Remedial Investigation Report

UMore Park/Former Gopher Ordnance Works

Prepared for
University of Minnesota

May 2017

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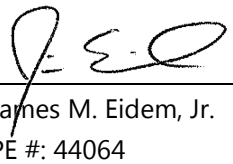
Certifications

I hereby certify that this plan, document, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Geologist under the laws of the state of Minnesota.



May 5, 2017

James M. Eidem, Jr.
PE #: 44064

Date

Acronyms

Acronym	Description
ACM	Asbestos Containing Material
AOC	Area of Concern
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
Bgs	Below Ground Surface
B(a)Pe	Benzo(a)pyrene Equivalent
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIP	Community Involvement Plan
COC	Constituent of Concern
COPC	Constituent of Potential Concern
DCTC	Dakota County Technical College
DNT	Dinitrotoluene
DRO	Diesel Range Organics
EIS	Environmental Impact Statement
ESA	Environmental Site Assessment
ESI	Expanded Site Inspection
ESSL	Ecological Soil Screening Level
eV	Electron Volts
FSI	Focused Site Inspection
FSP	Field Sampling Plan
FUDS	Formerly Used Defense Sites
GOW	Gopher Ordnance Works
GPS	Global Position System
GUE	George's Used Equipment
HHRA	Human Health Risk Assessment
HRL	Health Risk Limit
IDW	Investigation Derived Waste
ISM	Incremental Sampling Method
ISV	Intrusion Screening Value
LIDAR	Light Detection and Ranging
LWBS	Laminex Wood Box Sewer
MCL	Maximum Contaminant Level
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDL	Method Detection Limit
MDNR	Minnesota Department of Natural Resources
MERLA	Minnesota Environmental Response and Liability Act
MPCA	Minnesota Pollution Control Agency
MSL	Mean Sea Level
NCP	National Contingency Plan

NHD	National Hydrography Dataset
NIRC	Naval Intelligence Reserve Center
NPL	National Priorities List
NWI	National Wetland Inventory
OC	Organochloride
PA	Preliminary Assessment
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PE	Porter Machine and Electric Co.
PHA	Public Health Assessment
PID	Photoionization Detector
PLP	Minnesota Permanent List of Priorities
PRT	Post Run Tubing
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
RI	Remedial Investigation
RL	Reporting Limit
RME	Reasonable Maximum
ROD	Record of Decision
RPF	Relative Potency Factor
SFSP	Supplemental Field Sampling Plan
SI	Site Inspection
SIM	Selected Ion Monitoring
SLERA	Screening Level Ecological Risk Assessment
SLRA	Screening Level Risk Assessment
SOC	Site of Concern
SRV	Soil Reference Value
SSBTV	Soil-Specific Background Threshold Value
SSI	Supplemental Site Inspection
SVOC	Semi-volatile Organic Compound
TPHs	Total Petroleum Hydrocarbons
UMA	UMore Mining Area
UMore Park	University of Minnesota Outreach, Research, and Education Park
UMRRC	University of Minnesota Rosemount Research Center
USACE	United States Army Corps of Engineers
USEPA	United State Environmental Protection Agency
UST	US Transformer
VOC	Volatile Organic Compound
XRF	X-ray Fluorescence

1.0 Introduction

This Remedial Investigation Report has been prepared on behalf of the University of Minnesota by Barr Engineering Co. (Barr) to present the results of the 2016 Remedial Investigation (RI) of the University of Minnesota Outreach, Research, and Education (UMore) Park/former Gopher Ordnance Works (GOW) located in Dakota County, Minnesota (RI project area or Site; Figure 1). The GOW was an approximately 13,500-acre federal government-owned, contractor-operated facility constructed during World War II for the production of smokeless cannon and rifle powder and related products. E.I. du Pont de Nemours and Company (DuPont) was the contractor that designed, built, and operated GOW for the federal government. Immediately after World War II ended, the GOW was declared surplus property, and the federal government completed significant decommissioning, decontamination, dismantling, and demolition activities throughout the GOW. The University acquired approximately 8,000 acres of GOW from the federal government in 1947 and 1948. Since then, the University established UMore Park in the northern portion of the RI project area and, in cooperation with the Minnesota Department of Natural Resources (MDNR), the Vermillion Highlands Research, Recreation, and Wildlife Management Area (Vermillion Highlands) was established in the southern portion of the RI project area (Figure 2).

1.1 Purpose

The University conducted this RI at the request of the Minnesota Pollution Control Agency (MPCA) to complete the RI process of determining the source, magnitude, and extent of releases of hazardous substances or petroleum at the RI project area. Specifically, based on comments the University received from the MPCA and on findings of earlier stages of the RI and other previous investigations, the following 10 sub-sites were identified for initial or further investigation:

- Waste Disposal Ditch, Primary and Secondary Settling Ponds (Area of Concern [AOC] 1);
- 154th Street Disturbed Area (AOC 6);
- Steam Plant and Associated 26.7 Acres (AOC 7);
- Temporary Shops Area;
- Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump;
- Acid Plant Area;
- Coal Ash Pond and Drainage Way;
- Building 237G;
- Laminex Wood Box Sewer (LWBS); and
- Northern Disturbed Area.

These 10 sub-sites are shown on Figure 3. As described in the RI Work Plan (Barr, 2016a) and based on the extensive and cumulatively comprehensive nature of this and past environmental investigations performed at the Site, this RI is intended to complete the RI process for purposes of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Minnesota Environmental Response and Liability Act (MERLA). As such, this RI Report includes comprehensive summaries of past investigations and appended tables and figures with analytical results from this RI and prior environmental investigations conducted by the University and others throughout the RI project area. These results were used to identify and delineate the source, magnitude, and extent of the releases of hazardous substances or petroleum at each of the 10 RI sub-sites, and assess the potential risks to human health and the environment posed by the releases identified in this phase of the RI and in prior studies. The results will be used to develop remediation strategies to address those releases as appropriate.

