N.W. Mauthe
Site Specific Sustainable Remediation System Evaluation

Prepared for:
Wisconsin Department of Natural Resources
Remediation and Redevelopment Program
101 South Webster Street
Madison, WI 53703

Prepared by:
AECOM
Project No. 60134224(107343)

September 2009

TABLE OF CONTENTS

Page

Chapter

LIST OF FIGURES

Figure **Follows Page**

LIST OF TABLES

Table **Follows Page**

LIST OF APPENDICES

Appendix

LIST OF ACRONYMS

µg/L	micrograms per liter
ACL	alterative concentration limit
CO_2e	Carbon Dioxide Equivalents
EPA	Environmental Protection Agency
ES	Enforcement Standard
FS	Feasibility Study
gpm	gallons per minute
KW	kilowatt
kWh	kilowatt hours
LED	light emitting diode
mg/kg	milligrams per kilograms
mg/L	milligram per liter
mpg	miles per gallon
NPL	National Priorities List
PAL	Preventative Action Limit
PLC	programmable logic controller
PV	photovoltaics
RI	Remedial Investigation
ROD	Record of Decision
RPO	Remedial Process Optimization
VOCs	volatile organic compounds
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources

1.0 INTRODUCTION

The purpose of this document is to provide a Site Specific Sustainable Remediation System Evaluation for the N.W. Mauthe site. To evaluate current conditions on the site, and the effect of any potential changes, a sustainability baseline was created that included current carbon footprint, energy usage, current operational costs and contaminant mass removal. A limited Remedial Process Optimization (RPO) was conducted for the site to identify major items that could be addressed to improve the sustainability and efficiency of the existing remedial system, and to reduce operation and maintenance costs. An alternative energy evaluation was conducted to see if alternative energy could be used to offset current energy usage at the site. Potential sustainable activities were evaluated to enhance the reduction of contaminant levels and lower costs. Three sustainable activities were selected and a sustainability matrix was generated outlining the costs and benefits of each activity in terms of various sustainability metrics, such as the increase or decrease in carbon footprint, energy usage, resource usage, waste generation and cost. The purpose of the sustainability matrix is to provide/quantify effects of the potential changes in terms of the sustainability metrics.

This document was generated using information supplied by Wisconsin Department Natural Resources (WDNR), including utility and operation and maintenance costs, monitoring reports and as builts where available, a site walk through and interviews with the WDNR site project manager. Due to the age of the site in some cases information was limited.

2.0 SITE DESCRIPTION

The N.W. Mauthe site is a former electroplating facility located at 725 South Outagamie Street, Appleton, Wisconsin. Chromium plating operations were conducted at the site from 1960 until 1976 after which zinc, cadmium, copper, and possibly silver plating operations were continued until 1987. A site location map is shown on Figure 1, and a site detail map is shown on Figure 2.

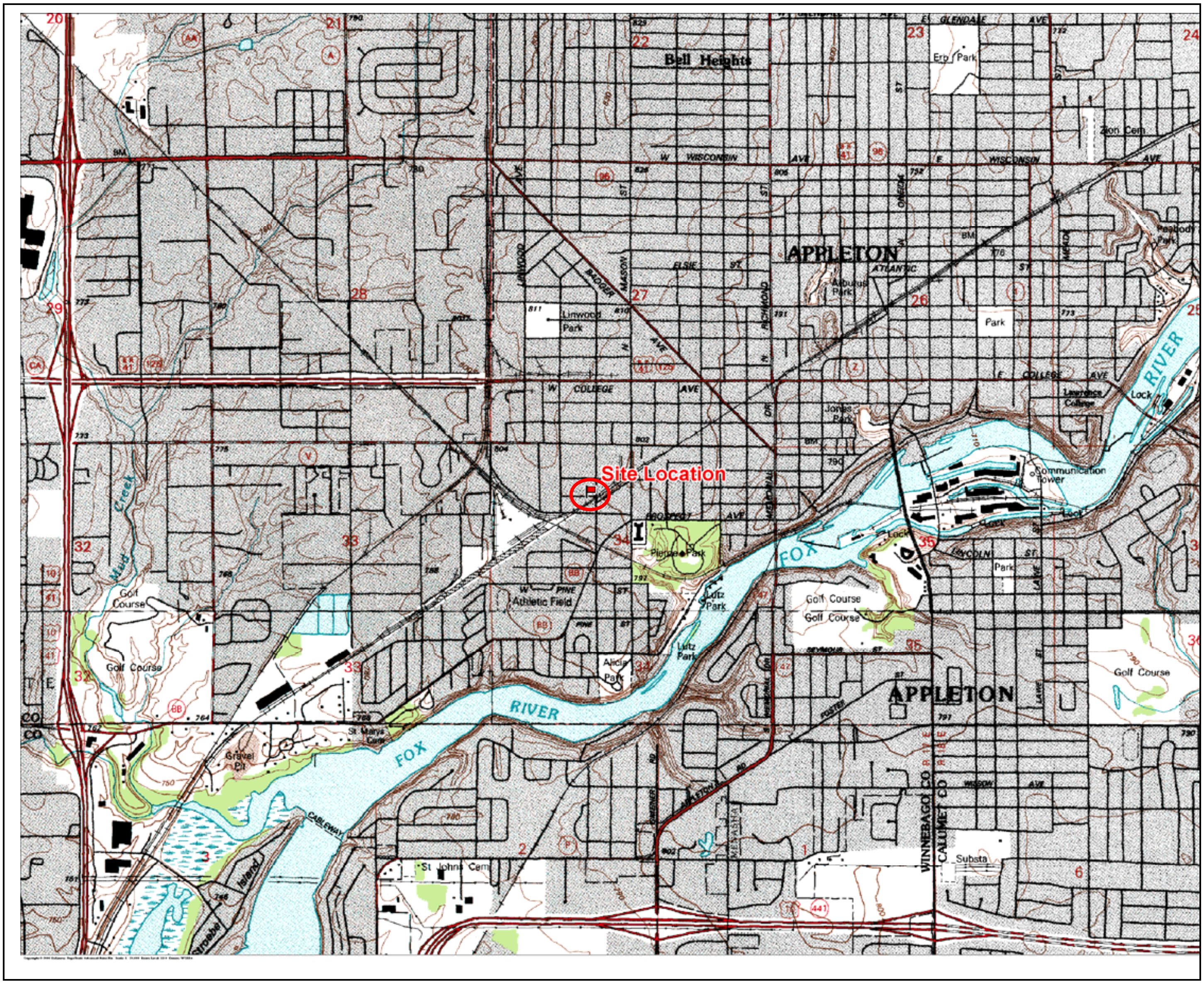
The WDNR initiated a site assessment in 1982 following a report of yellowish-green water being pumped from a residential foundation drain sump south of the site. Plating solutions that leaked from tanks and vats in the plating buildings had reportedly been discharged to ground surface via sump pumps. Immediate action included installation of a shallow drain system to collect contaminated groundwater and surface water. A temporary asphalt cover was installed in 1984 to limit infiltration of surface water, while a cleanup plan was developed. The site assessment subsequently lead to a series of investigations that culminated in the National Priorities List (NPL) listing of the site in 1989, at which time it became Wisconsin's No. 1 priority site.

