small with reddish or purplish borders. Severe infestations can prevent flower buds from opening, distort leaves, and weaken trees. Fungicides containing bordeaux 4-4-100, chlorothalonil, or mancozeb can control spot anthracnose on new plant tissue. Clean up and dispose of infected leaves on the ground near the tree since this is where the fungi survive the winter.

Cankers form at wound sites and allow entrance to harmful insects and fungi. Initial symptoms of cankers are blackened or water soaked areas on the bark. This area will grow and will ooze a black liquid. Leaves will appear smaller and paler. Cankers cannot be controlled. Prevent formation by avoiding trunk wounds.

Root injury, over-fertilization, or lack of soil drainage can lead to root rot. Powdery mildew forms on new growth causing reddish discoloration, premature defoliation, and dead patches. Leaf scorch symptoms are browning and drying leaf margins. These symptoms can be caused by a lack of available soil moisture, transplanting shock, fertilizer or salt injury to roots or root rot diseases. Raking up fallen leaves and improving air circulation through the canopy can control and prevent powdery mildew and leaf scorch.

Seeds and Plant Production

Flowering dogwood seeds can be hand-sown into outdoor beds soon after collection (September to October). This allows for the seeds to undergo natural warm stratification prior to exposure to cooler winter temperatures. Imbibe seeds overnight, dust with fungicide, and hand-sow 5 to 6 inches apart in rows. Sprinkle endomycorrhizae over the seed before covering with soil. Mulch the bed with sawdust. Seeds can be artificially cold stratified for 100 to 130 days and germinated at 15 to 27^{o}C. Prior to spring emergence (March to April), remove mulch. Place shade cloth above newly emerged seedlings and keep it in place until August.

Flowering dogwood can also be propagated by cutting, grafting, layering, and root division. It roots easily from cuttings taken in June or immediately after the plants bloom. Cut 8 cm of the terminal shoot tip, keeping 2 to 4 leaves, and dip into a one part indole-butyric acid (IBA) to 250 part talc (by weight) mixture. Set cuttings approximately 3 cm deep in rooting medium and grow under a misting system with a photoperiod of at least 18 hours.

Plants are best suited for transplanting at the beginning of the third year. Seedling survival is generally best on moist, rich, well-drained soils. Flowering dogwood may be difficult to transplant,

but seedlings with a root ball are more successful than bare root transplants.

Cultivars, Improved, and Selected Materials (and area of origin)

Several cultivars of flowering dogwood are readily available from commercial sources. These cultivars have been developed for leaf color and variegation, flower color, fruit color, plant height, growth rate, and disease resistance.

Some examples of flowering dogwood cultivars include ‚Apple Blossom,' ‚Bay Beauty,' ‚Cherokee Brave,' ‚Cherokee Chief,' ‚Cloud 9,' ‚First Lady,' ‚Mystery,' ‚Purple Glory,' ‚Sweetwater Red,' and ‚Welchii.'

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Edited: 25May2004 sbw; 20Oct2004 rln; 25may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Natural Resources Conservation Service

Plant Fact Sheet

FLOWERING DOGWOOD

Cornus florida L.

Plant Symbol = COFL2

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
USDA NRCS 1995
Northeast Wetland Flora
@USDA NRCS PLANTS

Uses

Wildlife: The fruit is choice fall and winter food of the gray squirrel and fox squirrel, bobwhite, cedar waxwing, cardinal, flicker, mockingbird, robin, wild turkey, and woodpecker. The leaves and twigs are choice food for the white-tailed deer. It is not an important nesting plant.

Ornamental: It is an important ornamental tree used around homes and office buildings because of its striking display when it is in full bloom.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Cornus florida L., flowering dogwood, is a small, bushy tree which rarely attains a height of more than 40 feet or a diameter of 12 to 18 inches. The leaves are opposite one another and from 3 to 6 inches long. The deeply ridged and broken bark resembles alligator hide. Flowering dogwood has large, showy, deeply notched bracts, 4 of which surround each cluster of inconspicuous perfect flowers, in bloom from May to June. The fruit clusters on this shrub-like tree are scarlet red.

Adaptation and Distribution

Flowering dogwood is adapted to most upland sites but grows best on rich, well-drained soils on middle and lower slopes. It develops best as an understory species in association with other hardwoods.

Flowering dogwood is distributed throughout the eastern United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Plants can be grown from seed planted 1/2 inch deep in late winter.

Management

In tree harvest or timber stand improvement operations, specify that 5 or 6 dogwoods per acre be left in the forest for aesthetic purposes and as a food source for squirrels, turkeys, deer, and non-game birds. Leave all dogwoods along highways and roads.

Pests and Potential Problems

There are several wood boring insects and canker diseases that attack the main stem while others invade the branches and leaves.

Cultivars, Improved, and Selected Materials (and area of origin)

Seedlings can be purchased from most commercial hardwood nurseries.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK ; 25may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Fact Sheet ST-123
November 1993

Carya ovata
Shagbark Hickory[1]

Edward F. Gilman and Dennis G. Watson[2]

INTRODUCTION

Shagbark Hickory reaches a height of 60 to 80 feet and spreads 25 to 35 feet (Fig. 1). The tree has a picturesque, oval outline with the lower branches somewhat drooping, the upper branches upright, and the middle branches just about horizontal. Probably the best ornamental hickory due to the open branching habit and shaggy, gray bark.

GENERAL INFORMATION

Scientific name: *Carya ovata*
Pronunciation: KAIR-ee-uh oh-VAY-tuh
Common name(s): Shagbark Hickory
Family: *Juglandaceae*
USDA hardiness zones: 5 through 8A (Fig. 2)
Origin: native to North America
Uses: shade tree; specimen
Availability: somewhat available, may have to go out of the region to find the tree

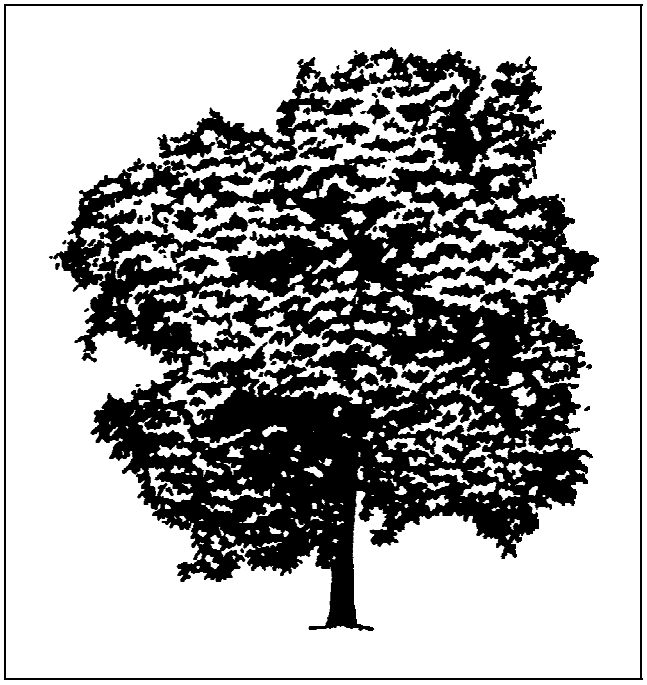

Figure 1. Mature Shagbark Hickory.

DESCRIPTION

Height: 60 to 80 feet
Spread: 25 to 35 feet
Crown uniformity: symmetrical canopy with a regular (or smooth) outline, and individuals have more or less identical crown forms
Crown shape: oval
Crown density: moderate
Growth rate: slow
Texture: coarse

Foliage

Leaf arrangement: alternate (Fig. 3)
Leaf type: odd pinnately compound
Leaflet margin: serrate
Leaflet shape: lanceolate; oblong; oblanceolate
Leaflet venation: pinnate
Leaf type and persistence: deciduous
Leaflet blade length: 4 to 8 inches
Leaf color: green
Fall color: yellow
Fall characteristic: showy

1. This document is adapted from Fact Sheet ST-123, a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: November 1993.

2. Edward F. Gilman, associate professor, Environmental Horticulture Department; Dennis G. Watson, associate professor, Agricultural Engineering Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

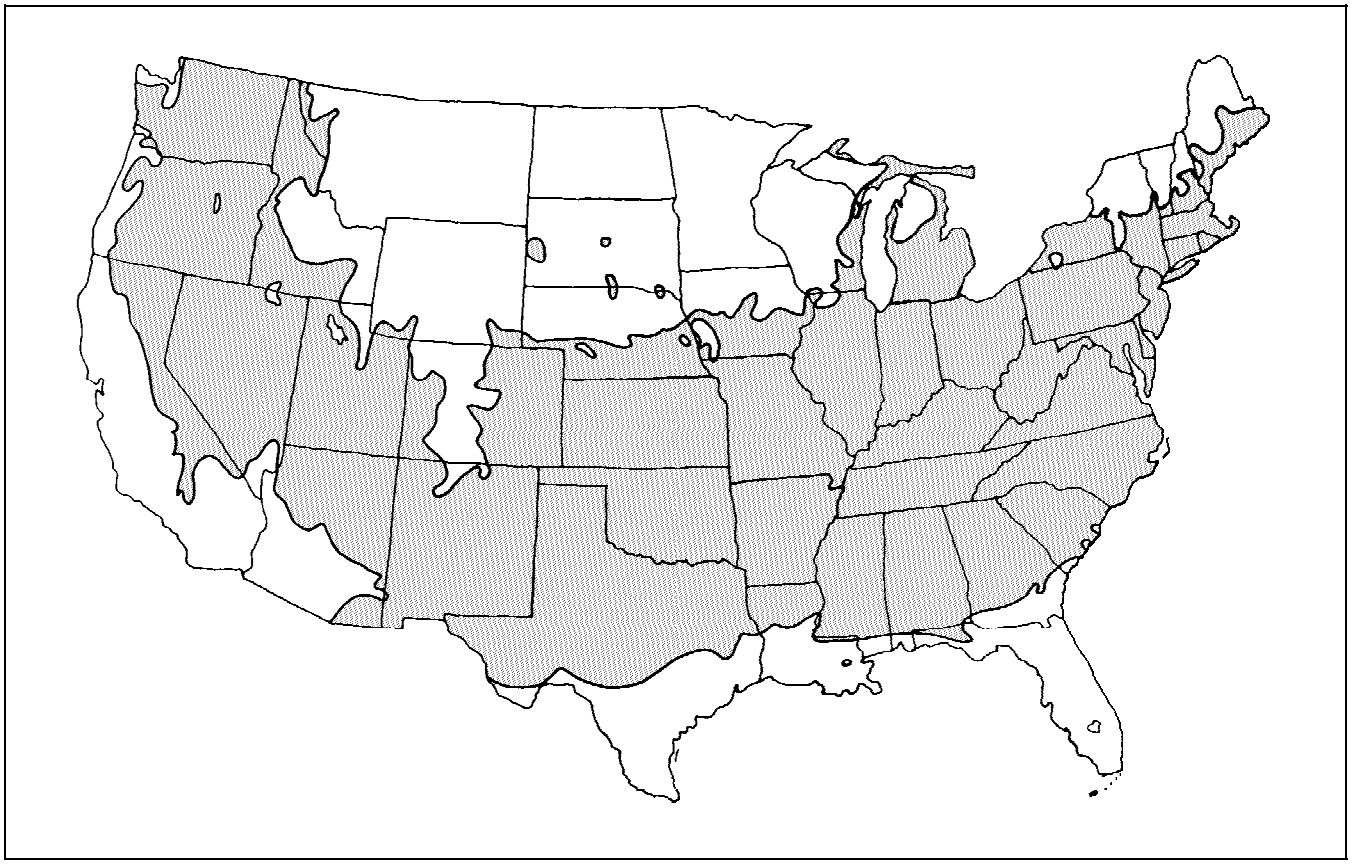

Figure 2. Shaded area represents potential planting range.

Flower

Flower color: green
Flower characteristics: showy; spring flowering

Fruit

Fruit shape: oval; round
Fruit length: 1 to 3 inches
Fruit covering: dry or hard
Fruit color: brown; green
Fruit characteristics: attracts squirrels and other mammals; fruit, twigs, or foliage cause significant litter; showy

Trunk and Branches

Trunk/bark/branches: grow mostly upright and will not droop; showy trunk; should be grown with a single leader; no thorns
Pruning requirement: needs little pruning to develop a strong structure
Breakage: resistant
Current year twig color: brown; gray
Current year twig thickness: thick
Wood specific gravity: 0.72

Culture

Light requirement: tree grows in part shade/part sun; tree grows in full sun
Soil tolerances: clay; loam; sand; slightly alkaline; acidic; occasionally wet; well-drained
Drought tolerance: moderate
Aerosol salt tolerance: none
Soil salt tolerance: moderate

Other

Roots: surface roots are usually not a problem
Winter interest: tree has winter interest due to unusual form, nice persistent fruits, showy winter trunk, or winter flowers
Outstanding tree: tree has outstanding ornamental features and could be planted more
Invasive potential: little, if any, potential at this time
Ozone sensitivity: tolerant
Verticillium wilt susceptibility: susceptible
Pest resistance: long-term health usually not affected by pests

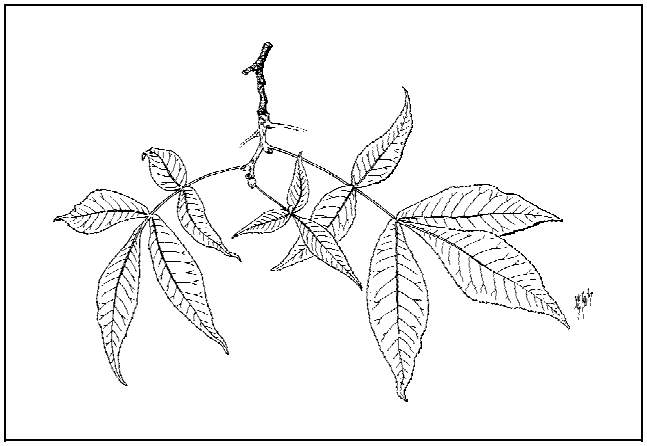

Figure 3. Foliage of Shagbark Hickory.