1.2 Scope

The scope of the RI was developed by the University with input from the MPCA, the Minnesota Department of Health (MDH; MDH, 2014), the United States Army Corps of Engineers (USACE), and Dakota County. The RI scope was based on a series of site assessments and environmental investigations that have been completed at the Site over approximately the last 15 years. The scope of the investigation was consistent with the University's draft RI Scope of Work provided to the MPCA, MDH, and USACE for review and comment in 2015 (Barr, 2015a). The draft scope of work was updated and clarified in subsequent RI planning documents, including the RI Work Plan (Barr, 2016a), the Sampling and Analysis Plan (Barr, 2016b), which included a Field Sampling Plan for the first stage of the RI (Stage 1 investigation; Barr, 2016c) and the Quality Assurance Project Plan (QAPP; Barr, 2016d), the Supplemental Field Sampling Plan (Barr, 2016e), and the revised QAPP (Barr, 2016f). These RI planning documents were reviewed and approved by the MPCA. Copies of the approval letters are provided in Appendix A.

Specific RI activities included the following:

- Preparing the preliminary scope of work (Barr, 2015a) and the RI planning documents (Barr, 2016a, 2016b, 2016c, 2016d, 2016e, and 2016f), and the Community Involvement Plan (CIP; University, 2016a). These documents are available for review at http://www.umorepark.umn.edu/planning/gowinvestigation/repository/index.htm;
- Providing public notice of the Draft RI Work Plan in April 2016, presenting the draft RI scope at a public meeting on April 26, 2016, accepting public comments on the draft RI scope between April 11 and May 17, 2016, and finalizing the RI planning documents;
- Soil sampling and field screening from 106 direct-push soil borings, 76 test trenches, 11 hand auger borings, and 44 surface soil sampling locations;
- Completing laboratory analysis of approximately 460 individual soil samples and three area-wide composite soil samples using Incremental Sampling Methodology (ISM; ITRC, 2012). Soil analytes included metals (Resource Conservation and Recovery Act [RCRA] metals and other metals), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), semi-volatile organic

compounds (SVOCs), volatile organic compounds (VOCs), and 2,4-dinitrotoluene and 2,6-dinitrotoluene (DNT);

- Collecting groundwater samples from eight existing wells and seven temporary wells at or downgradient of investigated sub-sites for chemical analysis. Groundwater analytes included metals, SVOCs, VOCs, and 1,4-dioxane;
- Collecting soil gas samples from two soil borings for chemical analysis. Soil gas analytes included VOCs and SVOCs;
- Video logging approximately 11,400 feet of the LWBS and collecting soil samples beneath observed breaks in the LWBS with angled soil borings;
- Preparing this RI report; and
- Presenting the RI findings at a public meeting after this RI report is published.

This RI and previous assessments of the RI project area were performed using methods that were consistent with CERCLA guidance, the National Contingency Plan (NCP), MERLA, and Formerly Used Defense Sites (FUDS) Program guidelines (USACE, 2004), with the oversight of the MPCA (Peer, 2003, 2006a and 2006b; USACE, 2006, 2009a, 2009b and 2009c; Barr, 2009b, 2009c, 2010a, 2010b, 2010c, 2011 and 2012). This RI and the previous investigations included the completion of the following RI project area-wide scope of work:

- 1,695 investigation locations, including surface soil samples, soil borings, test trenches, groundwater sampling locations, monitoring and water wells, and subsurface soil gas sampling locations;
- 2,171 soil samples collected and analyzed for constituents of potential concern (COPC);
- 47 groundwater samples collected and analyzed for COPC; and
- 116,304 analytical data records (*i.e.*, individual parameter results for soil or groundwater samples).

The University conducted this RI to complete the RI process for the Site consistent with CERCLA, the NCP, and MERLA. As indicated in communications with the MPCA and in accordance with recommendations by the MDH in the draft Public Health Assessment for the Former GOW (MDH, 2014), the University recognizes that additional investigation of specific areas of the Site may be required in the future during redevelopment or when land use changes in those areas.

1.3 Report Organization

The remainder of this report is organized into the following sections:

- Section 2: RI Project Area Background, Physical Setting and Previous Studies – describes the location, physical setting, operational history, and previous environmental investigations conducted at UMore Park/GOW;

- Section 3: Investigation Activities – describes the sampling approaches and investigation activities;
- Section 4: Source, Nature, and Extent of Impacts – describes the source, nature, and extent of hazardous substances or petroleum identified at the 10 sub-sites;
- Section 5: Baseline Risk Evaluation – provides an evaluation of the potential risk to human health posed by the identified releases;
- Section 6: Constituents of Concern – identifies and discusses the presence and distribution of constituents of concern at the RI project area with respect to applicable screening criteria;
- Section 7: Summary – provides a summary of the investigation results;
- Section 8: References – provides a list of cited references;
- Tables – summaries of the RI sampling programs, analytical data, and site summary details;
- Figures – maps showing the locations of the 10 sub-sites, investigation locations for each sub-site, and analytical results compared to risk-based screening criteria; and
- Appendices – consist of RI documentation, analytical reports, tables with data from this RI and previous investigations, the quality assurance/quality control review summary of the RI data, maps showing the RI and previous investigation locations for the 10 RI sub-sites and sites investigated during previous RI phases, technical memoranda, the Screening Level Risk Assessment for AOC 1 with recommended next steps, and pertinent RI-related approvals and other correspondence.

2.0 RI Project Area Background, Physical Setting and Previous Studies

2.1 Site Description and Current Use

UMore Park/GOW is located approximately 15 miles southeast of the Twin Cities in Dakota County (Figure 1). The City of Coates is located east of the RI project area and Dakota County Technical College (DCTC) and the City of Rosemount are located to the north and northwest, respectively. The portion of the UMore Park/GOW located south of Dakota County Road 46 is located within Empire Township.

The RI project area is comprised of the three subareas: the UMore Mining Area (UMA), UMore East, and Vermillion Highlands (Figure 2). The UMA comprises the western one third of UMore Park and is approximately 1,700 acres in size. The UMA was the subject of an Environmental Impact Statement (EIS) and associated environmental assessments that were completed in 2010 for aggregate mining activities (University of Minnesota, 2010a). The eastern two thirds of UMore Park, referred to as UMore East, is approximately 3,500 acres in size and includes most of the industrial portion of the GOW. The UMore East subarea was the subject of RI activities in 2011 and was further subdivided into functional areas including GOW East, ABC Line, GOW Central, GOW West, and GOW North for the purpose of describing prior GOW and post-GOW land uses (Barr, 2012a). Much of the UMore East subarea has never been used by the University due to the presence of GOW foundations and other ruins; the primary land uses in the balance (usable) portion of UMore East are agricultural research and farming. The portions of the UMore East subarea that contain former GOW building foundations and structures are posted for no trespassing. The Vermillion Highlands subarea is a 2,822-acre research, recreation, and wildlife management area located south of the UMA and UMore East subareas and is jointly managed by the University and the MDNR. Vermillion Highlands is used for farming and recreation activities, including hunting, hiking, biking, trail riding, and cross-country skiing. Former GOW operations in the Vermillion Highlands subarea primarily included smokeless powder packaging and storage and disposal of GOW process waste water through the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1), located along the eastern boundary of the Vermillion Highlands subarea.