The Environmental Protection Agency (EPA) conducted a removal action in 1991, aimed at removing chromium impacted soils adjacent to the former chrome plating building and securing the site with a chain-link fence. Building interiors were decontaminated and miscellaneous debris and wastes were containerized and stored in the building or were properly disposed of off site. Remedial Investigation (RI) and Feasibility Study (FS) reports were approved by the WDNR and EPA in 1993. A Record of Decision (ROD) was issued by the EPA in 1994.

Implementation of the ROD included demolition of site buildings and disposal of containerized wastes in 1994. Soil with total chromium concentrations of 500 milligrams per kilograms (mg/kg) or greater were excavated and removed from site in 1995. The treatment building and system components were constructed and installed between 1995 and 1996. The site was capped with 2 feet of clay and a vegetative cover established in 1996. Treatment system operation began in January 1997. The groundwater cleanup standard set forth in the ROD for chromium is 5 micrograms per liter (µg/L), which was the 1992 Wisconsin Administrative Code (WAC) NR 140 Preventative Action Limit (PAL).

The remedial system includes collection of groundwater from three groundwater extraction trenches, totaling 1,080 linear feet in length. Four house foundation drain systems are also hooked up to the extraction trenches. Groundwater collected in the extraction trenches gravity flows to two manholes and is subsequently pumped to the treatment building. Between 1997 and April 2006 the treatment system was a batch process. Extracted groundwater was transferred from a storage tank to a reaction tank for each batch and treated utilizing ferrous sulfate and caustic additions. After chemical addition, mixing, aeration, and settling, the treated groundwater was discharged to the City of Appleton sanitary sewer system. In April 2006, the treatment system was taken off-line, but remains in-place. Since April 2006, groundwater recovered from the extraction trenches has been discharged directly to sanitary sewer under a permit with the City. Total chromium concentrations in the influent flows have been at levels below discharge standards since the system began operation in 1997.

The site owner is identified as Carol Mauthe; however, site remediation efforts are 100 percent state funded.



Source: 2000 DeLorme Topo Tools

N

Figure 1
Site Location Map

N.W. Mauthe
725 South Outagamie Street
Appleton, Wisconsin 54914-5072

OMNNI ASSOCIATES

Project Number:
N1866A05

Date: May 14, 2008

One Systems Drive, Appleton, Wisconsin 54914-1654
Phone: (920) 735-6900 Fax: (920) 830-6100

Legend

- Monitoring Well
- Piezometer
- Collection System
- Pump Discharge
- Railroad Tracks
- Former Building
- Approximate Soil Remediation Limits*
- Property Line

*Approximate Soil Remediation Limits
July 11 - October 27, 1995
(10,834 tons)

0 25 50 100 Feet

N

FIGURE 2
SITE DETAIL MAP

N.W. MAUTHE
725 SOUTH OUTAGAMIE STREET
APPLETON, WISCONSIN

OMNI ASSOCIATES

ONE SYSTEMS DRIVE
APPLETON, WI 54914

PHONE (920) 735-6900
FAX (920) 830-6100

PROJECT MANAGER:	BDW	PROJECT NO:	N1866A05
PROJECT ENGINEER:	BDW	FILE NO:	SITEDET.MXD
DRAWN BY:	JCW	SCALE:	1 " equals 48 '
REVIEWED BY:	BDW	DATE:	5/14/2008

3.0 CURRENT CONDITIONS

The current remedial approach at the N.W. Mauthe site is to contain the contaminate plume on the property with no source area treatment of the groundwater plume. As a result, the WDNR has projected the site will not achieve remedial cleanup goals for approximately 500 years. As indicated above, the remedial equipment at the site is sitting idle and groundwater pumped from the extraction trenches is being discharged directly to the City of Appleton sanitary sewer under an industrial discharge permit, which is valid until May 2012.

The extraction system appears to be extracting a baseline flow of approximately 20,000 to 50,000 gallons per month (0.46 to 1.2 gallons per minute (gpm)) out of the 1,080 linear feet of groundwater extraction trench and four residential house drain systems. Elevated monthly flows up to 150,000 gallons have been recorded. Elevated flows are most likely the result of infiltration from drainage ditches adjacent to the site during the spring snow melt or periods of excessive rainfall. The groundwater table is located approximately 7 to 10 feet below ground surface beneath the site.