USE AND MANAGEMENT

Growth rate is slow and the tree is somewhat difficult to transplant due to a coarse root system but the tree is adaptable to many different soils. There is usually a tap root on trees grown in well-drained soil. The nuts are produced in abundance and are edible and used by birds and mammals but must also be cleaned up from the ground in a maintained landscape. They can damage cars when they fall from the tree, so do not locate them near streets or parking areas. Shagbark Hickory grows best in a sunny location and light well-drained soil. It grows naturally in moist river bottoms, not inundated flood plains,

The tree has two ornamental characteristics: peeling, shaggy bark, which peels off in long strips, and a golden yellow fall color. The light grey bark is quite striking. Not a tree for general use, Shagbark Hickory is best saved for an occasional specimen on golf courses and parks and in other open areas.

Pests

Aphids of various types feed on hickory causing distorted and stunted growth. The hickory leaf stem gall causes the formation of hollow green galls on leaves, stems, and twigs. The galls form in June and turn black in July. The galls are up to a half inch in diameter.

Hickory bark beetles mine the bark and sapwood. The boring causes wilting of young twigs, or trunks may be girdled and trees killed. Keep trees healthy by fertilizing regularly and by watering during dry weather. It can kill trees of low vigor.

The twig girdler larva girdles twigs causing weakened twigs to break off and drop. The larva is about a half-inch-long and rides the branch to the ground where it overwinters. Gather the fallen twigs and destroy them.

June beetles eat the leaves of hickory at night. The injury is usually not severe but can be mysterious since no insects are seen during the day.

Caterpillars of various types feed on hickory.

Scales of various types attack hickory but can be controlled with sprays of horticultural oil.

Spittlebugs can be a nuisance.

Diseases

Hickory anthracnose or leaf spot is caused by a fungus. In wet years the disease causes severe defoliation. The symptoms are large reddish brown spots on the upper leaf surface but brown on the lower surface. The spots may not have distinct marginal markings. The disease overwinters on fallen diseased leaves so dispose of infected leaves in the fall. A large number of fungi cause leaf spots on hickory. Severe infections can cause defoliation. Many of the fungi overwinter on diseased leaves, dispose of infected leaves when they fall.

Witches broom can follow a leaf spot disease. Symptoms are yellow blotches on the upper sides of the leaves but white on the undersides. Severe infections may cause defoliation, and when the fungus invades the stem a witches broom forms. Leaves on the stems of the witches broom are yellowish, small, and fall prematurely. Prune out witches brooms when they form.

Powdery mildew causes a white powdery growth on the leaves. If the disease occurs late in the season, no chemical control will be needed.

Try to prevent cankers by keeping trees healthy through watering during dry weather and regular fertilization. Avoid wounding the trees unnecessarily and prune out weak or dead branches.

Verticillium wilt kills individual branches or sometimes entire sections of the tree. Foliage on affected branches wilts and later turns brown. Keep trees healthy and prune out small infected branches.

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Plant Guide

REDOSIER DOGWOOD

Cornus sericea L. ssp sericea

Plant Symbol = COSES

Contributed By: USDA NRCS National Plant Data Center & Carlinville (IL) Field Office

Robert H. Mohlenbrook
USDA, NRCS, Wetland Science Institute
@ PLANTS

Alternative Names

Red willow, redstem dogwood; *Cornus stolonifera* var. *nevadensis* Jepson and *Cornus stolonifera* Michaux (Hickman 1993). A related subspecies, *Cornus sericia* spp. *occidentalis* (Torr. & Gray) Fosberg is known as western dogwood.

Uses

Ethnobotanic: Native Americans smoke the inner bark of redosier dogwood in tobacco mixtures used in the sacred pipe ceremony. Dream catchers, originating with the Potawotami, are made with the stems of the sacred redosier dogwood. Some tribes ate the white, sour berries, while others used the branches for arrow-making, stakes, or other tools. In California, peeled twigs were used as toothbrushes for their whitening effect on teeth (Strike 1994). Bows and arrows were made from *Cornus* shoots. The inner bark is used for tanning or drying animal hides.

The Apache, Cheyenne, Dakota, Montana Indians, Ojibwa, Potawatomi, Omaha, Ponca, and Thompson Indians all use the inner bark in a tobacco mixture for smoking the sacred pipe (Moerman 1986). The leaves and/or inner bark of redosier dogwood are also used as a smoking mixture by the Okanagan-Colville, the Flathead, the Kootenay, and the Blackfeet peoples in the western United States and Canada (Hellson 1974, Hart 1976, Turner 1978, Turner et al. 1980, Johnston 1987). The Navaho-Kayentaf and Navaho-Ramah used the plant ceremonially as a Mountain-top-way emetic (Moerman 1986). An infusion of redosier dogwood bark was used as an anti-diarrheal by the Chippewa and the Potawatomi, an antidote for weak kidneys by the Shuswap, and a pediatric aid for children who wet the bed by the Shuswap. The Chippewa used an infusion of the bark for eruptions caused by poison ivy. The Chippewa and the Micmac used a decoction of redosier dogwood root for sore eyes and catarrh. The Okanagan and the Thompson Indians took a decoction of the leaves. Other remedies treated by redosier dogwood included headaches, sore throats, a wash for ulcers, a substitute for "larb", and a decoction of bark was taken as an antidote for weakness.

The Maidu of Northern California used redosier dogwood as a tonic, a laxative, emetic, and cathartic (Strike 1994). Maidu women took a dogwood decoction after childbirth.

The fruits were eaten by the Indians of the Missouri region (Densmore 1974). The berries are known to be tart and bitter, but were nonetheless eaten by all of the southern Interior peoples of British Columbia, including the Nlaka'pamux, Lillooet, Okanagan-Colville, Shuswap, Kootenay, Blackfeet, and the Flathead of Alberta and Montana (Kuhnlein and Turner 1991). The fruits were gathered from August to October and eaten fresh, a few at a time, or, more commonly, were pounded and mixed with other fruits, such as chokecherries (*Prunus virginiana*) or Saskatoons (*Amelanchier almifolia*). Some people mashed the berries and dried them in cakes; others dried and stored them. Eating a few raw fruits was considered to be a good tonic among the Nlaka'pamux and the Okanagan-Colville, who ate them, raw as a kind of "relish" (Turner 1978; Turner et al. 1990).

Redosier dogwood is used for basket weaving. Sometimes called red willow, both *Salix* species and *Cornus sericea* are used interchangeably. Differences in stem color create a multi-hued design

element. Indian people from the mid-Columbia River used redosier dogwood to make "ribbons" for basket decorations (Schlick 1994). If gathered in the early spring, the bark will retain its deep red color when dried and could be mistaken for cherry. The Hidatsa, Arikara, and Mandan made twill plaited burden baskets with two-toned dark and light designs; these baskets were made of willow (*Salix nigra*), redosier dogwood, and boxelder (*Acer negundo*) splints (Turnbaugh et al. 1986, Hart 1976). Willow and redosier dogwood were used by the Cheyenne, Arapaho, Kiowa, Pawnee, and Teton Sioux to make a coarsely coiled gambling basket for dice.

The Ojibwa and the Chippewa used redosier dogwood bark as a dye. The inner bark was mixed with other plants or minerals and used to make a red dye, a light red dye, a black dye, and an ecru or "khaki" colored dye (Densmore 1974).

Wildlife: The fleshy fruits of dogwoods are very valuable to wildlife, particularly in the Northeast (Martin et al. 1951). The fruit ripens in late summer, and besides being available through the fall, some of the berries may persist on the plants into the winter months. Wildlife browse the twigs, foliage, and fruits. Birds known to eat the fruit include: wood ducks, eastern bluebirds, cardinals, catbirds, long-tailed chats, crows, purple finches, yellow-shafted flickers, crested flycatchers, grosbeaks, kingbirds, American magpies, mockingbirds, crested mynah birds, orioles, robins, yellow-bellied sapsuckers, European starlings, tree swallows, scarlet tanagers, brown thrashers, thrushes, vireos, pine warblers, cedar waxwings, and woodpeckers. Game birds who eat both the fruits and buds include grouse, ring-necked pheasants, band-tailed pigeons, greater prairie chickens, bobwhite quail, and wild turkeys. The shrubs provide excellent nesting habitat for songbirds. Mammals that eat the fruit and foliage include black bear, beaver, mountain beaver, cottontail rabbits, raccoons, eastern skunks, squirrels, chipmunks, mice, and rats. Deer, elk, Mountain goat, and moose browse the twigs and foliage.

Landscaping & ornamental: Redosier dogwood is often planted as an ornamental, both to beautify the landscape and to attract birds. Dogwood is often used for landscaping and as a secondary plant in windbreaks.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Dogwood Family (Cornaceae). Redosier dogwood is a woody deciduous shrub generally 1.4-6 m (4.6-20 ft) tall. The bark and twigs are reddish to purple and fairly smooth from autumn to late spring; after the leaves have fallen, the deep burgundy branches add color to the winter landscape. The bark, twigs, and leaves are bright green in spring through summer. The simple, opposite leaves are 5-10 cm (2-4 in) long, dark green above and hairy and lighter-colored below, with smooth margins, rounded bases, pointed tips, and falsely parallel veins. Flowering occurs from June to August. The inflorescence is a cyme, with 2-3 mm (0.08-0.12 in) white to cream-colored flowers. The white berries are smooth on the faces, furrowed on the sides.

Distribution

For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. Redosier dogwood has a wide distribution from California north to Alaska and throughout the country to the eastern United States south to Mexico. It generally grows at elevations below 2500 m.

Establishment

Adaptation: Redosier dogwood grows in soils that are saturated for at least a portion of the growing season. Redosier dogwood is common on the edges of lakes, ponds, within wetlands, and along streams. Not as tolerant of long-term root saturation as are some other shrubs, dogwood seems to prefer wetland margins where soils are nitrogen-rich, saturated, and shallowly inundated in the spring, and may be completely dry by late summer. It is tolerant of fluctuating water tables. The "osier" in redosier dogwood is derived from French, meaning "willow-like"; it is often called red willow because of its red stems.

Propagation from cuttings: Redosier dogwood can be started easily by division, French layering, and hardwood cuttings. To propagate suckers by division:

- Lift a root with suckers on it without disturbing the parent plant. Check that there are fibrous roots at the base of the suckers.
- Remove the suckering roots by cutting it off close to the parent plant. Firm the soil around the parent plant.

- Cut the main root back to the fibrous roots, then divide the suckers so that each has its own roots. Cut back the top-growth by about half.
- Treat each sucker or hardwood cutting at the base with IBA at 20,000 ppm liquid formulation to promote rooting. Alternatively, treatment with 2 percent IBA talc; this will promote rooting on both suckers and stem cuttings.
- Replant the suckers in open ground in prepared holes with good potting soil. Firm the soil around the suckers and water.
- Before growth starts in the spring, lift the plant. Break the clump into sections, retaining those with vigorous shoots and well-developed roots.
- Prune any damaged roots, and cut back the top-growth by one-third to a half to reduce water loss. Replant the divisions in the open and water in dry weather.
- Ultimately, simply lift a suckering root, sever it from the parent plant, and then replant it in the open.

To ensure survival of cuttings or suckers through the following winter in cold climates, the potted cuttings should be kept in heated cold frames or poly-houses to hold the temperature between 0-7°C (32-45°F). Rooted cuttings that had shoot growth in the fall, but were not given nitrogen, had the best over-winter survival in a cold frame with microfoam.

French layering: Layering is a method where a stem is encouraged to develop roots before being removed from the parent plant.

- In spring, plant a rooted layer or young plant, label it, and grow it for a season. Then, in the dormant season, cut back the stem to within 3 inches (8 cm) of the ground.
- In the following spring, apply a balanced fertilizer at the rate of 2-4-oz/sq yd (60-110 g/sq m). Space the stems evenly again; dropping each into a 2-inch (5-cm) deep trench. Peg down each stem and cover with soil, leaving the shoot tips exposed. Hill up all but 2-3 inches (5-8 cm) of the new shoots as they develop, until the mound is 6 inches (15 cm) high. Water as needed.
- After leaf fall, carefully fork away the soil from around the new shoots until the stems that were laid horizontally are exposed. Cut these flush with the basal area of the stems. Then cut the stems to separate the rooted sections. Pot these or plant them out in the open garden, and label them. The same redosier dogwood basal area may be used to propagate further layers.

Propagation by seed: Redosier dogwood is established easily from seed. The best germination is obtained if the seeds are gathered as soon as the fruit starts to color or ripen, from August to October. If the seeds are allowed to dry out, it is best to remove seeds from the fruit and soak in water.

The best results are obtained from fall sowing of freshly harvested seeds. Fruits collected too late to sow in the fall should be stored, pre-chilled until the next season, and sown outdoors the following fall. To effectively condition the seed for germination, store for two months in moist sand at 5ºC for 90 days. After pre-chilling, expose the seeds to fluctuating temperatures from 12/72ºC for 10 days (Young and Young 1992). With some species, the warm stratification period may be replaced by mechanical scarification or soaking in sulfuric acid. Seeds sown in nursery beds should be covered with 0.25-0.5 in (0.6-1.25 cm) of soil. Fall-sown beds should be mulched during the winter.