The 10 sub-sites investigated in this RI are located in the UMore East and Vermillion Highlands subareas (Figure 3).

2.2 Physical Setting

The physical setting of the RI project area in terms of climate and topography, soils, surface water, geology, and hydrogeology is described in the following subsections.

2.2.1 Climate and Topography

The average daily maximum temperature at the Site ranges from 23 to 83 degrees Fahrenheit and the average annual precipitation is approximately 32.5 inches (NOAA, 2008). The ground surface elevation varies from approximately 960 feet mean sea level (MSL) near the northwestern corner of the Site to

approximately 860 feet MSL near the southeastern corner (Figure 4). The topography is relatively flat in the former GOW operating areas with the exception of former soil borrow pits.

The total precipitation in the Twin Cities was 17.4 inches between June and August 2016. This precipitation amount is approximately five inches above the average precipitation for this area during the summer months. Based on a review of available data, 2016 was the eighth wettest summer on record (MDNR, 2016).

2.2.2 Soils

Waukegan and Wadena series soils cover much of the UMA and UMore East and the northern portion of Vermillion Highlands (Figure 5). The Waukegan series soils consist of deep, well-drained soils that formed from loess (windblown silt), silty glacial alluvium, or outwash plains and stream terraces. These soils are described as moderately to rapidly permeable and have the ability to readily infiltrate water. Wadena series soils consist of well drained soils formed in glacial outwash. Wadena soils have moderate permeability and form on slopes of zero to 18 percent. The soils in the GOW Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) include loams in the Waukegan and Wadena soil series, well-drained sandy loam of the Hawick series, and silty clay loam of the Kato series that consist of poorly drained soils (USDA, 2016). The soils in the southern portion of the Vermillion Highlands subarea are loams (Figure 5).

2.2.3 Surface Water

The Mississippi River is located approximately five miles northeast of UMore Park. The Vermillion River is located near the southern boundary of Vermillion Highlands (Figure 1).

Wetland delineation activities were conducted in the UMA as part of the EIS (University of Minnesota, 2010a). Two wetlands were delineated as small, shallow, primarily seasonal, and isolated depressions (Figure 6) and four similar wetlands were delineated along the western and northern UMA boundaries. Two intermittent streams (*i.e.*, potential tributaries to the Vermillion River) from the National Hydrography Dataset (NHD), were identified in the southern portion of the UMA. Both intermittent streams were investigated in the field and reviewed using light detection and ranging (LIDAR) contour maps and high resolution aerial photography. Both were noted to lack a defined channel. Jurisdictional Determinations for the intermittent streams were submitted to the USACE, and the USACE concurred that there are no Waters of the United States in the UMA.

Wetland delineation activities have not been conducted to confirm the presence or absence of water bodies or wetlands in the UMore East and Vermillion Highland subareas. Wetland and surface water features from the National Wetland Inventory (NWI) and NHD for these subareas are shown on Figure 6. Intermittent streams trending from northwest to southeast are mapped through Vermillion Highlands and throughout the northern and middle portions of the Waste Disposal Ditch, Primary and Secondary Settling Ponds (AOC 1). Perennial streams (potential tributaries to the Vermillion River) and NWI-identified wetlands are mapped in the southern portion of the Waste Disposal Ditch, Primary and Secondary Settling Ponds (AOC 1) and in the southwestern corner of Vermillion Highlands. Potential, isolated wetlands are

shown in the northern portions of the UMore East subarea. Based on delineation activities in the UMA, the extent of the intermittent streams in Vermillion Highlands may be overestimated by the NHD.

In recent years, surface water was usually only observed in the southern portion of the Waste Disposal Ditch, Primary and Secondary Settling Ponds (AOC 1) sub-site, near of the former dam/weir outlet structure for the secondary settling basin (USACE, 2009d). However, during the RI activities, standing water was observed throughout much of the southern portion of AOC 1, including the Secondary Settling pond. This condition was likely due to the above average precipitation totals in 2016. Flowing water was not observed in the northern and middle portions of the Waste Disposal Ditch, Primary and Secondary Settling Ponds (AOC 1) sub-site during this RI.

2.2.4 Geology

A generalized stratigraphic column for the RI project area is shown on Figure 7.

The top soil at the UMore Park/GOW is generally less than five feet thick and is derived from loess and outwash plain deposits. In the former GOW operations area, the top soil structure was disturbed or removed in many areas during the construction and operation of GOW by DuPont and/or decommissioning, decontamination, dismantling, and demolition of GOW by the federal government. The underlying glacial deposits consist of outwash comprised of sand and gravel or Superior Lobe till that is described as a lean clay textured matrix with variable percentages of sand and gravel (Barr, 2009a; ProSource, 2008).

The uppermost laterally contiguous bedrock unit beneath the RI project area is the Prairie du Chien Group (Barr, 2009a), a thin to thickly bedded dolomitic unit. Isolated erosional remnants of the overlying St. Peter Formation Sandstone are present above the Prairie du Chien Group in the UMore East subarea. Approximate top-of-bedrock elevation contours are shown on Figure 8 (Barr, 2009a). Bedrock is present at the ground surface in the south-central portion of Vermillion Highlands (*e.g.*, Lone Rock).

2.2.5 Hydrogeology

The Prairie du Chien Group and the underlying Jordan Sandstone Formation together comprise the primary aquifer that is used locally for potable water supply and crop irrigation. The St. Lawrence Formation, which is considered an aquitard (or confining unit), is present below the Jordan Sandstone.

Regional groundwater flow in the unconsolidated deposits and underlying bedrock aquifers is to the northeast towards the Mississippi River (Figures 9 and 10; Barr, 2009a). The groundwater elevation in the unconsolidated deposits is anticipated to vary from approximately 880 feet MSL to 840 feet MSL across the RI project area. The groundwater flow direction in the northeastern portion of the project area is affected locally by the presence of bedrock valleys (Twin Cities Testing, 1985; Barr, 2009a). Minor amounts of perched water may be present above the till in some areas (USACE, 2009b). The water table is located in the Prairie du Chien Group east of the Site (Barr, 2009a).