Groundwater infiltrating into the collection trenches gravity flows to two manholes and is conveyed to the treatment building by an electric submersible pump located in each manhole. The manholes are approximately 33-feet deep. Water levels within the manholes are controlled by float switches. The pumps each have a pumping capacity of 43 gpm. Hydrogen sulfide was reportedly corroding the concrete, piping, and wiring in Manhole No. 2. This has lead to several complaints about odors emanating from this manhole. Maintenance on Manhole Nos. 1 and 2 was completed November 2008, including repairs to conduit and wiring. The rigid piping at Manhole No. 2 was replaced with a flexible hose to simplify pump access. The pump at Manhole No. 2 is scheduled to be replaced in the near future.

An unfiltered sample of the discharge water is currently being collected weekly and analyzed by a laboratory for hexavalent chromium. Influent samples are also collected from Manhole Nos. 1 and 2 on a weekly basis and field screened for hexavalent chromium and pH. A filtered sample of the discharge water is collected monthly and submitted to the laboratory for analysis of total dissolved chromium. Compliance sampling of the remedial system effluent is conducted by the City of Appleton twice per year, and by an environmental consultant once per year.

Groundwater samples collected from monitoring wells at the site indicate that concentrations of chromium and several other volatile organic compounds (VOCs) have been detected above the WDNR NR 140 PALs and Enforcement Standards (ESs) at several monitoring wells across the site. The highest total chromium concentrations currently detected at the monitoring wells are approximately 76,000 ug/L (April 2009). Based in this chromium concentration, a reduction of 99.99 and 99.93 percent would be needed to meet the PAL and ES, respectively. Although standards are exceeded at most monitoring wells, contaminant trends appear to be stable or decreasing and the groundwater contaminant plume appears to be controlled by the extraction trenches.

Remedial equipment located in the treatment building generally consists of a 9,000-gallon storage tank with a top mounted mixer, 6,100-gallon reaction tank, diaphragm pump for water transfer between tanks, reaction tank mixer and air diffuser, water level indicators, pH monitors, air compressor, sludge transfer pump, sludge tank, and tanker truck feed pump. A programmable logic controller (PLC) system, with telemetry, controls the process equipment. The treatment system at the site is generally considered antiquated and the WDNR has previously indicated that it would likely not be used going forward, if groundwater treatment was required.

The treatment building consists of three main areas including the treatment system area housing the remedial equipment, control room, and truck bay. The truck bay was built for anticipated sludge removal but has never been used. The control room was built assuming a full-time operator would remain on site during treatment system operation. In May 2008, a cooperative agreement was established between WDNR and The City of Appleton Parks Department. The City is currently using the truck bay for equipment storage and the control room is being utilized by City workers. In exchange, site maintenance, lawn mowing, and snow removal is conducted by the City.

4.0 BASELINE EVALUATION

A sustainability baseline analysis was conducted for the N.W. Mauthe site. The sustainability baseline is a quantification of current site conditions using various sustainability metrics. This allows costs and benefits of potential changes/modifications to the remedial system to be measured using the same set of sustainability metrics.

4.1 CARBON FOOTPRINT

The N.W. Mauthe site is a relatively simple site that is currently in a long-term operation and maintenance mode. An analysis of site operations has identified applicable items associated with Scope 1 (direct discharge), Scope 2 (electricity) and Scope 3 (other indirect) at the site. The only Scope 1 item identified at the site is electrical usage. The only Scope 2 item is natural gas, used for heating the building. Scope 3 items were limited to consultant travel to/from the site for operation and maintenance and sampling activities. Scope 1 and 2 items were taken directly from utility bills provided by WDNR. For Scope 3, it was estimated that a contractor visited once per week and groundwater sampling was conducted four times per year. It was assumed that the consultant had to drive 50 miles to get to and from the site in a vehicle that gets 18 miles per gallon (mpg). Based on all information provided, it is estimated that the N.W. Mauthe site has a yearly operational carbon footprint baseline of 14.60 tons of Carbon Dioxide Equivalents (CO_2e). The carbon footprint analysis is included in Appendix A.

4.2 ENERGY

Electric service at the site is required to operate the remedial equipment and provide indoor and outdoor lighting. The treatment equipment area, control room, and truck bay are heated with natural gas furnaces. Electrical and natural gas services are provided by WE Energies. In 2008, utility costs for electricity and gas were $1,659 and $1,996, respectively. The average monthly cost for electricity and gas is approximately $138 and $166, respectively. Total electrical and gas service requirements for the 2008 operational year equals energy consumption of about 13,488 kilowatt hours (kWh) and approximately 1,714 therms, respectively. Total costs average $0.12 per kWh and $1.16 per therm. Average monthly costs for the first eight months of 2009 operation were slightly elevated from 2008. The average monthly cost for electricity and natural gas was $153 and $190, respectively. Gas and electric rates remained relatively constant.

4.3 OPERATIONAL COSTS

In additional to natural gas and electrical services discussed above, other operation costs associated with the treatment system operation and monitoring include telephone service, municipal utility charges, consulting costs, supply and equipment costs, subcontractor costs, and WDNR management.

Historical telephone charges average approximately $35 and $45 per month for AT&T and Ameritech services, respectively, or $420 to $540 per year. Municipal utility charges historically averaged about $295 per month. City of Appleton sewer/water and stormwater charges were $25 per month and $40 per month, respectively. Total costs, including telephone service and municipal water and sewer charges, average approximately $400 per month or $4,800 per year. Utility services are billed directly to the WDNR.

Operation and maintenance costs vary significantly from year to year depending on the amount of unscheduled maintenance that needs to be conducted at the facility or on the remedial system. These costs tend to increase as the remedial system and building in which it is housed ages. The operation and maintenance costs incurred for the period from May 2008 through April 2009 are summarized below.

The total costs reported for the May 2008 to September 2008 (5 months) time period on WDNR Form 4400-194 was $18,782. This included consultant services, roof snow guard and gutter repairs, man-door replacement, and lock replacement. Utility services are not included in the above dollar amount. Based on utility bills, electric and gas services during the May to September 2008 time period totaled $507 and $107, respectively. The approximate WDNR management cost of $689 was incurred during the May to September 2008 time period. As such, total costs for the May to September 2008 period are $20,485.