Management

Redosier dogwood is often coppiced in late fall after the leaves turn brown and fall off the stem. Cut all stems to approximately 2-3 in (5-8 cm) from the base before growth begins in spring. Apply fertilizer around the shrub to promote new growth, then apply mulch around the base. Coppicing stimulates the growth of new, vigorous stems whose deep burgundy color is especially vivid.

Traditional resource management: Redosier dogwood was traditionally tended by pruning or burning to produce long straight stems.

- Often basket weavers will prune many redosier dogwood stems, sometimes replanting the stems, so there will be nice straight basketry material the following year.
- Before gathering, offerings of thanks and prayers for permission to gather are given. Often tobacco or sage or other offerings are given before beginning to gather.
- Basket weavers process materials with their hands and mouths. Herbicides sprayed along streams have a much higher health risk for humans when they are processed and used for traditional materials.

Overgrazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production. Livestock grazing can cause the replacement of bird and mammal species requiring the vertical vegetation structure of riparian habitat to species, which are

ubiquitous in their habitat preferences. Previous heavy cattle grazing changed the bird and small mammal community composition in riparian areas through reduction of shrub and herbaceous cover.

Cultivars, Improved and Selected Materials (and area of origin)

Cultivars: „Alman's Compacta', „Allamans', „Bailey', „Cardinal', „Coloradensis', „Flaviromea', „Isanti', „Kelseyi', „Lutea', „Ruby', „Silver' and „Gold', and „White Gold' have been planted in the growing range of redosier dogwood.

Consult your local nurseries to choose the right cultivar for your specific landscape.

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Edited 05dec00 jsp; 01may03 ahv; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

REDOSIER DOGWOOD

Cornus sericea L. ssp. *sericea*

Plant Symbol = COSES

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
USDA NRCS 1989.
Midwestern Wetland Flora
@USDA NRCS PLANTS

Alternate Names
Cornus stolonifera *Michx.*

Uses
The primary use of this species is for streambank protection. It can be planted alone or with other species, such as willows. Other beneficial uses are for fish and wildlife habitat improvement, windbreaks, slope stabilization, borders, and as an ornamental.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Redosier dogwood is a large shrub, often 6-9 feet in height. The growth habit is upright rounded, but where stems are in contact with the ground, roots are formed. This behavior creates thickets. This dogwood has bright red stems in the fall, winter and early spring, which turn greenish in the summer. It also has white pith, dark green ovate leaves, white flowers, and whitish colored fruit. There are 18,500 seeds per pound.

Adaptation and Distribution
Redosier dogwood is adapted from Ohio to Maine and south to northern Virginia and New Jersey. It performs best in soils that are moist, somewhat poorly drained, moderately acidic to neutral, and in areas that have medium to coarse soils. It is tolerant of some shade but not of droughty conditions.

For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Streambanks that have steep slopes must first be graded. The slope should be 1:1 or flatter. Any trees considered unstable should be removed. One year old rooted cuttings should be used for planting. Plant in early spring, preferably before May. Do not plant after June 1. Plant the cuttings two feet apart for streambank erosion control, four to six feet apart for wildlife habitat. Establishment with other species, such as willow and other riparian species, is a good practice. On sites with banks that may become dry over the summer, utilize redosier dogwood next to the water, with willows above. Immediately after planting, grasses and legumes may be planted to provide initial stabilization. After 2 or 3 years the dogwoods will become effective. The cultivar 'Ruby' is vulnerable to livestock browsing. In order to ensure survival, fencing must be incorporated into the plan.

Redosier dogwood can also be mixed with willows in soil bioengineering methods. Stems can be used in live fascines, brush layering and brush mattressing.

Rooted hardwood cuttings are taken in January, allowed to develop callus in refrigerated storage, and planted in mid-May in well drained soil 2 inches apart. The cuttings should be 1/4-1/2 inch in diameter and 9 to 12 inches long. They should be planted with about 2 inches exposed above ground level. Rooting hormone is recommended to enhance success in the nursery.

Management
Erosion is a continuous process and, because of this, careful management is required at these streambank

plantings. The areas should be examined each spring after the major runoff period has ended. Areas where vegetation has been destroyed must be immediately replaced with new plants. If any mechanical measures are being used to prevent erosion, they must also be maintained to prevent any more damage.

Pests and Potential Problems

'Ruby' redosier dogwood has few problems with disease or insect pests. There has been some problem with cicadas stinging the stems. Lesions and cankers may also occur. However, these are not pathogenic and are thought to just be the tree's reaction to injury.

Cultivars, Improved, and Selected Materials (and area of origin)

'Ruby' (NY) redosier dogwood was released in 1988 from the Big Flats, NY Plant Materials Center. It is available from commercial nurseries.

Prepared By & Species Coordinator:

USDA NRCS Northeast Plant Materials Program

Edited: 01Feb2002 JLK; 25may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Audubon AT HOME

PLANT PROFILE

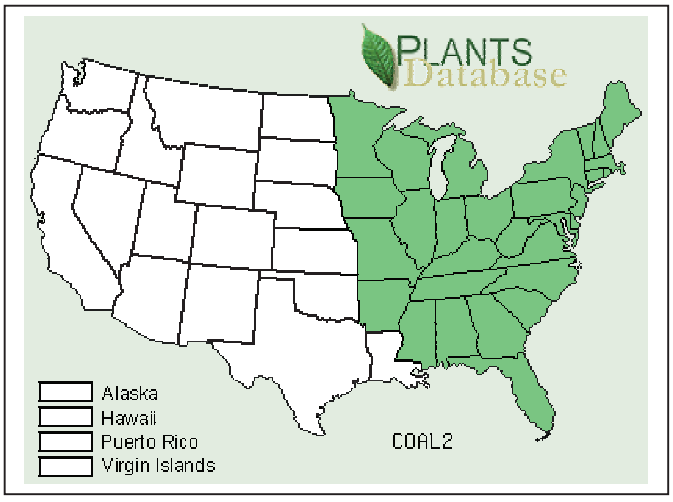
Alternate-leaf Dogwood (***aka*** **Pagoda dogwood)**

Scientific name:	***Cornus alternifolia***
Growth habit:	**Shrub or tree (to 30 feet)**
Duration:	**Perennial**
Light preference:	**Partial shade/sun**
Soil preference:	**Moist, well drained**
Plant associates:	**Chokecherry, serviceberry, striped maple, other dogwoods, Vaccinium species, American hazel**

Photo courtesy University of Connecticut Plant Database www.hort.uconn.edu/plants

Value to Wood Thrush: Food and cover

Native range: Eastern states to central U.S.



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Plant Fact Sheet

AMERICAN HOLLY

Ilex opaca Ait.

Plant Symbol = ILOP

Contributed by: USDA NRCS Plant Materials Program

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Uses
The attractive evergreen foliage and bright red fruit of this small tree make it a very popular for landscaping. The same attributes that allow this tree to be a desirable ornamental make it one of the most sought after greens for Christmas decoration. The firm bright red berries are consumed by white-tail deer and 18 species of birds. The dense foliage also provides cover and nesting habitat for various songbirds.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
American holly normally grows to heights of 15 to 30 feet tall, but records indicate mature heights of up to 100 feet. On the poor soils of coastal beaches, this holly may never exceed shrub size. The bark of it is smooth, and grayish to grayish-brown. The dense branches of this holly grow nearly horizontal in a spreading crown, which takes on a pyramidal silhouette.

The evergreen foliage is stiff and leathery in texture, with large, remotely spined teeth. The leaves are arranged alternately. They are 2 to 4 inches long, satin green and smooth above, and yellowish-green below.

Small, axillary, greenish-white flowers bloom from April to June. Like most others in the holly genus, American holly is dioecious. Pistillate flowers emerge in small clusters from one plant, while staminate flower clusters develop on another. Newly established plants will not flower for 4 to 7 years; prior to flowering there is no practical means of determining the gender of a plant. Bright red, rarely orange or yellow, globular fruit mature from September to October, but may be retained on the plant into the following spring. The berry-like fruit is about 1/3 inch in diameter, and contains 4 to 9 small nutlets. There are an average of 28,430 seeds per pound.

Adaptation and Distribution
American holly grows from Massachusetts to Florida, west to Texas and Missouri, and is adapted to a wide range of site conditions. It grows best on well drained, sandy soils, but will tolerate those which are somewhat poorly drained. This small tree has good shade tolerance, but does well in direct sun. Although this species is often found growing on coastal sand dunes, it is not very salt spray tolerant.

For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Utilize standard tree and shrub planting procedures to establish containerized or balled and burlapped plants. Bare rooted transplants usually have marginal success.

When establishing American holly, it is important to plant males as well as females if berry production is desired. In a nursery situation the gender ratio should be 1:10, males to females. Establish American holly only where surrounding vegetation or physical barriers protect the plants from harsh winds. Holly plants prefer partial shade, with some full sun exposure during the day.

Cultivars, Improved, and Selected Materials (and area of origin)

There are many ornamental varieties, available from commercial nurseries, selected for berry and leaf color. There are also commercial sources of locally and regionally collected material available from native plant nurseries.

Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 05Feb2002 JLK; 060801 jsp

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Plant Guide

BLACK WALNUT

Juglans nigra L.

Plant Symbol = JUNI

Contributed by: USDA NRCS National Plant Data Center

Robert Mohlenbrock
@ PLANTS

Uses

Ethnobotanic: The bark of black walnut was used by many native groups, including the Cherokee, in tea as a laxative and chewed for toothaches. Caution: Bark should be used cautiously in medicine, because it is poisonous. The Cherokee also ate the fruit of the black walnut. The Chippewa and the Cherokee used the bark to make brown and black dyes. The Comanche created a paste from the leaves and husk of the fruit for treatment of ringworm. Black walnut was also used by the Appalachian, Cherokee, Comanche, Iroquois, and Rappahannock to treat athlete's foot, hemorrhoids, and as an insecticide.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Walnut Family (Juglandaceae). Black walnut is usually a medium sized tree ranging from 70-90 feet tall and 2-3 feet in diameter at breast height. However, black walnut can reach 150 feet tall and 8 feet in diameter at breast height. The branches are widely spread and form a massive crown. The bark is thick and brown to grayish-black in color. The bark has deep furrows and narrow forking ridges. The furrows and ridges form a diamond pattern. The twigs are stout with notched leaf scars. They are light brown to orangish in color. The terminal buds are short, blunt, and covered with a few hairy scales. The leaves are up to 6 dm long with 9-23 leaflets attached directly to a stout rachis without a supporting stalk. The rachises are covered with fine short hairs. Flowers appear in late May to early June. The flowers bear 17-50 stamens, but lack pistils. The fruits are 4-6 cm in diameter and spherical shaped. They can be found in groups of 2-3 or solitary. The fruits have a thick, semi-fleshy, husk covered with short hairs and are yellowish-green in color. The nut is corrugated with rounded ridges.

Distribution: For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Black walnut is found in fields and rich woodlands.

Adaptation

Black walnut produces a toxin, known as "juglone", which inhibits the growth of other plants around it, thereby reducing competition. Juglone deprives sensitive plants of energy needed for photosynthate production. The symptoms of plants being affected by juglone include foliar yellowing, wilting, and eventually death. The largest sources of juglone on the tree are located in the buds, roots, and nut hulls.

Establishment

Black walnut is difficult to transplant and therefore, propagation by seed is recommended. Seeds should be planted in the fall in moist, well-drained, deep soil that is rich in organic matter. Black walnut prefers full sun.

Management

Black walnut is a very intolerant tree. Planted in fairly dense stands or under forest competition the tree develops a tall and well formed, clear bole. This bole form results from the tree putting its resources into competing for sunlight and is ideal for wood fiber production. Logs 10 inches in diameter at

breast height can be developed in 35 years under ideal growing conditions.

Pests and Potential Problems
Black walnut suffers from a variety of deforming and deadly pests and diseases including parasitic nematodes, mistletoe, fusarium canker, bacterial blight, white trunk rot, and cylindrockadium root rot.

Environmental Concerns
Juglone may be a concern when landscaping or planting black walnut near a garden.

Cultivars, Improved, and Selected Materials (and area of origin)
These materials are readily available from commercial plant sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Plant Fact Sheet

BLACK WALNUT

Juglans nigra L.

Plant Symbol = JUNI

Contributed by: USDA NRCS New York State Office

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Uses

Traditionally the dark colored wood was used for gun stocks, fencing, airplane propellers, and cabinetry. Today the high valued wood is utilized for some of the finest quality furniture. The large nuts produced by this tree are consumed by wildlife and humans.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Black walnut usually matures in about 150 years. An average site will produce mature black walnut trees which are 70 to 80 feet in height and attain diameters of 2 to 4 feet when grown in a forest stand. On the best sites this tree may reach up to 150 feet tall and over 8 feet in diameter. When grown at low stocking or in open fields, black walnut produces a short, wide spreading crown.

A deep, wide spreading root system supports this large tree. Mature trees have a deeply furrowed gray-brown to nearly black bark. The brown to orange-brown twigs are stout, with large, shield shaped, conspicuous leaf scars. The deciduous leaves are 1 to 2 feet long, alternate, and compound. The 15 to 23 leaflets are stemless, unequally rounded, and wider at the base than at the pointed tips.