2.3 Site History

The U.S. War Department condemned approximately 12,000 acres and acquired easements on another approximately 1,500 acres of farmland for the construction and operation of the GOW. In military parlance, the term "Works" was used for an ordnance plant dedicated to the manufacture of gun powder and other raw materials that were shipped elsewhere for munitions manufacturing. Government records indicate that no high explosives or live munitions were assembled, stored, or tested at the GOW.

The GOW was a federal government-owned, contractor-operated manufacturing facility that was commissioned for the production of smokeless cannon and rifle powder as part of the World War II effort. It was sized and partially constructed by DuPont to accommodate six powder production lines (Figure 11). The powder production lines were known as the ABC Lines, which were located in the northeastern portion of the GOW and were used for the production of smokeless cannon powder, and the DEF Lines, which were located in the north central portion of the GOW and were intended for the production of rifle powder. Due to staffing shortages and positive outcomes of the war effort, among other things, the DEF lines were not fully constructed and were not operated. In total, the GOW produced smokeless cannon powder, primarily on the "B" production line, for approximately nine months between January 1945 and October 1945. After the war, the federal government declared the GOW to be surplus property, completed decontamination activities for explosives residues, and dismantled and demolished most of the buildings. The University then acquired approximately 8,000 acres of the GOW from the federal government, along with certain buildings and related infrastructure in 1947 and 1948. At the direction of the federal government, the University conveyed the GOW Power Plant A and surrounding area, referred to as the Steam Plant and Associated 26.7 Acres (AOC 7), back to the federal government in 1951. The University reacquired AOC 7 in 1961 after the government had "cannibalized" equipment in the building during and after the Korean War (USACE, 2009a).

Recent post-GOW uses have primarily involved agricultural and other research, farming, commercial tenant operations, and more recently, aggregate mining in the UMA and outdoor recreation activities in Vermillion Highlands. Additional details of post-GOW uses are described in the Phase I Environmental Site Assessment (ESA) reports (Barr, 2011 and 2010a; Peer, 2006a).

The historical uses of the 10 sub-sites investigated in this RI are described in Section 4.0.

2.4 Previous Investigations

UMore Park/GOW has been the subject of numerous investigations that have involved site assessment and environmental sampling and analyses (Table 1). These investigations have been completed in a manner that is consistent with CERCLA, MERLA, and the NCP. The primary steps in the CERCLA site investigation process are:

1) A Preliminary Assessment (PA) that involves completing an initial site assessment by reviewing readily available information and conducting a site visit to screen out portions of the site that pose little risk of significant environmental threat. The results of a PA are used to focus future investigation efforts on significant issues. A Phase I ESA is analogous to a PA.

2) A Site Inspection (SI) is performed on the areas identified for additional investigation in the PA. The objective of a SI is to determine if a release of hazardous substances or petroleum has occurred and to determine if additional investigation is required. A Phase II ESA, including release sampling, is analogous to a SI.

3) An RI involves collecting data to characterize site conditions and determine the source, magnitude, and extent of identified releases of hazardous substances or petroleum, assess risk to human health and the environment, and collect data to support the development of strategies for needed response actions.

As described in the following subsections, UMore Park/GOW has been the subject of CERCLA/MERLA-compliant site investigations, starting with site-wide coverage of PAs and Phase I ESAs that were conducted to screen out areas where releases of hazardous substances or petroleum are considered unlikely and to focus investigation efforts on AOCs/SOCs. Two SIs performed by the USACE, multiple Phase II ESAs (or equivalent investigations) by the University, and one Phase II ESA by the University, MPCA, and Dakota County have been conducted for release identification purposes to focus work on AOCs/SOCs with identified releases of hazardous substances or petroleum. RI activities were completed in the industrial portion of the former GOW in the UMore East subarea (Barr, 2012a) and in two AOCs in the UMA associated with the former GOW (AOC 3-DA1 and AOC 5; Barr, 2010b). This RI incorporates the data from these past investigations and includes additional new data collected at the 10 sub-sites that were identified as requiring additional investigation to complete the RI, and to help inform decision-making regarding potential cleanup requirements and future land use decisions.

2.4.1 Preliminary Assessments and Phase I ESAs

As described above, a PA is the first step in the CERCLA site assessment process and involves the review of readily available information and the completion of a site visit for the purpose of determining if additional site investigation or removal or remedial actions are warranted (USEPA, 1991). Similar to a PA, a Phase I ESA is a background study that involves the collection and review of existing and readily attainable information, a site reconnaissance visit, and other tasks to identify Recognized Environmental Conditions (RECs) at a site. No sampling is conducted during a PA or a Phase I ESA. The recognized standard for completing a Phase I ESA is published by American Society for Testing and Materials International (ASTM). The Phase I ESAs completed by the University at the UMore Park/GOW were performed in accordance with the then-current ASTM standard.

As described below, the entire RI project area has been evaluated in one or more PAs and/or Phase I ESAs. The areas with identified or suspected releases of hazardous substances or petroleum have been carried forward for further investigation and/or will be further investigated in the future in connection with redevelopment or land use changes proposed for those areas.

2.4.1.1 1947 Quitclaim Deed Property PA (USACE, 2006)

The USACE retained a consultant and conducted a PA on the 1947 Quitclaim Deed Property to determine if former Department of Defense activities may have resulted in a release or threatened release of

hazardous substances or petroleum, whether further investigations were warranted, and if so, which areas required further investigation (USACE, 2006). The 1947 Quitclaim Deed Property includes most of the UMA and Vermillion Highlands subareas (*i.e.*, the entire RI project area except for the UMore East subarea). In the 2006 PA, the USACE recommended further investigation of the following sites, referred to as areas of concern or AOCs, all of which were associated with the former GOW:

- AOC 1: Waste Disposal Ditch, Primary and Secondary Settling Ponds;
- AOC 2: Shipping/Storage Buildings South of 170th Street;
- AOC 3: Miscellaneous Drainage Areas;
- AOC 4: Sanitary Buildings;
- AOC 5: DNT Storage Bunkers; and
- AOC 6: 154th Street Disturbed Area.

2.4.1.2 Phase I ESA – UMore Park (Peer, 2006)

In 2006, a University consultant conducted a Phase I ESA of UMore Park in accordance with ASTM E 1527-05, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process" to identify RECs (Peer, 2006a). The Phase I ESA identified the following RECs:

- Releases and potential releases of hazardous substances or petroleum in GOW operational/functional areas;
- Potential releases from one or more waste sites identified by Dakota County; and
- Potential releases from past and present University tenants.