The total cost reported for the October 2008 to April 2009 (7 months) time period on WDNR Form 4400-194 was $32,507. This included consultant services, heater maintenance, fire extinguisher service, a cross-connection control performance test, damper repairs and maintenance, manhole repairs, pump maintenance, piping retrofit, and electrical and conduit repairs. Based on utility bills, electric and gas services during the October 2008 to April 2009 time period totaled $1,244 and $1,951, respectively. The approximate WDNR management cost of $700 was also incurred during the October 2008 to April 2009 time period. As such, total costs for the October 2008 to April 2009 period are $36,802.

The total cost for operating and maintaining the N.W. Mauthe remediation system for the May 2008 to April 2009 (12 months) time period is approximately $57,286, not including telephone and utility services, which are estimated to be approximately $4,800 per year.

Currently, groundwater is not being treated before discharge to the City of Appleton sanitary sewer. The City industrial discharge permit is valid through May 2012. If the City does not renew, the permit costs of operating a treatment system would likely double or triple the current operating budget, not including capital costs of designing and installing a new treatment system.

4.4 CONTAMINANT MASS REMOVAL

The estimated mass of chromium removed at the site was extrapolated from the total flow from extraction trenches and chromium concentrations in effluent samples collected from the discharge to the City of Appleton sanitary sewer. During the period from May 2008 to September 2008, approximately 324,350 gallons of groundwater was extracted from the collection trenches and discharged to the sanitary sewer. During this period, total chromium concentrations in the effluent ranged from 0.679 to 1.29 milligrams per liter (mg/L). Based on this flow and discharge sampling results, approximately 2.8 pounds of chromium was removed from the subsurface during this period. Similarly, during the period from October 2008 to April 2009 approximately 375,342 gallons of groundwater were extracted from the collection trenches and discharged to the sanitary sewer. During this period, total chromium concentrations in the effluent ranged from 0.73 to 2.9 mg/L. Based on this flow and discharge sampling results, approximately 5.6 pounds of chromium was removed from the subsurface during this period.

A total of 8.4 pounds of chromium were removed during the operational period from May 2008 to April 2009. Operational costs for the same period were approximately $62,086. This equates to costs of approximately $7,309 per pound of chromium extracted from the site. It should be noted that there may be limited removal of the chromium in the sanitary wastewater system so the overall net effect of the cleanup is to transfer contaminants from groundwater to surface water.

5.0 LIMITED REMEDIAL PROCESS OPTIMIZATION STUDY

RPO is a specific process that examines overall system effectiveness including incremental changes or system replacement to include considerations of new technologies, as well as alternative regulatory approaches. Optimization must be implemented within the confines of the existing decision document for the site.

The purpose of the limited RPO study is to identify possible changes to the site or remedial system that would significantly improve the system with regards to overall remedial sustainability. This includes decreasing the costs of operating the system and/or increasing the efficiency of chromium mass removal. The limited RPO study is based on the current conditions previously noted in this document.

The following RPO recommendations were based on the assumption that the current technology will continue to be employed as the site remedy for the foreseeable future. Potential alternative remedies are discussed in the Potential Sustainable Activities section (Chapter 7) of this document.

5.1 DEVELOP EXIT STRATEGY

The current regulatory "driver" for groundwater contamination at the site is the 5 µg/L 1992 WAC NR 140 PAL for chromium. Given site and operational conditions, the 5 µg/L standard is not possible to achieve in a reasonable time period. The ROD outlines a procedure in which an alternate concentration limit (ACL) can be established under the substantive requirements of WAC's NR 140.28, which can be no higher than the ES of 100 µg/L or a technical impractical waiver under Section 12d of CERCLA may be used to set a goal higher than the ES.

Based on groundwater monitoring well data, it is not clear whether the south leg of Trench No. 2 is removing any contaminants. Placement of sentinel wells immediately upgradient of this trench section would determine if any chromium contamination above WDNR standards is flowing into this portion of trench. A similar approach could be used with Trench No. 1. If chromium concentrations do not exceed the WDNR ES for chromium, the trenches should not be operated. The trenches would be reactivated if the WDNR ES for chromium is exceeded in the sentinel wells. This approach would decrease operational costs going forward and potentially reduce the length of the trench that may need to maintained or replaced in the future.

5.2 EXAMINE ALTERNATIVES TO PUMP AND TREAT

The current remediation system installed at the N.W. Mauthe site is unlikely to clean up groundwater contamination in a reasonable time period. The current time period to achieve cleanup goals is estimated to be 500 years. During this timeframe, and most likely within the next 10 years, the extraction trenches will need to be maintained, which may include rehabilitation or reinstallation if the existing remedy is to remain in-place. The cost of replacing the existing trenches could exceed $1,000,000 and create a significant carbon footprint during the construction phase of trench replacement. In all likelihood, trenches and the associated remedial system would need to be replaced multiple times if the technology at the site remains the same.

It would be beneficial to examine alternative treatment technologies such as phytoremediation of chromium in the source area, and chemical injection in the source area to reduce chromium concentrations. Another possibility is placing a slurry wall around the site to fully encapsulate the contaminants as there is a 2-foot clay cap already present at the site.

5.3 EVALUATE SURFACE WATER INFILTRATION INTO TRENCH NOS. 1 AND 2

Based on the data provided, groundwater extraction Trench Nos. 1 and 2 appear to be highly sensitive to infiltration of surface water during wet periods, which is then pumped into the City of Appleton sanitary sewer system. Based on an analysis of the data, there appears to be a baseline flow of approximately 20,000 gallons of groundwater combined from both trenches and four residential house drains. Based on 2009 data, this increases to approximately 133,000 gallons per month during spring run off period. Lining the drainage ditches immediately adjacent to Trench Nos. 1 and 2 could limit the processing of clean surface water through the sanitary sewer system. The rapid infiltration through these ditches could also be the primary “driver” for off site plume migration. An engineering study would be required to determine the exact costs of lining the ditch, but an order of magnitude cost would be approximately $100,000 for 5,000-square yards. Costs do not include allowances for working in railway right of way. It is estimated that by limiting infiltration at the site, water discharged to the sanitary sewer could be reduced by 50 to 60 percent.