Unisexual flowers emerge on black walnut from mid-April to mid-June, appearing with the leaves on a separate inflorescence of the same tree. A globular fruit is produced which contains a corrugated nut in its yellowish-green husk. The nut is usually 1 1/2 to 2 1/2 inches in diameter, containing an oil-rich, sweet, and edible seed. The large fruit ripens between September and October. Upon ripening the husk softens and turns dark brown to black.

Adaptation and Distribution

Found throughout the eastern U.S., black walnut thrives in deeper, well drained, neutral soils. Black walnut is a shade intolerant species, and must have direct sunlight to grow optimally. It requires about 35 inches of annual precipitation, an annual average temperature of about 55 degrees F., with no less than 170 growing days for optimum growth and development. This species survives beyond its ideal site requirements as it approaches the limits of its native range. Black walnut is found naturally growing from Vermont to Minnesota, south to Florida and Texas.

When acquiring planting stock it is important to utilize local or regional sources, since climatic variation has been noted.

For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Seed dormancy is broken by natural over-winter freezing and thawing conditions or artificially with cool moist stratification.

Natural: Shortly after leaves fall from the tree, the nuts fall. This species is naturally distributed by various wildlife, as they store nuts in the soil for winter. After the freezing and thawing of winter, those nuts not consumed by wildlife will normally germinate the first or second spring. On good sites, seedlings will grow 3 feet the first year and double that the second year.

Nursery: Propagating seedlings under nursery conditions is a viable choice, but precautions must be taken to protect against rodent predation. Direct seeding onto raised beds or at a site will lead to productive results. Seedlings should be distributed as 1/0 bare-root or containerized stock. On fertile nursery soils, black walnut should not require additional nutrients for adequate growth.

Pests and Potential Problems

European canker and walnut caterpillar are the only two pests documented to attack black walnut.

Cultivars, Improved, and Selected Materials (and area of origin)

Over 100 varieties of black walnut have been selected for their nut quality, but most commercially available seedlings are produced from local collections. Specific varieties are typically propagated from grafts.

Prepared By & Species Coordinator:

John Dickerson (retired), USDA NRCS New York State Office, Syracuse, New York

Edited: 05Feb2002 JLK; 060801 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Mesic-To-Dry Prairie

Aster novae-angliae, New England Aster

Eryngium yuccifolium, Rattlesnake Master

Silphium laciniatum, Compass Plant

For current pricing, availability, and information on our full installation and management services, visit **www.cardnojfnew.com/nursery.**

Offers a broad spectrum of prairie grass and wildflower species at varied heights, with species ranging from short to tall. This profile creates a more diverse habitat, offering a variety of cover and food options for wildlife. This seed mix includes at least 6 of 7 native permanent grass and sedge species and 25 of 32 native forb species. Apply at 38.8 PLS pounds per acre.

BOTANICAL NAME	COMMON NAME	PLS OZ./ACRE
PERMANENT GRASSES		
Andropogon gerardii	Big Bluestem	18.00
Bouteloua curtipendula	Side-Oats Grama	8.00
Carex spp.	Prairie Sedge Mix	4.00
Elymus canadensis	Canada Wild Rye	24.00
Panicum virgatum	Switch Grass	4.00
Schizachyrium scoparium	Little Bluestem	20.00
Sorghastrum nutans	Indian Grass	20.00
	Total	**98.00**
TEMPORARY COVER		
Avena sativa	Common Oat	360.00
Lolium multiflorum	Annual Rye	100.00
	Total	**460.00**
FORBS		
Anemone cylindrica	Thimbleweed	0.50
Asclepias tuberosa	Butterfly Weed	1.25
Aster laevis	Smooth Blue Aster	0.75
Aster novae-angliae	New England Aster	0.25
Aster oolentangiensis	Sky-Blue Aster	0.25
Baptisia bracteata	Cream Wild indigo	0.50
Baptisia lactea	White Wild Indigo	2.00
Chamaecrista fasciculata	Partridge Pea	13.00
Coreopsis lanceolata	Sand Coreopsis	3.50
Coreopsis palmata	Prairie Coreopsis	0.75
Desmanthus illinoensis	Illinois Sensitive Plant	1.00
Desmodium illinoense	Illinois Tick Trefoil	0.50
Echinacea purpurea	Broad-Leaved Purple Coneflower	6.50
Eryngium yuccifolium	Rattlesnake Master	2.00
Lespedeza capitata	Round-Headed Bush Clover	2.00
Liatris aspera	Rough Blazing Star	2.00
Liatris pycnostachya	Prairie Blazing star	0.50
Lupinus perennis	Wild Lupine	1.25
Monarda fistulosa	Wild Bergamot	0.75
Parthenium integrifolium	Wild Quinine	1.00
Potentilla arguta	Prairie Cinquefoil	0.50
Pycnanthemum virginianum	Common Mountain Mint	0.50
Ratibida pinnata	Yellow Coneflower	3.50
Rudbeckia hirta	Black-Eyed Susan	5.00
Silphium integrifolium	Rosin Weed	3.00
Silphium laciniatum	Compass Plant	2.00
Silphium terebinthinaceum	Prairie Dock	4.00
Solidago nemoralis	Old-Field Goldenrod	0.25
Solidago rigida	Stiff Goldenrod	2.00
Solidago speciosa	Showy Goldenrod	0.50
Veronicastrum virginicum	Culver's Root	0.25
Zizia aptera	Heart-Leaved Meadow Parsnip	0.50
	Total	**62.25**

Black Hills Spruce

Black Hills Spruce *(Picea glauca var. densata)*

General Description

A large tree, very dense and pyramidal when young. Not as drought tolerant as Colorado Spruce. Black Hills Spruce is a naturally occurring variety of white spruce native to South Dakota. Better adapted than White Spruce (*Picea glauca*) which is native in the eastern United States, as far west as Minnesota. The largest spruce tree in North Dakota is 95 feet tall with a canopy spread of 42 feet.

Leaves and Buds

Bud Arrangement - Whorls.

Bud Color - Chestnut brown scales, blunt tips, not resinous.

Bud Size - Buds are about 1/4 inch long.

Leaf Type and Shape - Needles attached individually on peglike projections called sterigmata.

Leaf Margins - Quadrangular in cross-section.

Leaf Surface - Slightly glaucous, 2 to 3 stomatal lines above, 3 to 4 on lower surface.

Leaf Length - 1/3 to 3/4 inch.

Leaf Width - 1/16 inch needles.

Leaf Color - Variably green and glaucous.

Flowers and Fruits

Flower Type - Moneocious, separate male and female strobili.

Flower Color - Female strobili are greenish to purplish; male are tan to pale red.

Fruit Type - Cone length 1½ to 2 inches long. Cone scales have a rounded, smooth margin; small winged seed.

Fruit Color - Brown cones, tannish seeds.

Form

Growth Habit - Long stout branches from ground up form a broad pyramidal to conical crown, compact ascending branches, denser growth form than species.

Texture - Medium, summer and winter.

Crown Height - 30 to 60 feet.

Crown Width - 15 to 25 feet.

Bark Color - Ash brown, scaly or flaky bark.

Root System - Shallow, fibrous, and wide spreading.

Environmental Requirements

Soils

Soil Texture - Grows best on moist loams.

Soil pH - 4.0 to 7.5.

Windbreak Suitability Group - 1, 3, 4, 5.

Cold Hardiness

USDA Zone 2.

Water

Fairly drought resistant. Needs additional moisture during droughts.

Light

Full sun.

Uses

Conservation/Windbreaks

Medium to tall evergreen for farmstead and field windbreaks.

Wildlife

Browsed by mammals. Nesting site for birds. Makes a good winter cover.

Agroforestry Products

Wood - Used for dimension lumber, pulpwood and Christmas trees.

Urban/Recreational

Good yard or ornamental tree. Used singly or in group plantings in recreation areas and public grounds.

Cultivated Varieties

Dwarf Alberta Spruce (*Picea glauca* 'Conica') - Dwarf, compact form, very subject to winterburn and spider mites.

Related Species

Norway Spruce (*P. abies*)

Colorado Spruce (*P. pungens*)

Pests

Common diseases include Lirula needle blight. White spruce is less affected than Colorado Spruce by Rhizosphaera needle cast and Cytospora canker. Common insect pests include spider mite, spruce needle miner, pine needle scale, yellow-headed spruce sawfly, and aphids.

Scientific Name
Prunus pennsylvanica

NC STATE UNIVERSITY

Trees
Plant Fact Sheets
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Common Name
Fire cherry; Pin cherry

- **Hardiness Zones:** 3-7
- **Habit:** Deciduous
- **Growth Rate:** Rapid
- **Site Requirements:** Sun; range of soil types
- **Texture:** Medium
- **Form:** Shrubby tree; horizontal branches; rounded open crown
- **Height:** 25 to 40'
- **Width:** --
- **Leaf:** 3 to 4.5" alternate, simple leaves; maroon, red, or orange fall color
- **Flower/Fruit:** White flowers in spring; light red fruit with large stone in summer
- **Comments:** Native; fruit attracts birds; leaves are poisonous to livestock; does not tolerate shade
- **Cultivars:** --

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Natural Resources Conservation Service

Plant Guide

BLUE SPRUCE

Picea pungens Engelm.

Plant Symbol = PIPU

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate names

Colorado blue spruce, white spruce, silver spruce, Parry spruce, water spruce, *Picea parryana* Sargent

Uses

Blue spruce has been little used for lumber or wood products because it is rarely abundant in nature and the wood is brittle and often full of knots. It sometimes is cut with Engelmann spruce. Because of its cold hardiness, symmetrical pyramidal form, and waxy, blue-hued foliage, blue spruce is widely planted in ornamental and general landscape settings. Numerous horticultural cultivars have been developed, based on needle color and crown form. It is used considerably for Christmas trees and blue spruce plantations have been established in the northeastern US – these probably the source of

escapes reported for several states far from its native range (Maine, Massachusetts, New York, Pennsylvania, Maryland). Blue spruce is the state tree of Colorado and of Utah.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Pine Family (Pinaceae). Native trees growing to 50 meters tall, the crown long-conic; branches whorled, ascending to slightly to strongly drooping; twigs not pendent, stout, yellow-brown, usually without hair; many small twigs produced on the main trunk and between the main whorls of branches; bark relatively thick, gray-brown, breaking into furrows and rounded ridges, only slightly scaly. Needles are evergreen, borne singly and at right angles from all sides of the twig, 1.6-3 cm long, 4-angled, stiff and sharply spine-tipped, silvery to blue-green. Seed cones are green or violet, ripening pale buff, (5) 6-11 (12) cm long, ellipsoid, pendent, the scales elliptic to diamond-shaped, widest below middle, stiff at the base, the tip flexible, unevenly toothed, and extending 8-10 mm beyond seed-wing impression. The common name is based upon the blue foliage color of some races.

Variation within the species: trees with similar color tend to occur in small, local populations, suggesting that color traits are under genetic control. The color variation does not conform to a clinal pattern. Most other variable features in blue spruce (e.g., physiology, early survival, growth rate) similarly do not follow geographical parameters; date of bud set follows a local altitudinal pattern.

Besides features of habit, leaf color, and habitat, blue spruce is distinguished from Engelmann spruce by its cones and cone scales that average larger in size, but these characteristics are often partially or completely overlapping. Blue spruce also differs in its glabrous twigs.

Distribution
The native range of blue spruce is the central and southern Rocky Mountains of the USA – in Idaho, Wyoming, Utah, Colorado, New Mexico and Arizona. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Blue spruce commonly occurs on stream banks in moist canyon bottoms (hence one of its common names, water spruce) but may grow on gentle to steep mountain slopes in Douglas fir or spruce-fir woods up to timberline; at 1800-3000 meters elevation in mid-montane forests. It often grows with subalpine fir, white fir, and Engelmann spruce. It is cultivated on a wide variety of soils, except those that are very moist.

Establishment
Blue spruce begins to produce seed at about 20 years; maximum seed production occurs between 50-150 years. Good cone years occur at intervals of 2-3 years. Seed germination is mostly confined to exposed mineral soil with side shade and overhead light, but natural reproduction is scanty, probably because the light seeds are prevented from coming into contact with mineral soil by the dense herbage, grass, or other ground-cover vegetation that is usually abundant in the habitat of the species. Seedling establishment is probably benefited by moisture availability and shading, which prolong snow and soil moisture in late spring.

Blue spruce is a slow-growing tree and some individuals have been reported to live for more than 600 years. Reproduction by layering has not been reported for this species.

Management
Western spruce budworm larvae feed on old needles in late April, then mine developing buds and defoliate new tree growth. Heavy repeated attacks kill the tree.

Cultivars, Improved and Selected Materials (and area of origin)
These plant materials are readily available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under ”United States Government.” The Natural Resources Conservation Service will be listed under the subheading “Department of Agriculture.”

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Plant Guide

NORTHERN RED OAK

Quercus rubra L.

Plant Symbol = QURU

Contributed by: USDA NRCS National Plant Data Center and the Biota of North America Program

© Mike Hogan
Trees of Alabama and the Southeast
Auburn University

Alternate Names
Red oak, common red oak, eastern red oak, mountain red oak, gray oak

Uses
Industry: Northern red oak is an important source of hardwood lumber. The wood is close-grained, heavy, and hard; it machines well and accepts a variety of finishes. It is used for furniture, veneer, interior finishing, cabinets, paneling, and flooring as well as for agricultural implements, posts, and railway ties.