2.4.1.3 Steam Plant & Associated 26.7 Acres & Segments B, C, and D PA (USACE, 2009a)

In 2009, the USACE conducted a second PA to determine if further investigation of the GOW Steam Plant and Associated 26.7 Acres (AOC 7) was warranted based on past Department of Defense activities. This area is also referred to as Power Plant A (USACE, 2009a). This portion of the UMore Park was deeded to the University in 1948, conveyed back to the federal government in 1951, and returned to the University in 1961. In this PA, the USACE recommended that further investigation be conducted in GOW Steam Plant and Associated 26.7 Acres (AOC 7) to identify areas of possible hazardous substance or petroleum releases.

2.4.1.4 Phase I ESA Activities – UMA (Barr, 2009c)

In 2009, the University completed key components of a Phase I ESA in the UMA (Barr, 2009c). The following sites, referred to as sites of concern or SOCs, were identified for further environmental investigation:

- SOC 1: Former GOW Railroad "Y";
- SOC 2: Forestry Research/Former GOW Storage;
- SOC 3: Ag Engineering Complex/Former "K" Street Dump Area;
- SOC 4: Miscellaneous Drainage Area 1 (referred to as AOC 3 – DA1 in USACE PA, 2006);
- SOC 5: DNT Storage Bunkers (referred to as AOC 5 in USACE PA, 2006);
- SOC 6: Southern Complex Storage Buildings and Wash Pads;
- SOC 7: Suspected Dump Area West of Patrol Road and South of CR 46; and
- SOC 8: Undetermined Use Area West of Patrol Road and South of CR 46 (added based on input from Dakota County staff).

These sites were subsequently investigated by the University (Barr 2009b; Barr 2010b).

2.4.1.5 Phase I ESA – Vermillion Highlands (Barr, 2010a)

In 2010, the University retained Barr to conduct a Phase I ESA in accordance with ASTM E 2247-08, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property" to identify RECs within Vermillion Highlands (Barr, 2010a). Nine RECs were identified, including GOW-era process waste water discharges to the GOW Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) and the potential for past filling activities at the Northern Disturbed Area. The Findings, Opinions, and Conclusions Table from this Phase I ESA were included in the RI Work Plan (Barr, 2016a).

2.4.1.6 Phase I ESA – UMore East (Barr, 2011)

In 2011, the University retained Barr to conduct a Phase I ESA of the UMore East subarea, including the areas that were the subject of the USACE PAs (USACE, 2006 and 2009a). The Phase I ESA was conducted in accordance with ASTM E 1527-05, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process." The results from the 2006 Phase I ESA (Peer, 2006) and sites identified by Dakota County were considered in the 2011 Phase I ESA. Sites where credible historical information suggested the potential for past releases were screened through records review, site observation, and/or testing performed with the oversight of the MPCA Remediation Program, as discussed in Section 2.4.2 and Section 2.4.3, below. Seven RECs were identified relating to GOW and post-GOW operations (Barr, 2011). Within those seven RECs, the Phase I ESA identified 69 SOCs that were subsequently investigated as part of the UMore East RI (Barr, 2012a). The Findings, Opinions, and Conclusions Table from this Phase I ESA were included in the RI Work Plan (Barr, 2016a).

2.4.1.7 Former Gopher Ordnance Works Public Health Assessment (MDH, 2014)

A public health assessment (PHA) was performed by the MDH at the former GOW in 2013-2014 (MDH, 2014). The PHA was prepared to review historical reports and evaluate potential human health risks. The

University supported the PHA effort by providing the MDH with the analytical database from the 2012 RI (and previous studies) and other UMore Park/GOW background information.

The MDH identified physical hazards created by GOW-era foundations and ruins as the most significant potential public hazard. As a result, the University completed a survey of physical hazards and has completed mitigation in several of the high priority areas (University of Minnesota, 2015 and 2016b). With regard to environmental conditions, the PHA states, "*Although new discovery of significant contamination* [at the former GOW] *is not expected, there are many potential sub-sites that may ultimately be shown to need future remediation*" (if land use changes). The PHA also included specific recommendations for additional investigation and/or preventing access to surface soils at the following SOCs (which were included in this RI):

- Waste Disposal Ditch, Primary and Secondary Settling Ponds (AOC 1);
- Steam Plant and Associated 26.7 Acres (AOC 7);
- Temporary Shops Area;
- GOW Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump; and
- GOW Acid Plant Area.

Based on discussions with the MDH regarding the PHA and the draft Work Plan for this RI, the University included collection of samples from the GOW Burning Grounds for analysis of the extended list of PAHs, collection of samples from AOC 1 for antimony and thallium analysis, the collection of a surface water sample from AOC 1, and the addition of 1,4-dioxane to the analyte list for the groundwater samples collected at/downgradient of the Building 237G sub-site.

2.4.2 Site Inspections and Phase II ESAs

If warranted based upon the findings of a PA or a Phase I ESA, an SI or a Phase II ESA is performed to determine if a release or threatened release of hazardous substances or petroleum is present and to support a decision regarding the need for further investigation or removal or remedial action (USEPA, 1992). The SIs and Phase II ESAs described below were conducted based on the findings of the PAs and Phase I ESAs described in Section 2.4.1, above. Available analytical data from the SIs and Phase II ESAs described below are appended to this Report and the data from the 10 sites investigated as part of this RI are discussed in Section 4.

2.4.2.1 Preliminary Environmental Investigation – GOW Operating Areas (Peer, 2003)

A Preliminary Environmental Investigation was conducted jointly by the MPCA, the University, and Dakota County in 2003 to evaluate the potential presence of environmental impacts at the following GOW operating areas (Peer, 2003):

- Oleum Plant and Nitric Acid Plant (*i.e.*, GOW Acid Plant Area);

- GOW Burning Grounds;
- Maintenance Shops;
- Primary Settling Pond (in AOC 1); and
- Wastewater Treatment Plant (including portions of AOC 7 and the Coal Ash Pond).

Releases of hazardous substances or petroleum to soil at concentrations above the MPCA Tier 1 Soil Reference Values for unrestricted use (SRVs) were identified in the Nitric Acid Plant, the GOW Burning Grounds, and the Wastewater Treatment Plant areas.