5.4 MOVE SANITARY DISCHARGE POINT FROM EXISTING BUILDING TO SMALL REMEDIATION ENCLOSURE

Currently, no treatment is being required prior to discharge of groundwater effluent from Trench Nos. 1 and 2 at the site provided chromium concentrations below permitted concentrations. The site has operated under this permit since 2006 without approaching the permitted concentration of 7 mg/L total chromium. It is unlikely that these concentrations, based on current operational status, will ever exceed the permitted values. Also, in the event that groundwater treatment is ever required again, it is likely that an ion exchange system will be used, as the existing treatment system is antiquated and would be very expensive to operate. An order of magnitude estimate for moving the connection to a small out building would be approximately $20,000 to $30,000.

Removal of the sanitary connection from the building would save approximately $3,000 per year in utility costs. In addition, the existing building could be rented out for $1,000 to $2,000 per month to offset the operation and maintenance costs. It is estimated that the payback time for this option would range from 2 to 3 years, assuming the building is rented and the tenant assumes utility and grounds keeping costs.

5.5 EVALUATE TRENCH PERFORMANCE

Based on data provided, there is approximately 1,080 linear feet of extraction trench with a base flow rate, from the entire length of the trench, of approximately 0.46 gpm. Specifications and data regarding installation and operation of the extraction trenches was limited, as a result, a mass flux calculation could not be completed. However, based on the baseline flow rates, it is questionable whether the groundwater trenches are effectively containing the contaminant plume. The fact that the extraction trenches appear to be having little impact on groundwater flow direction, water table elevations and gradients may be evidence of this. The extraction trenches have been active for a period of 12 to 13 years. In general, extraction trenches, depending on chemical conditions within the aquifer and biological growth within the trench, have an operational lifespan of about 10 to 25 years before requiring major rehabilitation or replacement.

6.0 ALTERNATIVE ENERGY ANALYSIS

A preliminary analysis of the potential use of alternative energy at the N.W. Mauthe site indicated that small scale solar energy appear to be the only feasible form of alternative energy that could be used at the site. Solar energy can be used through several methods including direct or indirect heating and lighting systems, photovoltaics (PV), or concentrating solar power. It is estimated that 11 kilowatt (KW) of photopholtaic solar power to offset the total amount of electricity used at the site. The estimated costs would be $87,000 with a payback period of approximately 30 years. If incentives were applied, the payback period would decrease significantly. It would be more feasible to offset electrical usage if the RPO recommendation of removing the sanitary connection from the building to a newly constructed small out building was implemented. The building could be constructed such that the only electricity required would be for light emitting diode (LED) lighting and to operate the two groundwater extraction pumps and small electric heater to keep the sanitary connections from freezing in the winter. This would eliminate the need for natural gas at the site. Supplying the current remediation system with 100 percent renewable energy would decrease the annual carbon footprint by 0.06 tons CO_2e per year. There would need to be a two meter system installed in which the power produced would be sold back to the utility at higher rate than it was purchased.

7.0 POTENTIAL SUSTAINABLE ACTIVITIES

The purpose of the groundwater treatment system was to reduce contaminant levels to meet state and/or federal groundwater quality standards. Based on system performance and contaminant levels detected in the groundwater monitoring wells, it does not appear that groundwater quality standards can be met in a reasonable time period. The following activities were evaluated to enhance the reduction of contaminant levels and lower costs.

7.1 PHYTOREMEDIATION

The feasibility of using phytoremediation to actively address soil and groundwater contamination on site needs to be examined. Phytoremediation may be utilized in conjunction with other remedial actions for hydraulic control and to degrade, extract, contain, or immobilize contaminants in both soil and groundwater. Several varieties of trees (hybrid poplars, willows, and cottonwoods) have shown the ability to effectively withdraw groundwater and control migration of a contaminant plume (phytopumping). For sites with metals contamination, the uptake of contaminants by the roots of plants and the translocation of contaminants within the plants (phytoextraction) is most often used. As such, the use of a phytoremediation tree plot for hydraulic control is likely more appropriate for the subject site. Placement of trees for the purpose of phytoremediation would also sequester carbon creating a carbon sink. There would only be a small carbon footprint generated as a result of employing this technology.

7.2 CHEMICAL INJECTION

The possibility of source area treatment using chemical injection technologies should also be examined. Metals, such as chromium, can be treated in-situ by injecting chemicals that will immobilize the metals by increasing the pH such as magnesium hydroxide and dipotassium phosphate (forming metal oxides and hydroxides that precipitate out and become permanently immobilized). This type of approach uses less energy and achieves objectives quicker and at a lower cost (i.e., sustainable). Chemical injection is an in-situ technology that is carbon neutral once employed.

7.3 REPURPOSING EXISTING TREATMENT FACILITY

Relocating a treatment system to a smaller building would allow the current building to be reused or rented in its entirety for another purpose. The cooperative agreement between the WDNR and the City Parks Department expires in May 2010, and the City currently only uses a portion of the building. If the treatment system area was cleared of unused remedial equipment and the entire building was available the building would likely be more attractive to another tenant, if the City decides not to renew their agreement. The N.W. Mauthe site is located in an area that has both industrial and residential development. The treatment building at the N.W. Mauthe site would readily lend itself for reuse as a light industrial or commercial facility.