Wildlife: Northern red oak provides good cover and nesting sites (including cavities) for a wide variety of birds and mammals. Deer, elk, moose, and rabbits commonly browse leaves and young seedlings and the acorns are eaten by a wide variety of large and small mammals and birds.

Ethnobotanic: The acorns of red oak (and other oak species) were an important food source for Native Americans. To remove bitter tannins, they were boiled, leached with ashes, soaked for days in water, or buried over winter. Some tribes used red oak bark as a medicine for heart troubles and bronchial infections or as an astringent, disinfectant, and cleanser.

Conservation: Northern red oak is commonly planted as a landscape tree in eastern North America and Europe -- used as a shade tree on lawns, parks, campuses, golf courses, etc, where space is sufficient. It is fast growing, easy to transplant, tolerant of urban conditions (including dry and acidic soil and air pollution), the abundant nuts attract wildlife, and the leaves develop a brick-red fall color. It has been used in various rehabilitation projects, including revegetation of coal mine spoils in states of the east central United States (Ohio, Indiana, Illinois, Kentucky, and Pennsylvania).

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Beech Family (Fagaceae). Native trees often reaching 20–30 m tall, less commonly up to 50 m; bark dark gray or black, shallowly furrowed into broad hard scaly ridges, inner bark reddish to pink; generally developing a strong taproot and network of deep, spreading laterals. Leaves are deciduous, alternate, elliptic, 10–25 cm long and 8–15 cm wide, divided less than halfway to midvein into 7–11 shallow wavy lobes with a few irregular bristle-tipped teeth, sinuses usually extending less than 1/2 distance to midrib, glabrous and dull green above, light dull green below with tufts of hairs in vein angles. Male and female flowers are borne in separate catkins on the same tree (the species monoecious), the staminate catkins in leaf axils of the previous year's growth, the pistillate in 2–many-flowered spikes in the leaf axils. Acorns maturing in the second year, about 15–30 cm long, with a broad usually shallow cup, borne singly or in clusters of 2–5. The common name is in reference to the red fall foliage color, red petioles, and reddish interior wood. This is a different species from "southern red oak" (*Q. falcata*).

Northern red oak is a member of the red oak subgroup (subg. *Erythrobalanus* = sect. *Lobatae*). It hybridizes with related species, including scarlet oak (*Q. coccinea*), northern pin oak (*Q. ellipsoidalis*), shingle oak (*Q. imbricata*), scrub oak (*Q. ilicifolia*), blackjack oak (*Q. marilandica*), swamp oak (*Q. palustris*), willow oak (*Q. phellos*), Shumard oak (*Q. shumardii*), and black oak (*Q. velutina*).

Variation within the species: There are different interpretations of variation patterns among trees of northern red oak. A single species without formally variants is sometimes recognized, or two varieties may be recognized.

Quercus rubra var. *ambigua* (A. Gray) Fernald
SY= *Q. borealis* Michx. f.
SY= *Q. rubra* var. *borealis* (Michx. f.) Farw.

Quercus rubra var. *rubra*
SY= *Q. maxima* (Marsh.) Ashe
SY= *Q. borealis* var. *maxima* (Marsh.) Ashe

Var. *rubra* has a shallow cup, to 3 cm wide, enclosing 1/4–1/5 of the nut. Var. *ambigua* has a deeper cup, to 2 cm wide, enclosing 1/3 of the nut. McDougal and Parks (1984, 1986) found evidence of correspondence between morphological types and flavonoid chemotypes but the evolutionary status and geographic distribution of these have not been worked out in detail.

Distribution
Northern red oak is widely distributed throughout much of the eastern United States and southeastern Canada. It grows from Quebec, Ontario, Nova Scotia, and New Brunswick southward to southwestern Georgia, Alabama, northern Mississippi, northern Arkansas, and eastern Oklahoma. Northern red oak extends westward through Minnesota and Iowa, south through eastern Nebraska and Kansas to eastern Oklahoma. It occurs locally in eastern and southwestern Louisiana and western Mississippi. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment
Adaptation: Northern red oak commonly grows on mesic slopes and well-drained uplands, less commonly on dry slopes or poorly drained uplands, at (0-) 150–1800 meters in elevation. It typically grows on lower and middle slopes, in coves, ravines, and on valley floors, most commonly on N- and E-facing slopes and on clay, loam, and sandy or gravelly soils. Best growth is in full sun and well drained, slightly acidic, sandy loam. It occurs as a dominant in many natural communities, including mixed mesophytic and pine-oak.

Northern red oak is intermediate in shade tolerance but generally unable to establish beneath its own canopy. Seedlings usually do not reach sapling or pole size unless gaps are created in the canopy. Northern red oak is often replaced by more shade-tolerant species such as sugar maple and American basswood.

Flowering occurs in April–May, during or before leaf development, while fruiting (August–) September–October.

General: Northern red oak generally first bears fruit at about 20–25 years, although most trees do not produce acorns in abundance until 40–50 years. Good crops are produced every 2–5 years. In most years, birds, mammals, and insects commonly destroy up to 80% of the crop and nearly the entire crop can be eliminated in poor years. Seeds on the soil surface are particularly vulnerable to rodent predation, and germination frequencies are much higher when a layer of leaf litter covers acorns. Under natural conditions, acorns generally germinate in the spring after over-wintering breaks dormancy.

Germination and seedling establishment may be successful in full and partial shade, but early growth is reduced by shade, poor soil, and competing herbaceous vegetation. Seedlings in mature stands may be present in large number, but few survive more than a few years or grow to more than 15–20 cm in height. Under optimal conditions, northern red oak is fast growing and trees may live up to 500 years.

Seedlings, saplings, and small poles of northern red oak can sprout if cut or burned. Although young oaks typically stump sprout readily, older and larger individuals also may sprout.

Management
The tight, relatively thin bark of northern red oak makes the trees more susceptible to fire damage than in species of oak with rougher, corkier bark. Apart from immediate mortality, damaged basal cambial tissue permits the entry of insects and heart-rot decay that may ultimately kill the tree. Even so, northern red oak is adapted to periodic fire, which is integrally associated with oak forests. Older, larger individuals often survive fire and seedlings, saplings, and pole-sized individuals commonly sprout vigorously from the stumps or root collar after being top-killed by fire. Increased fire suppression has favored more shade-tolerant hardwoods and resulted in a decrease in oaks.

Acorns can maintain viability in controlled storage for up to 2–3 years. They should be stratified at 1-3° C for several months; those from northern populations require the longer period. Growth is best

when sown as soon as ripe into permanent position or in an outdoor seedbed protected from predation. Cuttings obtained from young trees can be rooted if treated with hormones. Transplants of bare root stock are best done in spring. Because of its usefulness and popularity, northern red oak is commonly available in ball-and-burlap and in containers.

The gypsy moth and numerous other insects can attack northern red oak, occasionally causing serious damage. Numerous caterpillars enjoy oak foliage, but feeding damage is usually not severe. Oak decline is a serious disease of northern red oak and has affected the species throughout much of the central Appalachian region.

Oak wilt

Northern red oak is susceptible to oak wilt, a fungal disease that invades the water-conducting vessels and plugs them. As water movement is slowed, the leaves wilt and rapidly drop off the tree. The disease begins with a crinkling and paling of the leaves, followed by wilting and browning from the margins inward. Necrosis may be strongest along the veins or between them. The symptoms move down branches toward the center of the tree and the tree may die within 1–3 months, although some diseased trees may survive up to a year. The disease may be spread by insects (primarily beetles) or pruning tools, but most of the tree loss in oak wilt centers results from transmission through root spread between adjoining trees. A trench (dug and then immediately filled) between neighboring trees severs the roots and prevents fungus spread. Dead and infected trees must be destroyed – once a tree has become infected, there is little chance to save it. The wood may be used for firewood provided it is debarked or covered and sealed during the spring and summer (Johnson and Appel 2000; Roberts 2000; Wisconsin Dept. of Natural Resources 2000; City of Austin 2000).

This disease most seriously infects species of the red oak group (including black and live oaks). Overcup oak, bur oak, white oak, and other members of the white oak group are not as susceptible and can be planted in oak wilt centers. Oak wilt has reached epidemic proportions in Texas and in the mid-West from Iowa and Minnesota through Michigan and Wisconsin into Ohio, West Virginia, and Pennsylvania.

Cultivars, Improved and Selected Materials (and area of origin)

These plant materials are somewhat available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Revised: 19jun02 jsp; 29may03 ahv; 060809 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
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Plant Guide

COMMON ELDERBERRY

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli

Plant Symbol = SANIC4

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Botany Dept., NMNH, Smithsonian Institution
@ PLANTS

Alternate Names

Arizona elderberry, American elder, sweet elder, wild elder, flor sauco, tree of music, Danewort, Walewort, New Mexican elderberry, velvet-leaf elder, hairy blue elderberry, and dwarf elder. Taxonomically, there have been recent changes in this elderberry species. It was previously divided into *Sambucus coriacea*, *Sambucus orbiculata*, *Sambucus velutina*, and *Sambucus caerulea* (Munz 1968). This species is known in some floras as *Sambucus mexicana*.

Uses

Ethnobotanic: Only the blue or purple berries of elderberry are edible. Edible berries and flower are used for medicine, dyes for basketry, arrow shafts, flute, whistles, clapper sticks, and folk medicine. The active alkaloids in elderberry plants are hydrocyanic acid and sambucine. Both alkaloids will cause nausea so care should be observed with this plant. Elderberries are high in Vitamin C. The red berries of other species are toxic and should not be gathered.

The wood is hard and has been used for combs, spindles, and pegs, and the hollow stems have been fashioned into flutes and blowguns.

Elderberries are quite edible. The blue or purple berries are gathered and made into elderberry wine, jam, syrup, and pies. The entire flower cluster can be dipped in batter and fried while petals can be eaten raw or made into a fragrant and tasty tea. The flowers add an aromatic flavor and lightness to pancakes or fritters.

The elderberry is of well-known value to the Indians of North America and the many purposes it serves (Barrow 1967). Elderberry is highly prized by both Spaniards and Cahuillas. Throughout the months of July and August the small clusters of berries are gathered in large quantities. These clusters are dried carefully on the drying floor and preserved in considerable amounts. When wanted, they are cooked into a rich sauce that needs no sweetening. A Cahuilla family during this season of the year will subsist largely on these messes of "sauco." Frequently, the elderberry was so greatly enjoyed that families would live for weeks on little else. Many were dried for use in the winter, and were either re-cooked or eaten raw. Elderberries are still highly prized for food by modern Indian people.

Elderberry twigs and fruit are employed in creating dyes for basketry. These stems are dyed a very deep black by soaking them for a week or so in a wash made from the berry stems of the elderberry (Barrows 1967). The Cahuilla split basketry materials from the aromatic sumac (*Rhus trilobata*).

Elderberry branches were used to make the shaft of arrows. Flutes and whistles were constructed by boring holes into stems hollowed out with hot sticks. Clapper sticks were made by splitting the stem and clapping the two halves against each other. Clapper sticks were used ceremonially in the round-house to accompany singing and dancing. The pith of the stems was used as tinder, and the stem itself was employed as a twirling stick for starting the fire. Hollowed-out elderberry stems can be made into squirt guns.

In the middle ages elderberry was considered a Holy Tree, capable of restoring good health, keeping good health, and as an aid to longevity.

Fruits of elderberry are gathered from the wild for wine, jellies, candy, pies, and sauces. The plants are commercially cultivated for fruit production in

Oregon. *Sambucus canadensis* and *S. nigra* have long been used in the same way, and cultivars of both have been developed. All parts of the elderberry plant are considered to be a valuable healing plant in many folk medicine traditions (Hutchens 1991, Walker et al. 1993; Barrett et al. 1933; Clarke 1977). Elderberry flowers contain flavenoids and rutin, which are known to improve immune function, particularly in combination with vitamin "C." The flowers also contain tannins, which account for its traditional use to reduce bleeding, diarrhea, and congestion.

The flowers are the mildest part of the plant and prepared as a tea, are used to break dry fevers and stimulate perspiration, aid headache, indigestion, twitching eyes, dropsy, rheumatism, appendix inflammation, bladder or kidney infections, colds, influenza, consumption (bleeding in lungs), and is helpful to newborn babies (Hutchens 1991). Used as a wash, the flowers or leaves are good for wounds, sprains, and bruises, as well as for sores on domestic animals. The leaves, which are stronger, have a slightly laxative property. Applied externally, leaves, flowers, bark and twigs are excellent as a poultice, mixed equally with chamomile, for soreness, inflammations, joint stiffness, and to reduce the swelling of bee stings. The flowers and berries, employed as a diuretic, can aid arthritis and rheumatism. Steeped in water, the flowers are used externally to aid in complexion beauty, tone and soften the skin, and lighten freckles or spots. The berry juice made into salve aids burns and scalds. The juice taken internally will act as a purgative.

Livestock: Elderberry is a useful range plant for domestic livestock, but is not equally palatable during all seasons. It is usually receives limited browsing in the spring and to a much greater extent in the late summer and fall. The leaves are eagerly devoured after the first heavy frost in the fall. Because many branches are beyond the reach of the animals, utilization is less destructive. Browse rating: Good for goats; good to fair for sheep; good to poor for deer; fair for cattle; and fair to poor for horses (Sampson and Jesperson 1981).

Wildlife: Structurally complex riparian vegetation communities provide many different habitats and support a diverse array of animal species. Different groups of animals occupy or use the different layers of vegetation, and this multi-story arrangement is often present nowhere else in the arid landscapes. Canopies of plants growing on stream banks provide shade, cooling stream water, while roots stabilize and create overhanging banks, providing habitat for fish and other aquatic organisms.