2.4.2.2 Concrete and Soil Assessment – GOW Operating Areas (Peer, 2006b)

In 2006, a consultant to the University conducted a Concrete and Soil Assessment to evaluate the environmental condition of soils adjacent to and/or in contact with remnant concrete foundations in several GOW operating areas (Peer, 2006b). Soil and concrete samples were collected for laboratory analysis of numerous COPC. The work was focused on structures located in the following ABC Line and GOW East operating areas (identified by Peer, 2006b):

- East Acid Area and Oleum Plant (*i.e.*, GOW Acid Plant Area);
- Power Plant "A" Area (*i.e.*, AOC 7);
- Main Shops Area (including the a portion of the Temporary Shops Area);
- East Guncotton/Nitrocellulose Production Area (A, B, C Lines);
- East Solvent Area;
- East Powder Manufacturing Area; and
- East Powder Testing Area.

COPC detected in soil at concentrations above the MPCA Tier 1 SRVs were mercury, lead, PAHs as reported as benzo(a)pyrene equivalent (B(a)Pe) concentrations, PCBs, cadmium, and arsenic.

2.4.2.3 Focused SI – AOCs 1 through 7 (USACE, 2009b)

In 2009, the USACE retained a consultant to conduct a Focused Site Inspection (FSI) to determine if releases of hazardous substances had occurred to soil or sediment as a result of past Department of Defense activities in the seven AOCs identified in the PAs (USACE, 2006 and 2009a), and if so, whether the releases had migrated to the groundwater or surface water. The field portion of the FSI involved surveying the Steam Plant and Associated 26.7 Acres (AOC 7) and collecting and analyzing soil samples from AOCs 1 through 7 and background locations. Soil sampling results/findings were as follows:

- Releases of hazardous substances or petroleum to soils at concentrations above screening criteria were identified in the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1), 154th Street Disturbed Area (AOC 6), and the Steam Plant and Associated 26.7 Acres (AOC 7);
- The identified releases included metals, PAHs, and PCBs; and
- No further environmental investigation was warranted at AOCs 2, 3, 4, and 5.

In addition to the soil investigation, 21 temporary groundwater monitoring wells were installed and sampled to assess groundwater quality at AOCs 1 through 7 (USACE, 2009b). Groundwater samples were analyzed for one or more of the following: dissolved metals, VOCs, SVOCs, PCBs, total petroleum hydrocarbons (TPHs), nitrocellulose, and explosives. Chloroform was detected in groundwater samples at concentrations below the federal Maximum Contaminant Level (MCL) and nitrocellulose and DNT were detected in groundwater samples from AOC 1 and AOC7. Minnesota Health Risk Limits (HRLs) have not been established for nitrocellulose or DNT. Metals, VOCs, PCBs, and TPH were not detected above screening criteria. Estimated (J-flagged) concentrations of 3,3-dichlorobenzidine and trichloroethene were reported below the screening criteria.

A Screening Level Human Health Risk Assessment and a Baseline Ecological Risk Assessment were also conducted as part of this FSI (USACE, 2009d and 2009e).

2.4.2.4 Expanded SI – AOCs 1, 6, and 7 (USACE, 2009c)

The USACE retained a consultant to conduct an Expanded Site Inspection (ESI) to further delineate releases identified during the 2009 FSI. The ESI involved additional data collection in AOCs 1, 6, and 7 and background locations to help determine the need for further human health and ecological risk assessments for the three investigated AOCs. Soil analytes were RCRA metals, PAHs, and DNT in AOC 1, and PCBs in AOC 7. Surface water analytes were RCRA metals, PAHs by selective ion monitoring (SIM), and VOCs. Sediment analytes were RCRA metals, PAHs (SIM), and explosives. Groundwater samples were analyzed for metals and VOCs.

The results were as follows:

- RCRA metals, PAHs, and DNT in AOC 1 and PCBs in AOC 7 were detected in soil above USACE screening criteria;
- RCRA metals and VOCs were detected in surface water in AOC 1;
- RCRA metals and PAHs were detected above USACE screening criteria in sediments in the southern portion of AOC 1; and
- Barium, selenium, methyl ethyl ketone, acetone, and chloroform were detected in one or more groundwater samples at concentrations below HRLs at AOC 7.

2.4.2.5 Phase II ESA – SOCs 1-3 and 6-8 (Barr, 2009b)

In 2007, the University retained Barr to conduct a Phase II ESA to determine if historical activities in six of the SOCs identified in the UMA resulted in releases of hazardous substances or petroleum. The SOCs included in this investigation were:

- SOC 1: Former Railroad "Y";
- SOC 2: Forestry Research/Former GOW Storage;
- SOC 3: Ag Engineering Complex/Former "K" Street Dump Area;
- SOC 6: Southern Complex Storage Buildings and Wash Pads;
- SOC 7: Suspected Dump Area West of Patrol Road and South of CR 46; and
- SOC 8: Undetermined Use Area West of Patrol Road and South of CR 46.

The remaining two SOCs that had previously been identified in the UMA, the GOW Drainage Area (AOC 3-DA1) and the DNT Storage Area (AOC 5), were investigated as part of the Supplemental Site Inspection/Remedial Investigation as described in subsection 2.4.3.2, below (Barr, 2010b).

Forty-six investigation soil samples and five background soil samples were collected during this Phase II ESA. One of nine soil samples collected from the former GOW railroad grade (SOC 1) had PAH concentrations above the MPCA Tier 1 SRVs. Additional investigation showed that the PAH exceedance was limited to a small area in this portion of this SOC. Additionally, the former GOW railroad grades were included as a site-wide SOC in the 2012 RI as described in subsection 2.4.3.3, below (Barr, 2012a). Other Phase II ESA soil-related results included the observation of minor amounts of demolition debris and detection of arsenic at concentrations slightly above the Tier 1 SRV in soil at SOC 3 and asbestos containing materials (ACM) in surface soils at SOC 8.

Groundwater samples were collected from six temporary wells, one water supply well, and three upgradient monitoring wells. Groundwater samples were analyzed for VOCs, SVOCs, dissolved metals, perchlorate, nitrocellulose, nitrate-nitrogen, and Minnesota Department of Agriculture (MDA) List 1 and 2 pesticides. Nitrate-nitrogen was detected above the MCL in one sample.

These six SOCs were fully investigated during this Phase II ESA and other past studies and therefore, they were not investigated further as part of this RI.