The unused remedial equipment on site could be salvaged or recycled dependant upon condition. Although the market for used remedial equipment is limited, the equipment could be sold and reused by another consultant or contractor at a different site. The equipment could also be reused by the WDNR at another state funded site, if equipment needs matched. If reuse is not possible, the equipment should be recycled or properly disposed of. As previously stated, this would decrease the carbon footprint at the site by approximately 12 tons CO_2e per year.

8.0 SUSTAINABILITY MATRIX

A sustainability matrix was created that compared sustainability metrics for the current operational baseline verses three potential modifications that could be made to the system. The options that were selected were lining of the ditch adjacent to the property to prevent surface water infiltration, moving the sanitary connection from the existing treatment building to a newly constructed remediation system enclosure and installing solar photovoltaics to replace all electric power at the site. It must be noted that the best or most applicable sustainable alternative at the site may be a combination of the proposed options. The analysis does not include potential extraction trench rehabilitation/replacement which was not included in the generation of sustainability metrics. Alternative technologies were not included as pilot studies would be required to determine what would be required to complete the remediation. The sustainability matrix is included in Table 1.

AECOM

Table 1
Sustainability Matrix N.W. Mauthe Site

	Baseline[3]		Option 1 Prevent Surface Water Infiltration		Option 2 Move Sanitary Sewer Connection and Repurpose Treatment Buidling		Option 3 Photovoltaic Installation	
Sustainability Metrics[1,2]	**Annual**	**Life Cycle**	**Annual**	**Life Cycle**	**Annual**	**Life Cycle**	**Annual**	**Life Cycle**
Stewardship								
System Optimization (Qualitative)	System may not be performing as designed.		Improve effectiveness of remedy as infiltration may be driving contaminant migration.		Will not increase the effectiveness of the remedy		Will not increase the effectiveness of the remedy.	
Restoration Timeframe (yrs)	NA	500	NA	500	NA	500	NA	500
Carbon Footprint/Air Emissions								
Tons CO2e	14.6	7,300	14.57	7,285	1.72	860	14.54	7,270
Energy Usage								
Electricity (kWh)	13,488	6,744,000	7000	3,500,000	13,488	6,744,000	0	0
Natural Gas (Therms)	1,714	857,000	1,714	857,000	0	0	1,714	857,000
Cost								
O&M Cost (dollars)	$62,086	$31,043,300	$58,486	$29,243,000	$60,086	$30,043,000	$60,467	$30,213,500
Cost of Modification (dollars)	NA	NA	NA	$100,000	NA	$20,000 to $30,000	NA	$87,000
Cost per Pound Contaminant Removed	$7,309	NA	$6,962	NA	$7,034	NA	$7,198	NA
Land & Ecosystems								
Community Benefits (qualitative)	NA	NA	Fifty to sixty percent less water is being discharged to sanitary sewer.		Building can be repurposed for beneficial purpose and potentially generate revenue		Use of Green Power. Lower Carbon Footprint.	
Materials & Waste Generation								
Sanitary Sewer Discharge (gallons)	820,000	410,000,000	240,000	120,000,000	820,000	410,000,000	820,000	410,000,000

[1] Metrics may be either qualitative (+/-), not applicable (NA) or quantitative based on available information and scope of project.
[2] Metrics may be added or deleted based on site specific conditions.
[3] Base Line : As the system is currently being operated.

APPENDIX A

CARBON FOOTPRINT ANALYSIS

Carbon Footprint Calculations - Baseline Conditions

Mauthe
725 South Outagamie Street
Appleton, WI 54914-5072

Scope 1

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Gaseous Fuels Burned On-Site	**Year**	**Usage (therms/yr)**	**Usage (TJ//yr)**	kg CO_2/TJ	kg CH_4/TJ	kg N_2O/TJ	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO_2e/kg CH_4	kg CO_2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Natural Gas	2008	1,714	0.18	64,200	10	0.6	11,606.94	1.81	0.11	11,606.94	45.20	32.11	11,684.24	25,763.76	12.88
		See Note 1		*See Note 2*	*See Note 2*	*See Note 2*					*See Note 3*	*See Note 3*			

Scope 2

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Purchased Electricity	**Year**	**Usage (kWh)**	**Usage (GWh)**	lb CO_2/GWh	lb CH_4/GWh	lb N_2O/GWh	lb CO_2	lb CH_4	lb N_2O	lb CO_2e/lb CO_2	lb CO_2e/lb CH_4	lb CO_2e/lb N_2O	kg CO_2e	lb CO_2e	ton CO_2e
	2008	13,488	0.013488	1.66	19.24	27.59	0.02	0.26	0.37	0.02	6.49	110.15	52.92	116.66	0.06
		See Note 1		*See Note 4*	*See Note 4*	*See Note 4*					*See Note 3*	*See Note 3*			

Scope 3

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Sampling/O&M Vehicle Usage	**Year**	**Usage (miles/yr)**	**Usage (gal/yr)**	kg CO_2/gallon	kg CH_4/gallon	kg N_2O/gallon	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO2e/kg CH_4	kg CO2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Unleaded Gasoline	2008	3,000	166.67	8.81	0.0036	0.0004	1,468.33	0.61	0.07	1468.33	15.18	19.54	1,503.05	3,314.22	1.66
				See Note 5	*See Note 5*	*See Note 5*					*See Note 3*	*See Note 3*			

Totals		
kg CO_2e	lb CO_2e	ton CO_2e
13,240.21	29,194.64	14.60

Assumptions: *Unleaded gasoline used for consultant transport to conduct O&M activities.*
60 site visits/year
50 miles/visit (roundtrip)
18 miles/gallon (for field vehicle)

Conversions: *1 therm = 105,506,000 joules*
1 Joules = 1.0E -12 Terajoules
1,000 kWh = 1.0E+6 GWh

Source Notes: *1. Utility usage reported by We Energies.*

2. IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006, Volume 2: Energy Tables 1.4 and 2.4, Emission Factors, Commercial/Instiutional - Stationary Combustion.