Game birds, squirrels and other rodents, and several kinds of browsers also feed on the fruit or foliage of elderberry. Bears love to eat the elderberry fruits while deer, elk, and moose browse on the stems and foliage. The elderberries are important sources of summer food for many kinds of songbirds. For example, the western bluebird, indigo bunting, common house finch, red-shafted flicker, ash-throated flycatcher, black-headed grosbeak, scrub jay, Stellar jay, ruby-crowned kinglet, mockingbird, red-breasted nuthatch, Bullock's oriole, hooded oriole, song sparrow, white-crowned sparrow, western tanager, California thrasher, russet-backed thrush, brown towhee, Audubon warbler, cedar waxwing, Lewis and Nuttall's woodpecker, wren-tit, grouse, pheasant, and pigeons all eat elderberries (Martin et al. 1951).

The valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*) was listed as threatened under The Endangered Species Act on August 8, 1980. The elderberry beetle is endemic to moist valley oak riparian woodlands along the margins of rivers and streams in the lower Sacramento and upper San Joaquin Valley of California where elderberry grows. The primary threat to the VELB is loss of habitat, insecticide and herbicide use, and lack of elderberry shrubs/trees as a food plant for the beetle. The mitigation for VELB habitat loss, considered a taking under The Endangered Species Act, is quite stringent (U.S. Fish and Wildlife Service Mitigation Guidelines).

In general, longhorn beetles are characterized by somewhat elongate and cylindrical bodies with long antennae, often in excess of 2/3 of the body length. Male VELB have a metallic-green pattern of 4 oblong maculations, surrounded by a bright red-orange border. The body length is about 13-21 mm, and antennae are about a long as the body. Females are more robust, with body length about 18-25 mm, and the dark pattern is not reduced.

Elderberry is planted because of its forage and cover value, productivity, adaptability, and ease of establishment. It is a useful ground cover for stabilizing streambanks and eroding sites. It provides food, cover, perching, and nesting sites for many species of birds and food and cover for various other wildlife, and it is important as browse for mule deer and elk. In the spring the leaves may be strongly scented and less palatable, but they sweeten and become more palatable by fall.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, wetland indicator values.

Description
General: Honeysuckle family (*Caprifoliaceae*). Native shrubs growing 2-4(-8) m tall, less commonly small single-stemmed trees, young twigs soft and pithy but the wood hard; bark thin, grayish to dark brown, irregularly furrowed and ridged. The pinnately compound leaves are deciduous, opposite, about 15-35 cm long, odd-pinnate with (3-)5-9 serrate leaflets 2-15 cm long, often with a long stalk, often asymmetrical at the base. Elderberry leaves, especially on seedlings or shrub-sized plants (without fruits or flowers) resemble California walnut (*Juglans hindsii*) and Oregon ash (*Fraxinus latifolia*). The inflorescence is flat-topped, 4-20(-30) cm across, broader than high; flowers bisexual, the corollas small, white to cream, rotate, 5-lobed, with a pleasant, yet slightly rancid odor. Fruit is berry-like, 5-6 mm wide, with 3-5 nutlets, blue- to purple-black at maturity with a white-waxy bloom and appearing powder blue. The common name "elder" is from the Anglo-Saxon "ellen," meaning fire-kindler, the dry, pithy stems; blue from the fruit color.

Distribution: Common elderberry is common along stream banks, river banks, and open places in riparian areas lower than < 3000 m. From west Texas north to Montana, western Alberta, and southern British Columbia, and all other western states, south into northwest Mexico. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat
Elderberry grows on moist, well-drained sunny sites, usually occurring in early seral communities or in openings in moist forest habitats (slopes, canyons, cliff bases, streamsides, streambanks) and moist areas within drier, more open habitats (sagebrush, mountain brush, pinyon-juniper, ponderosa pine, often along fence rows and roads); at elevations of 3-3000 meters.

Adaption
Elderberry is a dominant understory species in riparian woodlands. It can persist past seral stages as scattered individuals in open forests, woodlands, chaparral, or riparian zones. This species flowers from May to September and fruits from July to October. Common elderberry is more common on warmer sites than red elderberry (*Sambucus racemosa*), although they overlap in habitat preference.

In California, common riparian woodland associates are valley oak (*Quercus lobata*), interior live oak (*Quercus wislizenii*), California walnut (*Juglans hindsii*), and California sycamore (*Platanus racemosa*). Box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), alder (*Alnus rhombifolia*), and willow (*Salix gooddingii, Salix exigua, Salix lasiandra, and Salix laevigata*) are particularly prevalent in the subcanopy. Understory species are mostly shrubs, including elderberry (*Sambucus mexicana)*, buttonbush (*Cephalanthus occidentalis)*, blackberry (*Rubus* spp.), and California rose (*Rosa californica*). Lianas, such as poison oak (*Toxicodendron diversiloba*) and California grape (*Vitis californica*) are a dominant feature. Herbaceous vegetation is 1% cover except in openings where tall forbs may occur.

Establishment
Elderberry produces a good seed crop almost every year. The seeds are dispersed by birds and other animals that eat the fruit. The seeds have a hard seed coat and embryo dormancy and may remain viable for up to 16 years in storage. Without pretreatment, seed germination may be delayed from 2 to 5 years after planting. Plants may flower and fruit after only 2-3 years and can reach full size in 3-4 years. They are said to be "short-lived." Vegetative reproduction is limited to coppicing if the stems are killed or injured.

Management
In six riparian restoration projects carried out in California, competition from exotic weed species was a key factor in mortality and site failure (Baird 1989). On small sites, hand weeding around trees and shrubs is the most effective means of weed control. One way to avoid competition from weeds on larger sites is to remove the surface soil, although this has the disadvantage of removing nutrients, mycorrhizal fungi, bacteria, and insect and invertebrate populations critical to a healthy habitat. A cover crop of native wildflowers was also used to control weeds, with wildflower seeds hand-broadcast over the site. On wetter, heavier soils this does not seem to provide effective weed control.

There is considerable evidence that fertilization can favor exotic weeds over native plants. Inoculation with mycorrhizal fungi enables seedlings of some species to better utilize limited supplies of both water and nutrients. Inoculation of transplanted shrubs may be accomplished through inclusion of large (1.2 m

deep by 2.8 m wide) root balls with plants. Smaller, more economical soil plugs scattered throughout the site serve the same purpose. The number of soil plugs needed to ensure the establishment of soil flora is directly related to the distance of the restoration site from a similar, mature community.

Given that elderberry provides habitat for the federally listed valley longhorn elderberry beetle, livestock grazing of elderberry is not recommended. Livestock grazing can alter vegetative structure and composition of riparian habitat. Overgrazing by livestock and big game frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production.

Seed and Plant Production

Seeds:

- Elderberry grows best from seed.
- Elderberry fruits are collected when ripe and spread in thin layers to dry.
- To separate seeds from fruits either 1)run fruit through a macerator with water and the pulp and empty seeds float; 2) crush, dry and use without separating fruits and seeds; and 3) for small amounts of fruit they can be cleaned in a fruit blender.
- Elderberry seed can be stored dry at 41 °F for several years.
- Elderberry seeds can be sown in the fall soon after collection, or stratified and sown in the spring. In either case, germination is often not complete until the second spring.
- A seedling density of 35 plants per square foot is sought. Seeds are sown 1/4 inch deep in drills and covered with about 3/8 inch of sawdust mulch.
- In the greenhouse, seeds are warm stratified for two months in a mixture of peat, vermiculite, and sand at 21° to 30°C; (70 to 85°F). Seeds are then placed close to the soil surface in flats in the greenhouse. There are usually several hundred seeds in one seed flat.
- Seedlings are then potted from the flats in deep 3" pots.
- After one season of growth, the seedlings are field planted in the fall or spring when they are 6 to 8 months old. If planted in the fall irrigation may not be necessary in moist sites. In drier sites or with spring planting, irrigation will be required for seedling establishment.

Cuttings:

- Cuttings of elderberry tend to have lower survival success than establishment from seed.
- Use hardwood cuttings from previous seasons growth.
- Take "heel cuttings" from older wood, so inner pith is not exposed.
- Cuttings should be at least 10", and have at least two nodes. Cuttings are placed in 4" pots with perlite and peat. Plants are kept moist.
- Cuttings have a fragile root system, with high mortality occurring when transplanted. Care should be taken to be very gentle with delicate roots when transplanting.
- The cuttings, which do survive, seem to establish and grow faster. Plant biomass production, height, flowering and seed set is more rapid than with seedlings.

Transplanting Trees and Stems:

- All elderberry plants with evidence of valley elderberry longhorn beetle use (i.e. emergence holes or presence of adults) should be transplanted, as they provide habitat for a threatened species under The Endangered Species Act. For further technical information, call a representative of the U.S. Fish and Wildlife Service.
- Cut tree back to 3 to 6 feet from the ground or to 50 percent of its height (whichever is greater) by removing branches and stems above this height. The trunk and all stems greater than 1.5 inches in diameter can be replanted.
- If the presence of tunnels excavated by the beetle larvae inside the elderberry stem and trunk are detected, place pruned material next to transplanted elderberries.
- Move plant by the root ball. Keep the root ball wet.
- Place transplant in holes 3 to 4 feet deep.
- Construct circular water retention basin from the excavated earth about 8-10 feet in diameter and 12 to 14 inches high. Plant the main trunk of an elderberry in the center of each water basin. Plant other stems that have been rooted around the circumference of the basin.
- Saturate soil with water. Irrigate as necessary, especially through first growing season.

Clear-cutting or seed tree cutting with high soil disturbance sometimes favors the development of elderberry in a seral community. It recovers well from heavy grazing in the Great Basin. For use in site stabilization or rehabilitation, seeds may be planted directly or seedlings and 1-2-year old stock may be transplanted. It also grows from transplanted seedlings, cuttings, and rootstocks.

Elderberry usually is not present in the understory of closed-canopy forests, and when fire occurs in these, regeneration occurs from seed banks that may occur between 2-10 cm deep in the soil, the seeds deposited from off-site dispersal or from plants of an earlier community. Fire scarifies the hard seed coat of buried seeds and stimulates their germination, which usually occurs the first growing season after the fire. Subsequent burns may eliminate elderberry since it spreads slowly by seed. Fire kills above-ground parts but the root crown may sprout but a severe fire can kill the root and stem buds from which sprouting occurs.

Cultivars, Improved and Selected Materials (and area of origin)

These plant materials are somewhat available from commercial sources. Vintage Germplasm was released through the USDA-NRCS Plant Materials Program in 2010. Vintage Germplasm is a selected class release that was evaluated for characteristics important to conservation uses, including stem production, plant height, fruit production and ability to regrow after cutting. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Citation

Stevens, M. 2001. Plant Guide for common elderberry (*Sambucus nigra* L. ssp. *Canadensis* (L.) R. Bolli.USDA-National Resources Conservation Service, National Plant Data Center, Baton Rouge, LA.

Edited 03apr01 jsp; 03jun03 ahv; 02sep,2010, jwl,060816 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

LILAC

Syringa vulgaris L.

Plant Symbol = SYVU

Contributed by: USDA NRCS National Plant Data Center

Conservation Trees & Shrubs for Montana
USDA, NRCS, Montana State Office

Alternative Name
common lilac

Uses
Economic: A green dye is obtained from the flowers and the leaves and a yellow-orange dye is obtained from the twigs (Grae 1974). An essential oil is obtained from the flowers and used in perfume fragrances.

Ethnobotanic: The bark and leaves has been chewed as a treatment for sore mouth (Moerman 1998).

Status
Please consult the Plants Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Olive Family (Oleaceae). Lilac is an introduced, perennial, deciduous shrub that grows between twelve to sixteen feet tall. The leaves are simple, ovate to broadly ovate, and five to twelve centimeters long. The flowers are mostly white, lilac, or purple, pleasantly fragrant in long terminal panicles (Copperrider 1995). The fruiting capsules are one to 1.5 centimeters long, with flat winged seeds (Bruggen 1976).

Distribution: Common lilac is native of Europe, introduced and naturalized in the United States, escapes from cultivation from New York to North Dakota, south to Georgia and Kansas (Steyermark 1963). For current distribution, please consult the Plant profile page for this species on the PLANTS Web site.

Adaptation
Lilac is easily grown on most soil types but prefers neutral to slightly acid soil. This species does not tolerate poorly drained soils. It performs best in a warm sunny position.

Establishment
Propagation by Seed: Lilac seeds should be sown in March, or as soon as they are ripe, in a cold frame. The seeds should be pre-treated for four weeks of warm stratification and then three weeks cold stratification to improve germination. Place the seedlings into individual pots when they are large enough to handle. If sufficient growth is made by the summer it is possible to out-plant otherwise grow seedlings in a cold frame for the first winter and out-plant in late spring the next year.

Management
Common lilac should be planted in areas with good air circulation to reduce problems with powdery mildew. The first year after planting, *Syringa vulgaris* will probably not produce many, if any blooms; only after it has adapted itself to its new surroundings will it begin to produce flower clusters with vigor. Pruning should be done yearly to maintain desired height and improve form.

Cultivars, Improved and Selected Materials (and area of origin)
Commonly available through commercial nurseries. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Sedge Meadow

Designed for level sites with saturated soil conditions, although it will tolerate drier soils late in the year. It creates a diverse habitat, offering a variety of cover and food options for wildlife. Many species attract butterflies, and some attract hummingbirds. This seed mix includes at least 13 of 17 native permanent grass, sedge, and rush species and 27 of 30 native forb and shrub species. Apply at 39.8 PLS pounds per acre.