2.4.2.6 Groundwater Assessment (Barr, 2009a)

In 2009, the University retained Barr to conduct a groundwater assessment, collect hydrogeologic data, and develop a calibrated groundwater flow model for UMore Park and the surrounding area (Barr, 2009a). The groundwater assessment involved placing borings to supplement the understanding of the hydrostratigraphy throughout UMore Park, installing and measuring water levels in a network of existing and new monitoring wells completed in the outwash, measuring groundwater elevations in a number of existing wells completed in the Prairie du Chien Group, completing aquifer testing to estimate hydraulic

parameters of the outwash deposit, and collecting water samples to determine baseline groundwater quality. Significant findings were as follows:

- Regional groundwater flow in the outwash and bedrock is to the northeast with discharge occurring toward the Mississippi River. A groundwater flow divide is located south of UMore Park; groundwater north of the divide flows toward the Mississippi River and groundwater south of the divide flows toward the Vermillion River; and
- Groundwater flow in the outwash appears to be affected locally by the presence of relatively lower permeability till in the central portion of UMore Park and by a bedrock valley in the northeastern portion of UMore Park.

As part of the UMA permitting process, five additional monitoring wells were installed in the northern portion of the UMA. These wells are monitored by the mining operator in accordance with the UMA groundwater monitoring plan (Barr, 2012b).

The groundwater assessment and related modeling effort provide the basis for the understanding of groundwater conditions within the RI project area.

2.4.2.7 NIRC Gun Range Investigation (Barr, 2010c)

In 2010, the University retained Barr to conduct a preliminary field investigation of the former skeet shooting range, trap shooting range, and firing range at the NIRC in the northcentral portion of UMore Park. A total of 88 soil samples were collected and analyzed for metals using x-ray fluorescence (XRF) methodology. Two samples were collected from the clay pigeon fallout zone and collected and submitted for laboratory analysis of SVOCs.

Lead and zinc concentrations were less than the MPCA Tier 1 SRVs. Arsenic was measured above the Tier 1 SRV but below the Tier 2 SRV for commercial/industrial land uses in five areas across the investigation area. The reported concentrations for lead, arsenic, and zinc were consistent with background soil concentrations. Trace concentrations of three SVOCs were detected in the samples from the clay pigeon fallout zone below their respective Tier 1 SRVs and below the Tier 1 SRV for B(a)Pe.

2.4.2.8 Environmental Baseline Survey (Versar, 2010)

In 2010, the Department of the Navy retained a consultant to conduct an Environmental Baseline Survey at the NIRC Site located at 14950 Akron Ave., Rosemount, MN. Based on observations and reviewed data, the property was judged to historically have had no storage, release, or disposal of hazardous substances or petroleum or their derivatives, including no migration of these substances, with the exception of the following:

- A former aboveground storage tank (AST) and underground storage tanks (UST). Regulatory closure has been obtained and no further action was deemed to be necessary;

- An area west of former Building 26 where surficial diesel spillage was documented but soil samples showed concentrations of hazardous substances below action levels and no further action was deemed to be necessary;
- The GOW burning grounds is located in north portion of this property and is included in this RI.
- PCB-impacted concrete, asphalt, and shallow soil near a pad-mounted transformer was excavated and disposed of off-site;
- An oil spill from a transformer was documented southeast of former Building I in August of 2010 during demolition operations. All affected soil was excavated and disposed of off-site. No PCBs were detected in the excavated soil; and
- ACM and lead-based paint was identified in structures on the property and removed prior to demolition of the structures.

2.4.2.9 Targeted Investigations

The investigations described below targeted specific sub-sites in the RI project area.

Soil Sampling at Possible Dog Park (Earth Tech, 2004)

In 2004, Dakota County conducted a soil investigation at a planned dog park located south of County Road 46 and east of Blaine Avenue to determine if soil impacts would preclude developing the study area into a dog park. The study area is located southeast of the intersection of East 164th Street and Blaine Avenue East and was used as a storage area for smokeless gunpowder during GOW operations. Smokeless powder was stored in this area in light-gauge rail cars in the "Christmas Tree" railroad spurs (Barr, 2012a).

Ten surface soil samples and five subsurface composite soil samples were collected and analyzed for nitroaromatic organic compounds, RCRA metals, PAHs, nitrogen, sulfur, and asbestos. None of COPC concentrations in the soil samples exceeded the Tier 1 SRVs.

Hmong Farm Cooperative Relocation Area (Barr, 2015b)

In 2015, The University retained Barr to conduct a limited environmental site assessment to evaluate soil conditions at a potential site that was proposed for the relocation of the Hmong Farming Cooperative to the northeast corner of 170th Street East and Blaine Avenue in Vermillion Highlands (Barr, 2015b). During GOW operations, the study area had been used for the temporary storage of smokeless gun powder. The environmental assessment identified the following RECs and findings:

- The former use of the "Christmas tree" railroad spurs to temporarily store rail cars and smokeless gun powder during GOW operations was considered a REC (Barr, 2011 and 2012a);
- Dumping of aerosol cans, chemical containers, car parts, appliances, and other miscellaneous debris observed during the site visit was considered a REC; and

- The GOW Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1), where concentrations of hazardous substances above industrial land use standards had been measured in surface soils, was considered a finding.

Following the environmental assessment, Barr conducted sampling to determine if releases of hazardous substances had occurred in areas of debris disposal and to verify that concentrations of COPC associated with former GOW operations were below Tier 1 SRVs for unrestricted use (Barr, 2015b).

Twenty-four composite soil samples were collected from the area considered for farming and fence installation. The composite samples were analyzed for arsenic, lead, mercury, and PAHs/SVOCs. Five discrete samples were collected from areas beneath dump and debris materials and were analyzed for VOCs, SVOC, RCRA metals, and organochlorine (OC) pesticides. The results from the analysis of these samples were below MPCA Tier 1 SRVs. The sampling activities did not identify a release of hazardous substances or petroleum in the area.