3. Greenhouse Gas Potential for CH_4 taken from IPCC (2006). Greenhouse Gas Potential for N_2O taken from IPCC Third Assessment Report (2001).

4. EPA (Environmental Protection Agency) eGRIDweb Parent Company Owner-based Level Emissions Profile- Wisconsin Energy Corp. Pollutant Output Emission Rates, 2005.

5. EPA (Environmental Protection Agency) Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance, Direct Emissions from Mobil Combustion Sources, Section 3, Table 2: CH_4 and N_2O Emission Factors for Highway Vehicles, Gasoline Light-Duty Trucks, and Section 4, Table 5: Factors for Gasoline and On-Road Diesel Fuel, May 2008.

Carbon Footprint Calculations **Option 1 - Prevent Surface Water Infiltration**

Mauthe
725 South Outagamie Street
Appleton, WI 54914-5072

Scope 1

										CO$_2$e					
										Greenhouse Gas Potentials					
				Emission Factors			Mass			1	25	296	Total		
Gaseous Fuels Burned On-Site	Year	Usage (therms/yr)	Usage (TJ/yr)	kg CO_2/TJ	kg CH_4/TJ	kg N_2O/TJ	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO_2e/kg CH_4	kg CO_2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Natural Gas	2008	1,714	0.18	64,200	10	0.6	11,606.94	1.81	0.11	11,606.94	45.20	32.11	11,684.24	25,763.76	12.88
		See Note 1		*See Note 2*	*See Note 2*	*See Note 2*					*See Note 3*	*See Note 3*			

Scope 2

										CO$_2$e					
										Greenhouse Gas Potentials					
				Emission Factors			Mass			1	25	296	Total		
Purchased Electricity	Year	Usage (kWh)	Usage (GWh)	lb CO_2/GWh	lb CH_4/GWh	lb N_2O/GWh	lb CO_2	lb CH_4	lb N_2O	lb CO_2e/lb CO_2	lb CO_2e/lb CH_4	lb CO_2e/lb N_2O	kg CO_2e	lb CO_2e	ton CO_2e
	2008	7,000	0.007	1.66	19.24	27.59	0.01	0.13	0.19	0.01	3.37	57.17	27.46	60.55	0.03
		See Note 1		*See Note 4*	*See Note 4*	*See Note 4*					*See Note 3*	*See Note 3*			

Scope 3

										CO$_2$e					
										Greenhouse Gas Potentials					
				Emission Factors			Mass			1	25	296	Total		
Sampling/O&M Vehicle Usage	Year	Usage (miles/yr)	Usage (gal/yr)	kg CO_2/gallon	kg CH_4/gallon	kg N_2O/gallon	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO2e/kg CH_4	kg CO2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Unleaded Gasoline	2008	3,000	166.67	8.81	0.0036	0.0004	1,468.33	0.61	0.07	1468.33	15.18	19.54	1,503.05	3,314.22	1.66
				See Note 5	*See Note 5*	*See Note 5*					*See Note 3*	*See Note 3*			

Totals		
kg CO_2e	lb CO_2e	ton CO_2e
13,214.76	29,138.53	14.57

Assumptions: *Unleaded gasoline used for consultant transport to conduct O&M activities.*
60 site visits/year
50 miles/visit (roundtrip)
18 miles/gallon (for field vehicle)
**** Electric usage reflects reduced pumping from the groundwater extraction trenches. Pumping from the groundwater extraction trenches is the major consumer of electricity at the site.***
An electric usage calculator was used to approximate the decrease in electric usage casued by reduced pumping.

Conversions: *1 therm = 105,506,000 joules*
1 Joules = 1.0E -12 Terajoules
1,000 kWh = 1.0E+6 GWh

Source Notes: *1. Utility usage reported by We Energies.*

2. IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006, Volume 2: Energy Tables 1.4 and 2.4, Emission Factors, Commercial/Instiutional - Stationary Combustion.

3. Greenhouse Gas Potential for CH_4 taken from IPCC (2006). Greenhouse Gas Potential for N_2O taken from IPCC Third Assessment Report (2001).

4. EPA (Environmental Protection Agency) eGRIDweb Parent Company Owner-based Level Emissions Profile- Wisconsin Energy Corp. Pollutant Output Emission Rates, 2005.

5. EPA (Environmental Protection Agency) Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance, Direct Emissions from Mobil Combustion Sources, Section 3, Table 2: CH_4 and N_2O Emission Factors for Highway Vehicles, Gasoline Light-Duty Trucks, and Section 4, Table 5: Factors for Gasoline and On-Road Diesel Fuel, May 2008.

AECOM

Carbon Footprint Calculations - Option 2 - Move Sanitary Sewer Connectiuon and Repurpose Treatment Building

Mauthe
725 South Outagamie Street
Appleton, WI 54914-5072

Scope 1

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials 1	25	296	Total		
Gaseous Fuels Burned On-Site	**Year**	**Usage (therms/yr)**	**Usage (TJ/yr)**	kg CO_2/TJ	kg CH_4/TJ	kg N_2O/TJ	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO_2e/kg CH_4	kg CO_2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Natural Gas	2008	0	0.00	64,200	10	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		See Note 1		*See Note 2*	*See Note 2*	*See Note 2*					*See Note 3*	*See Note 3*			

Scope 2

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials 1	25	296	Total		
Purchased Electricity	**Year**	**Usage (kWh)**	**Usage (GWh)**	lb CO_2/GWh	lb CH_4/GWh	lb N_2O/GWh	lb CO_2	lb CH_4	lb N_2O	lb CO_2e/lb CO_2	lb CO_2e/lb CH_4	lb CO_2e/lb N_2O	kg CO_2e	lb CO_2e	ton CO_2e
	2008	13,488	0.013488	1.66	19.24	27.59	0.02	0.26	0.37	0.02	6.49	110.15	52.92	116.66	0.06
		See Note 1		*See Note 4*	*See Note 4*	*See Note 4*					*See Note 3*	*See Note 3*			