BOTANICAL NAME	COMMON NAME	PLS OZ./ACRE
PERMANENT GRASSES		
Calamagrostis canadensis	Bluejoint Grass	1.00
Carex comosa	Bristly Sedge	2.00
Carex cristatella	Crested Oval Sedge	2.00
Carex frankii	Bristly Cattail Sedge	1.50
Carex lupulina	Common Hop Sedge	2.50
Carex lurida	Bottlebrush Sedge	4.00
Carex stipata	Common Fox Sedge	1.00
Carex vulpinoidea	Brown Fox Sedge	4.00
Elymus virginicus	Virginia Wild Rye	30.00
Glyceria striata	Fowl Manna Grass	0.50
Juncus effusus	Common Rush	0.25
Leersia oryzoides	Rice Cut Grass	1.25
Panicum virgatum	Switch Grass	1.50
Scirpus atrovirens	Dark Green Rush	0.75
Scirpus pendulus	Red Bulrush	0.25
Scirpus validus	Great Bulrush	1.00
Spartina pectinata	Prairie Cord Grass	2.00
	Total	**55.50**
TEMPORARY COVER		
Avena sativa	Common Oat	540.00
FORBS		
Alisma spp.	Water Plantain Mix	2.00
Angelica atropurpurea	Great Angelica	4.00
Asclepias incarnata	Swamp Milkweed	1.00
Aster novae-angliae	New England Aster	0.50
Aster puniceus	Bristly Aster	1.00
Aster umbellatus	Flat-Top Aster	0.25
Bidens cernua	Nodding Bur Marigold	2.00
Coreopsis tripteris	Tall Coreopsis	2.00
Eupatorium maculatum	Spotted Joe-Pye Weed	1.00
Eupatorium perfoliatum	Common Boneset	0.50
Helenium autumnale	Sneezeweed	2.00
Hibiscus laevis	Smooth Rose Mallow	2.00
Iris virginica	Blue Flag	3.00
Liatris spicata	Marsh Blazing Star	2.00
Lobelia cardinalis	Cardinal Flower	0.25
Lobelia siphilitica	Great Blue Lobelia	2.00
Lycopus americanus	Common Water Horehound	0.25
Penthorum sedoides	Ditch Stonecrop	0.50
Physostegia virginiana	Obedient Plant	0.25
Polygonum spp.	Pinkweed Mix	0.50
Pycnanthemum virginianum	Common Mountain Mint	0.50
Sagittaria latifolia	Common Arrowhead	1.00
Senna hebecarpa	Wild Senna	0.75
Silphium perfoliatum	Cup Plant	3.00
Sparganium eurycarpum	Common Bur Reed	4.00
Spiraea alba	Meadowsweet	0.25
Thalictrum dasycarpum	Purple Meadow Rue	1.50
Verbena hastata	Blue Vervain	2.00
Vernonia spp.	Ironweed Mix	1.00
Zizia aurea	Golden Alexanders	1.00
	Total	**42.00**

Established Sedge Meadow Mix

Lobelia cardinalis, Cardinal Flower

Zizia aurea, Golden Alexanders

For current pricing, availability, and information on our full installation and management services, visit **www.cardnojfnew.com/nursery.**

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

BASSWOOD
Tilia americana L.
Plant Symbol = TIAM

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Linn, American linden, white basswood (var. *heterophylla*), American basswood

Uses
Ethnobotanic: Native Americans and settlers used the fibrous inner bark ("bast") as a source of fiber for rope, mats, fish nets, and baskets. Basswood is still valued for its soft, light, easily worked wood, especially for turned items and hand carving. It once was the material of choice for prosthetic limbs, but these are now made from synthetics. Other uses have included boxes, toys, woodenware, drawing boards, veneer, venetian blinds, excelsior, and pulp.

Native Americans used fresh basswood sap, which contains moderate amounts of sugar, as a watery drink or boiled it into syrup. They also ate young basswood leaves and used the cambium for soups and breads. Various medicinal uses were made of leaf and bark extracts, and Iroquois used freshly cut bark as an emergency bandage for wounds.

Wildlife: Basswood is good browse and buds are important for birds and deer in winter. Fruits are eaten by birds and small mammals. The wood decays easily and produces many cavities (especially in trees past 120 years of age), which are used by cavity-nesting animals (wood ducks, pileated woodpeckers, other birds, and small mammals). Basswood is a prolific nectar producer and pollination by honeybees results in a choice grade of honey.

Restoration: Basswood is planted as a shade tree or ornamental. For sites of smaller size or with compacted soils, other *Tilia* species may be more suitable. Basswood is said to be a soil-enriching species, bringing calcium and magnesium up from deep in the soil profile and depositing it in leaf litter on the surface.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Basswood family (Tiliaceae). Native, large deciduous trees, the bark gray and furrowed with flat ridges. Leaves deciduous, alternate, more or less unevenly heart-shaped or the base often nearly truncate, petiolate, the blades 5-12.5 cm wide, thick and slightly leathery, with shallowly toothed margins, glabrous on both sides or with some pubescence on the lower surface. Flowers yellowish-white, 10-14 mm broad, fragrant and nectar-bearing, in drooping, 6-20-flowered clusters hanging on a stalk that diverges from near the center of an oblong, leaflike and strongly veined bract 5-10 cm long. Fruits mostly globose, 8-10 mm broad, hard and dry, indehiscent. The common name is from "bastwood," referring to use of the inner bark, the "bast," for rope, baskets, etc.

Variation within the species:
North American basswoods have been separated into many species (usually three or four) or treated as

several varieties within only a single species. "Given the inconstancy of most vegetative and reproductive characters [of North American basswood], the ecophenic, ecotypic, and seasonal variation in vestiture, and also the probability of introgression," trichome morphology provides the best evidence for recognizing the component taxa (see Hardin 1990).

a. *Tilia americana* var. *americana*
synonym: *Tilia neglecta* Spach
b. *Tilia americana* var. *heterophylla* (Vent.) Loud.
synonym: *Tilia heterophylla* Vent.
synonym: *Tilia michauxii* Nutt.
c. *Tilia americana* var. *caroliniana* (P. Mill.) Castigl.
synonym: *Tilia caroliniana* P. Mill.
synonym: *Tilia floridana* Small

The varieties of *Tilia americana* intergrade, but in their typical forms are separated as follows:

a. Leaves green beneath, sometimes glaucous, glabrous or sparsely hairy with simple trichomes, sometimes with a few stellate ones. var. *americana*
a. Leaves pale or whitish beneath from the close tomentum of dense, sessile-stellate trichomes, sometimes glabrate with age but remaining stellate-pubescent at least along the major veins. (b)

b. Young twigs tomentose or tomentose-hirsute; clusters of hairs on leaves more than 0.5 mm wide. var. *caroliniana*
b. Young twigs glabrous; clusters of hairs on leaves less than 0.5 mm wide. var. *heterophylla*

Trees identified as *Tilia neglecta* may be variants of var. *americana* or they have been suggested to be introgressants between var. *americana* and var. *heterophylla*. *Tilia floridana* is often recognized as separate entity.

Distribution: *Tilia americana* is native to the Northern Deciduous and Great Lakes - St. Lawrence forest regions of North America. It also extends into grassland areas along river courses in Manitoba and the mid-western United States, where it forms a component of riverine gallery forests. In Canada, it is found from western New Brunswick into southern and central Québec and Ontario, extending as far west as north-western Ontario (along the U.S. border) and southern Manitoba. In the United States, the species occurs as far south as the mountainous regions of North Carolina, Tennessee, and northern Arkansas. The western limit for the species is south-central Manitoba and North Dakota, and along the Niobrara River in north-central Nebraska. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Basswood occurs on rich, mesic sites (coves, lower slopes, river bottoms), usually on deep, well-drained soils. It rarely occurs in pure stands but is usually mixed with other forest species. Var. *americana* is codominant in the sugar maple-basswood cover type and all varieties are a common component of many other rich forests. Basswood occurs up to 1500 meters elevation in the southern Appalachian Mountains. Flowering May-June (-July), usually 1-4 weeks after the leaves appear in mid-May. Seeds are dispersed in October.

Establishment
Seed production begins in basswoods about 15 years old (or as early as 8 years) and continues until the trees reach at least 100 years. Heavy seed crops are irregular but good quantities of seed are produced at 1- to 3-year intervals. Germination in the first year or two is often poor, apparently because of an impermeable testa, but seeds may remain dormant and viable in seed banks for up to three years. Few established seedlings are found where the species forms a major component of the canopy, apparently because seedling loss from herbivory by rabbits and deer.

Seedlings can establish in as little as 25% of full sunlight, but heavy shade limits subsequent growth and development. Seedling growth begins slowly, but established young trees are fairly fast-growing. The typical life of a basswood is about 100 years but some are known to live 140-200 years.

Basswood stump sprouts are often very common, and this may produce trees growing in close clusters. Stump sprouts arise from the main stem after its death, fire or logging injury, or aging, or even after disturbance of the surrounding stand. Almost all basswoods 10 cm or less d.b.h. will sprout from the stump, and sprouts have been obtained from basswoods over 100 years old.

Management
Basswood stump sprouts can be managed for saw timber. The number of sprouts declines with the age and size of the cut trees. Since sprouts originating at or below the ground line are more resistant to butt rot, stumps should be cut very close to the ground or burned. Early thinning of sprouts is needed to ensure good quality and rapid growth.

Over-browsing by high densities of white-tailed deer can result in basswood seedling height growth reduction or even complete loss of basswood from

the stand. Mice and voles on oldfield sites may often girdle the stems, and rabbits also feed heavily on seedlings and small saplings. Seed predators include mice, squirrels, and chipmunks. Basswood is easily decayed by fungi, and butt rot is an important factor in loss of merchantable timber.

Basswood is most common in forests with long fire-free intervals, because the thin bark and shallow roots are easily damaged by fire and basal fire wounds increase susceptibility to butt rot. Prescribed fire is not recommended for established stands of hardwoods in which basswood occurs, as too-frequent fire intervals eliminate basswood or restrict it to the most mesic sites. In some places, however, these trees are encroaching onto former grasslands since fires have been suppressed.

Cultivars, Improved and Selected Materials (and area of origin)

These plant materials are readily available from commercial sources. Cultivars of *Tilia americana* have been selected for mature shape, fall leaf color, and rust resistance. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
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Natural Resources Conservation Service

Plant Guide

ARROWWOOD VIBURNUM

Viburnum dentatum L.

Plant Symbol = VIDE

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Southern arrow-wood, roughish arrow-wood, southern arrowwood

Uses
The dense foliage, white flower clusters, and dark blue berries make arrow-wood viburnum an attractive shrub for landscaping. Various cultivars have been selected for hardiness, shape of the plant, fall foliage color (yellow or red to reddish purple), and abundance of fruit. They can be used for borders or screens or as mass plantings and groupings to attract birds, which eat the fruit. Cultivars have been selected for characteristics of the foliage, compactness of habit, flowering time, and persistence of fruits. Many species of *Viburnum* are cultivated (see Dirr 1997 and Floraguide 2000).

Viburnum species have been used for numerous medicinal purposes – see Alternative Medicine Foundation: HerbMed (2000) for notes and internet links on medicinal use and other health related topics

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Honeysuckle family (Caprifoliaceae). Native shrubs growing 1-3 meters tall, with arching branches forming an overall rounded crown, sometimes spreading up to 2.5 meters; twigs slender, ridged and angled. Leaves deciduous, opposite, simple, oval to oblong, obovate, or elliptic, 4-10 cm long, with coarsely but regularly toothed margins, shiny dark green above, paler beneath, at least sparsely stellate-pubescent beneath and on the petioles, turning yellow to red or reddish-purple in late fall. Flowers are 5-8 mm wide, white, in flat-topped clusters 5-8 cm broad. Fruits ovoid, berry-like (drupes), 5-8 mm in diameter, bluish-black. The common name refers to the Native American use of the straight young stems as arrow shafts.

Variation within the species: Leaves of *V. dentatum* are stellate-pubescent in variable density on the lower surfaces and petioles. Localized geographic variants are often evident over the range of the species, with leaf shape and size often more consistent on a local or regional level than the type of vestiture. A number of varieties have been recognized – but these distinctions apparently have not been recognized among the horticultural forms.

V. dentatum var. *deamii* (Rehd.) Fern.
V. dentatum var. *venosum* (Britt.) Gleason
V. dentatum var. *indianense* (Rehd.) Gleason
V. dentatum var. *lucidum* Ait. (= *V. recognitum* Fern.)
V. dentatum var. *scabrellum* Torr. & Gray (= *V. scabrellum* (Torr. & Gray) Chapm.)

Viburnum recognitum has the leaves completely glabrous or sparsely strigose with simple hairs along the veins and petioles, commonly with tufts of soft, white hair in the vein axils of the lower surface. With *V. dentatum*, *V. recognitum* ranges from Texas to New England, but *V. recognitum* is the common form in the northern part of the range, *V. dentatum* in the southern part. *Viburnum scabrellum* is a form with broader, rougher leaves and primarily occurs in the southern part of the *V. dentatum* range.

Distribution
The *Viburnum dentatum* species complex is widespread in the eastern United States, from Maine to Florida and westward to Iowa and east Texas. For

current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Open woods and margins, streambanks. Arrow-wood viburnum prefers loamy, neutral to acid soil with ample moisture, but is adaptable to a range of conditions from dry to fairly wet soil. Plants are salt-tolerant in New England coastal areas. The can grow in generally drier conditions than *V. acerifolium*. They most commonly occur in partial shade but can be grown in full sun. Flowering May-June; fruiting August-November.

Establishment
Plants may begin to produce fruits by the third year. Fruits apparently are consistently formed every year. Like related species of *Viburnum*, the seeds of *V. dentatum* probably have a cold requirement for breaking embryo dormancy. Vegetative reproduction is through short rhizomes and sprouts from the root crown.

Management
Plants of arrow-wood viburnum are propagated from cuttings or seed. They are easily transplanted and free from serious problems of disease or insect pests (with the caveat below). Occasional pruning is helpful in rejuvenation and shaping. Prune off basal suckers to restrict spreading if necessary.

Viburnum leaf beetle: The viburnum leaf beetle (*Pyrrhalta viburni*), native to Europe and Asia, was first encountered in North America in 1947, perhaps arriving earlier from Europe on nursery plants. It received little notice until 1978, when it caused severe defoliation of ornamental viburnums in Ontario and Quebec. It has now reached western New York and Maine and become a concern in urban landscapes and nurseries.

The adult and the larva "skeletonize" leaves by feeding on the leaves between the midrib and larger veins. Plants, which have been defoliated for 2-3 consecutive years, may be killed. The preferred host is *Viburnum opulus* and its selections; lesser damage is caused to *V. lantana* and *V. rafinesquianum*, *V. dentatum*, *V. acerifolium*, and *V. lentago*. Other species, particularly *V. rhytidophyllum* and *V. carlesii*, are relatively unaffected.

The entire life cycle of the viburnum leaf beetle takes about 8-10 weeks. Larvae hatch in early May and feed on the viburnum leaves throughout the larval period, which lasts 4-5 weeks. The larvae pupate in the soil. The adults (4.5-6.5 mm long, brown) appear by mid-July and continue eating the leaves, then mate and lay over-wintering eggs on the twigs. Egg-laying holes are in a straight line on the underside of the current season's growth.

Chemical control of the viburnum leaf beetle is best applied to young larvae, because adults will fly away or drop to the ground if disturbed. If over-wintering egg sites are found, affected wood should be pruned and destroyed before the eggs hatch. Examine upper and lower leaf surfaces for feeding larvae. Potential biological control mechanisms are being studied.

Cultivars, Improved and Selected Materials (and area of origin)
These plant materials are somewhat available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

SOUTHERN ARROWWOOD

Viburnum dentatum L.

Plant Symbol = VIDE

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Arrow-wood viburnum, southern arrow-wood, roughish arrow-wood. (Arrowwood is frequently hyphenated: arrow-wood.) The common name refers to the Native American use of the straight young stems as arrow shafts.

Uses
Landscape: V. dentatum is an adaptable native, multi-stemmed shrub. Creamy white flowers, dark blue berries and colorful fall foliage make southern arrowwood an attractive landscape plant. It suckers freely from the base. It can be used for borders or screens or as mass plantings and groupings to attract birds, which eat the fruit.
Medicinal: Viburnum species have been used for numerous medicinal purposes (Alternative Medicine Foundation: HerbMed, 2000--for notes and internet links on medicinal use and other health related topics for *Viburnum* species).

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Southern arrowwood is a native shrub growing 3-9 feet tall and spreading sometimes up to 8 feet. The plant's arching branches form an overall rounded crown; twigs are slender, ridged and angled. Its leaves are deciduous, opposite, simple, oval to oblong, obovate (inversely egg-shaped), or elliptic in shape and 1½ - 4 inches in length, with coarsely, but regularly, toothed margins. Leaves are shiny dark green above and paler beneath, sparsely stellate (with hairs in small star-like tufts) on undersides and petioles. Foliage turns yellow to red or reddish-purple in late fall. Small white flowers are borne in 2 to 4-inch flat-topped clusters in May to early June. The ¼ inch berry-like drupes are bluish-black and attractive to wildlife. Fruiting occurs from August - November.

Localized variations of southern arrowwood occur over the geographic range of the species. Most common differences between the variants are in the shape and size of leaves, the type and placement of pubescence (hairs) on the leaf underside and petioles, and the region of occurrence. Some variations of southern arrowwood include *V. dentatum* var. *dentatum*; *V. dentatum* var. *scabrellum* Torr. & Gray (= *V. scabrellum* (Torr. & Gray) Chapm.) and *V. dentatum* var. *venosum* (Britt.) Gleason.

Adaptation and Distribution
Southern arrowwood is found natively in open woods and margins, and along streambanks. It prefers loamy, neutral to acid soil with ample moisture, but is adaptable to a range of conditions from dry to fairly wet soil. Plants are salt-tolerant in New England coastal areas. They can grow in generally drier conditions than *V. acerifolium*. They most commonly occur in partial shade but can be grown in full sun.

Southern arrowwood is distributed throughout the East. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Southern arrowwood plants are propagated by seed or vegetatively. Seed bearing age begins at approximately 3-4 years. Depending on region of collection, the seeds of *V. dentatum* may have a cold requirement for breaking embryo dormancy. Vegetative reproduction is through short rhizomes

and sprouts from the root crown or softwood cuttings. Southern arrowwood has a fibrous root system and is easily transplanted.

Management
V. dentatum is free from serious problems of disease or most insect pests (see, however, discussion on viburnum leaf beetle below). Occasional pruning is helpful to rejuvenate and shape the plant. Prune off basal suckers to restrict spreading if necessary.

Pests and Potential Problems
The viburnum leaf beetle *(Pyrrhalta viburni*) was introduced from Europe and Asia to North America around 1947. It became a problem in Canada in 1978 and has now moved to the northeastern United States where it is a concern in urban landscapes and nurseries. *Viburnum dentatum* leaves can be damaged or skeletonized by the beetle adults and larvae, though *Viburnum opulus* (European cranberrybush viburnum) appears to be the insect's preferred host and is most seriously affected. The beetle larvae hatch in early May, feed for about 4-5 weeks then pupate in the soil. Adults emerge by mid-July, feed, mate, and females lay over-wintering eggs in a straight line on viburnum twigs. If found, the eggs should be pruned out and destroyed before hatching. Chemical control is best applied to young larvae, which feed on both upper and lower leaf surfaces.

Cultivars, Improved, and Selected Materials (and area of origin)
Several cultivars of *V. dentatum* are available.

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Edited: 26Jul2002 JLK; 060818 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Plant Guide

NANNYBERRY

Viburnum lentago L.

Plant Symbol = VILE

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

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Alternate Names
Sheepberry, wild raisin, sweet viburnum, nanny-berry

Uses
Nannyberry is shade-tolerant species useful in landscape plantings as shrub borders, taller barriers, hedges, and windbreaks. It produces good seasonal displays of flowers, fruits, and fall leaf color and the fruit are eaten by many species of birds and wildlife. Cultivars are not commonly available.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Honeysuckle family (Caprifoliaceae). Native, multi-stemmed shrubs or small trees growing to 9 m high, somewhat open at maturity and leggy at the base, the crown irregular to rounded, often suckering at the base; bark dark gray to black, forming a pattern of small blocks. Leaves are deciduous, simple, opposite, elliptic-obovate to ovate, 5-10 cm long, long-pointed, glabrous or nearly so on both sides, the petiole with a wavy-winged margin, margins finely toothed; mature foliage dark glossy, green, becoming deep maroon to red in the fall. Flowers are small, all bisexual, creamy white, in flat-topped clusters 5-12 cm wide. Fruit in hanging clusters, berry-like (a drupe), oval to nearly round, 10-15 mm long, changing from green to yellow, pink, rose and finally to blue-black, sweet and edible, with an odor of wet sheep wool when ripe and rotting, with a single, smooth, nearly flat stone.

Distribution
Across northeastern North America, from New Brunswick and Quebec to Saskatchewan, south to Colorado and Nebraska (rare), Missouri (extinct), West Virginia, and Pennsylvania, rare in the Appalachians in Maryland and Virginia and apparently disjunct in Georgia. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. A detailed distribution map is also provided by Northern Prairie Wildlife Research Center (2000).

Adaptation
Common habitats for nannyberry are low woods, swamp borders, and rich valleys at or near streambanks, usually in rich loam to clay-loam soil. It also occurs in moist soil of wooded slopes and other upland sites, sometimes even in sandy or rocky soil. It is a shade-tolerant understory shrub, but reaches relatively larger size in partial openings or along edges. Flowering occurs in May-June and fruits in July–September.

Establishment
Reproduction is primarily by seed. Suckering from the base can replace and add to main stems. The "leggy" habit sometimes allows lower branches to fall over – they root where touching the ground.

Management
Nannyberry is one of the more shade-tolerant woody plants, but it also grows well in open sites. It is tolerant of both moist and dry soils. It is easily transplanted and established and can be propagated by cuttings. Although the growth habit is primarily a multi-stemmed shrub, it can be maintained as a small tree by pruning stems and removing basal suckers.

Pests & Potential Problems
Nannyberry is susceptible to powdery mildew where air circulation is not good. Infected plants are not killed but the leaves can be discolored and disfigured in late summer and fall.

Viburnum leaf beetle. The viburnum leaf beetle (*Pyrrhalta viburni*), native to Europe and Asia, was first encountered in North America in 1947, perhaps arriving earlier from Europe on nursery plants. It received little notice until 1978, when it caused severe defoliation of ornamental viburnums in Ontario and Quebec. It has now reached western New York and Maine and become a concern in urban landscapes and nurseries.

The adult and the larva "skeletonize" leaves by feeding on the leaves between the midrib and larger veins. Plants, which have been defoliated for 2-3 consecutive years, may be killed. The preferred host is *Viburnum opulus* and its selections; lesser damage is caused to *V. lantana* and *V. acerifolium*, *V. dentatum*, *V. lentago*, and *V. rafinesquianum*. Other species, particularly *V. rhytidophyllum* and *V. carlesii*, are relatively unaffected.

The entire life cycle of the viburnum leaf beetle takes about 8-10 weeks. Larvae hatch in early May and feed on the viburnum leaves throughout the larval period, which lasts 4-5 weeks. The larvae pupate in the soil. The adults (4.5-6.5 mm long, brown) appear by mid-July and continue eating the leaves, then mate and lay over-wintering eggs on the twigs. Egg-laying holes are in a straight line on the underside of the current season's growth.

Chemical control of the viburnum leaf beetle is best applied to young larvae, because adults will fly away or drop to the ground if disturbed. If over-wintering egg sites are found, affected wood should be pruned and destroyed before the eggs hatch. Examine upper and lower leaf surfaces for feeding larvae. Potential biological control mechanisms are being studied.

Cultivars, Improved and Selected Materials (and area of origin)

These plant materials are readily available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Edited 17jan01 jsp; 060818 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

NANNYBERRY

Viburnum lentago L.

Plant Symbol = VILE

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Sheepberry, wild raisin, sweet viburnum, nanny-berry

Uses
Nannyberry is a shade-tolerant, understory species useful in landscape plantings as shrub borders, taller barriers, hedges, and windbreaks. It produces good seasonal displays of flowers, fruits, and fall leaf color. The fruits are sweet and edible and are eaten by many species of birds and wildlife.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
General: Nannyberry is a native, deciduous, multi-stemmed shrub or small tree that may reach 36 ft. in height. The plant is also known as "sheepberry" because its fruit smells like wet sheep wool when over ripe. Nannyberry is leggy and somewhat open at maturity with an irregular to rounded crown. Suckers often form at the base. The bark is dark gray to black in a pattern of small blocks. Leaves are simple, opposite, and ellipse to egg-shaped with finely toothed margins. They are 2-4" long and hairless, or nearly so, on both sides. The ½-1" petiole has a wavy, mostly winged margin. Mature foliage is dark glossy green, becoming deep maroon to red in the fall. Small, creamy-white, bisexual flowers in flat-topped clusters appear May-June. The ½" berry-like fruits (drupes) are blue-black and form hanging clusters from July - September.

Adaptation and Distribution
Nannyberry is adaptable to a wide range of sites, but is commonly found natively in moist areas with rich loam to clay-loam soil, such as low woods, swamp borders, or near stream banks. It also occurs on moist, wooded slopes, but tolerates drier sites. Although quite shade-tolerant, it achieves relatively larger size in more open areas.

Nannyberry is distributed throughout the north and northeastern United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Nannyberry seed requires alternating temperatures and a cool moist period to germinate (Dirr, 1990). The plant can be readily propagated by softwood cuttings. Hanging branches may also root, or layer, where they touch the ground. Nannyberry has fibrous roots and is easily transplanted and established.

Management
Although nannyberry grows naturally as a multi-stemmed shrub, it can be maintained as a small tree by pruning stems and removing suckers at the base.

Pests and Potential Problems
Powdery mildew, which may affect leaves in late summer, decreases aesthetic value but will not kill the plant. The viburnum leaf beetle (*Pyrrhalta viburni)*, first a problem in Quebec and Ontario in 1978, has moved to New York and Maine and is now a concern in urban landscapes and nurseries. *V. lentago* leaves can be damaged or skeletonized by the adults and larvae, although *V. opulus* is the beetle's preferred host. The beetle larvae hatch in early May, feed for about 4-5 weeks then pupate in the soil. Adults emerge by mid-July, feed, mate, and lay over-wintering eggs on viburnum twigs. Chemical control

is best applied to young larvae. Over-wintering eggs should be pruned out and destroyed before hatching.

Cultivars, Improved, and Selected Materials (and area of origin)
Nannyberry cultivars are not readily available.

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Edited: 24Jul2002 JLK; 060818 jsp