Scope 3

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials 1	25	296	Total		
Sampling/O&M Vehicle Usage	**Year**	**Usage (miles/yr)**	**Usage (gal/yr)**	kg CO_2/gallon	kg CH_4/gallon	kg N_2O/gallon	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO2e/kg CH_4	kg CO2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Unleaded Gasoline	2008	3,000	166.67	8.81	0.0036	0.0004	1,468.33	0.61	0.07	1468.33	15.18	19.54	1,503.05	3,314.22	1.66
				See Note 5	*See Note 5*	*See Note 5*					*See Note 3*	*See Note 3*			

Totals		
kg CO_2e	lb CO_2e	ton CO_2e
1,555.97	3,430.89	1.72

Assumptions: *Unleaded gasoline used for consultant transport to conduct O&M activities.*
60 site visits/year
50 miles/visit (roundtrip)
18 miles/gallon (for field vehicle)
**** No natural gas would be consumed if the sanitary sewer connection were moved to a small remediation enclosure. Natural gas is used for heating the existing treatment building***
**** Revenue generated by rental/repurposing of the existing treatment building are not included in the analysis.***

Conversions: *1 therm = 105,506,000 joules*
1 Joules = 1.0E -12 Terajoules
1,000 kWh = 1.0E+6 GWh

Source Notes: *1. Utility usage reported by We Energies.*

2. IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006, Volume 2: Energy Tables 1.4 and 2.4, Emission Factors, Commercial/Instiutional - Stationary Combustion.

3. Greenhouse Gas Potential for CH_4 taken from IPCC (2006). Greenhouse Gas Potential for N_2O taken from IPCC Third Assessment Report (2001).

4. EPA (Environmental Protection Agency) eGRIDweb Parent Company Owner-based Level Emissions Profile- Wisconsin Energy Corp. Pollutant Output Emission Rates, 2005.

5. EPA (Environmental Protection Agency) Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance, Direct Emissions from Mobil Combustion Sources, Section 3, Table 2: CH_4 and N_2O Emission Factors for Highway Vehicles, Gasoline Light-Duty Trucks, and Section 4, Table 5: Factors for Gasoline and On-Road Diesel Fuel, May 2008.

AECOM

Carbon Footprint Calculations - Option 3 - Installation of Photovoltaics at Site

Mauthe
725 South Outagamie Street
Appleton, WI 54914-5072

Scope 1

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Gaseous Fuels Burned On-Site	**Year**	**Usage (therms/yr)**	**Usage (TJ/yr)**	kg CO_2/TJ	kg CH_4/TJ	kg N_2O/TJ	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO_2e/kg CH_4	kg CO_2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Natural Gas	2008	1,714	0.18	64,200	10	0.6	11,606.94	1.81	0.11	11,606.94	45.20	32.11	11,684.24	25,763.76	12.88
		See Note 1		*See Note 2*	*See Note 2*	*See Note 2*					*See Note 3*	*See Note 3*			

Scope 2

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Purchased Electricity	**Year**	**Usage (kWh)**	**Usage (GWh)**	lb CO_2/GWh	lb CH_4/GWh	lb N_2O/GWh	lb CO_2	lb CH_4	lb N_2O	lb CO_2e/lb CO_2	lb CO_2e/lb CH_4	lb CO_2e/lb N_2O	kg CO_2e	lb CO_2e	ton CO_2e
	2008	0	0	1.66	19.24	27.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		See Note 1		*See Note 4*	*See Note 4*	*See Note 4*					*See Note 3*	*See Note 3*			

Scope 3

				Emission Factors			Mass			CO_2e Greenhouse Gas Potentials			Total		
										1	25	296			
Sampling/O&M Vehicle Usage	**Year**	**Usage (miles/yr)**	**Usage (gal/yr)**	kg CO_2/gallon	kg CH_4/gallon	kg N_2O/gallon	kg CO_2	kg CH_4	kg N_2O	kg CO_2e/kg CO_2	kg CO2e/kg CH_4	kg CO2e/kg N_2O	kg CO_2e	lb CO_2e	ton CO_2e
Unleaded Gasoline	2008	3,000	166.67	8.81	0.0036	0.0004	1,468.33	0.61	0.07	1468.33	15.18	19.54	1,503.05	3,314.22	1.66
				See Note 5	*See Note 5*	*See Note 5*					*See Note 3*	*See Note 3*			

Totals		
kg CO_2e	lb CO_2e	ton CO_2e
13,187.29	29,077.98	14.54

Assumptions: *Unleaded gasoline used for consultant transport to conduct O&M activities.*
60 site visits/year
50 miles/visit (roundtrip)
18 miles/gallon (for field vehicle)
**** Assumes 100 percent of the electricity will be generated by photovoltaic power.***

Conversions: *1 therm = 105,506,000 joules*
1 Joules = 1.0E -12 Terajoules
1,000 kWh = 1.0E+6 GWh

Source Notes: *1. Utility usage reported by We Energies.*

2. IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006, Volume 2: Energy Tables 1.4 and 2.4, Emission Factors, Commercial/Instiutional - Stationary Combustion.

3. Greenhouse Gas Potential for CH_4 taken from IPCC (2006). Greenhouse Gas Potential for N_2O taken from IPCC Third Assessment Report (2001).

4. EPA (Environmental Protection Agency) eGRIDweb Parent Company Owner-based Level Emissions Profile- Wisconsin Energy Corp. Pollutant Output Emission Rates, 2005.

5. EPA (Environmental Protection Agency) Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance, Direct Emissions from Mobil Combustion Sources, Section 3, Table 2: CH_4 and N_2O Emission Factors for Highway Vehicles, Gasoline Light-Duty Trucks, and Section 4, Table 5: Factors for Gasoline and On-Road Diesel Fuel, May 2008.