Wind Turbine Phase II (Barr, 2010d)

In 2010, the University retained Ryan Construction to develop a wind turbine site in the northeastern portion of UMore Park. Ryan Construction retained Barr to conduct a limited Phase II investigation in the area of a proposed wind turbine at UMore Park. Fourteen samples were collected at the ground surface to evaluate soil disturbed during initial site clearing, and three samples were collected at depth in the proposed foundation areas to evaluate soils that would be encountered during construction. Soil samples were analyzed for arsenic, lead, mercury, and PAHs. All samples were below the MPCA Tier 1 SRVs. Two additional test trenches were completed along 152nd Street between Blaine and Babcock Avenues, south of the former GOW Lead Burner Shop and the GOW Pipe Shop and Tool Shed to evaluate soils encountered along a proposed fiber optic alignment. One soil sample was collected from each test trench and analyzed for RCRA metals. The soil sample near the former GOW Pipe Shop and Tool Shed was also analyzed for PCBs. Metals concentrations were consistent with background concentrations and no PCBs were detected (University, 2010b).

2.4.3 Remedial Investigation Activities

The objectives of an RI are to collect data to characterize site conditions; determine the source, magnitude, and extent of identified releases of hazardous substances or petroleum for the purpose of assessing risks to human health and the environment; and support the development of strategies for response actions, if needed. Available RI analytical data for the investigations described below are appended to this report, and the data from the 10 sub-sites investigated as part of this RI are discussed in Section 4.

2.4.3.1 2009 USACE Risk Assessments

A Baseline Human Health Risk Assessments (HHRA) and Screening Level Ecological Risk Assessment (SLERA) were conducted by the USACE as part of the Expanded Site Inspection (USACE, 2009c). The HHRA estimated an excess cancer risk that exceeded the United States Environmental Protection Agency's (USEPA) target range for an area in AOC 7. The results of the SLERA indicated the potential for ecological

risks at each of the AOCs; however, USACE concluded that current and future uses of the AOCs in the UMore East subarea did not warrant additional investigation to refine the ecological risks (USACE, 2009c).

The USACE also prepared a Final HHRA (USACE, 2009e) and a Final SLERA (USACE, 2009d) for the former GOW. The purpose of the Final HHRA was to evaluate potential human health risks associated with current environmental conditions assuming that no actions to control or mitigate releases of hazardous substances or petroleum were implemented (*i.e.*, no further action or baseline scenario) and to help determine whether remedial actions are needed as a result of GOW operations in AOC 1, AOC 6, and AOC 7A and AOC 7D (USACE, 2009e). Based on the Final HHRA, USACE concluded that no adverse health effects would be expected as a result of exposure to COPC at the evaluated AOCs. The purpose of the Final SLERA was to evaluate the potential for ecological receptors to be exposed to chemicals at AOC 1, AOC 6, and AOC 7A and AOC 7D and to calculate conservative estimates of risk, based on maximum exposure concentrations. Results showed that AOC 1N and AOC 1M and AOC 7A and AOC 7D have the highest potential to contribute to impacts to surface soil-associated receptors (USACE, 2009d). Surface water and sediment results suggest that threats to aquatic receptors are potentially significant at AOC 1S and low at the other AOCs investigated. Although nitrocellulose from smokeless gun powder production activities is present in surface water and sediment, toxicity information shows that it is not highly toxic and its detection was concluded to not warrant additional evaluation.

With respect to the ecological risk assessment work, one objective of this RI was to collect additional data for better spatial characterization of AOC 1 so that decisions regarding future actions and associated risks can be evaluated with a higher degree of confidence. Based on current use and likely future development in AOC 7, no further ecological risk assessment is planned for AOC 7.

2.4.3.2 Supplemental SI/RI – SOCs 4 and 5 (a.k.a., AOC 3 and AOC 5) (Barr, 2010b)

In 2010, the University retained Barr to conduct a Supplemental Site Inspection and Remedial Investigation (SSI/RI) to identify and evaluate the nature and extent of hazardous substances or petroleum released during or after GOW operations at the following sites:

- AOC 3 – DA1: Miscellaneous Drainage Area 1 (referred to as SOC 4 in Barr, 2010b); and
- AOC 5 – DNT Storage Bunkers (referred to as SOC 5 in Barr, 2010b).

No releases were identified in SOC 4. Groundwater samples were collected at seven temporary well locations during the SSI/RI. The sample results showed thallium and beryllium concentrations above the HRLs but below MCLs. Both analytes are naturally occurring and anthropogenic sources were not identified.

Concentrations of PAHs, lead, and mercury in soil in SOC 5 exceeded MPCA Tier 1 SRVs. The magnitude and extent of the identified releases of these hazardous substances to soils in AOC 5 were adequately defined to support the development of strategies for response actions, if needed.

The results from the SSI/RI provided the information needed to support future land use changes. Further environmental investigation may be needed to support specific land use changes, but additional RI work is not needed at these SOCs.

2.4.3.3 UMore East Remedial Investigation (Barr, 2012a)

The 2012 UMore East RI was conducted on the former industrial production areas of the GOW. The RI was conducted to investigate known and potential releases of hazardous substances or petroleum associated with GOW and post-GOW activities on the portions of the GOW powder production area that were not investigated by the USACE. A total of 71 SOCs were identified in the UMore East subarea. A total of 578 soil samples were collected from test trenches, soil borings, surface soil locations, and sewer locations. Six temporary monitoring wells and nine existing monitoring wells were sampled to assess groundwater quality at locations downgradient of many of the SOCs (Barr, 2012a). Groundwater samples were analyzed for dissolved metals, VOCs, SVOCs, cations, anions (including perchlorate), and alkalinity. Samples from a monitoring well installed downgradient of AOC 7 (MW-B7-015) were also analyzed for explosives as a follow-up to the USACE SI results. Additionally, two geophysical investigations were completed in the central portion of the study area and portions of the GOW LWBS were inspected with remotely operated video equipment.

Results from this RI identified releases above MPCA Tier 1 SRVs in 39 of the 71 SOCs. Arsenic, lead, mercury, PAHs, and PCBs accounted for 160 of the 169 COPC detected at concentrations above the MPCA Tier 1 SRVs in soil samples collected during this RI and soil samples collected from the prior investigations described above.

Nitrate-nitrogen was detected in groundwater above the MCL upgradient of the UMore East subarea. The nitrate was attributed to regional agricultural land use. Chloroform concentrations ranged from non-detect upgradient of the UMore East subarea to 7.9 micrograms per liter at monitoring well PDC-C7-425291 in the eastern portion of the subarea. All chloroform concentrations were below the HRL and the MCL. Dinitrotoluene (including 2,4-dinitrotoluene or 2,6-dinitrotoluene), arsenic, lead, mercury, and silver were not detected in groundwater and no VOCs or SVOCs were detected above HRLs or MCLs. No explosives were detected in groundwater from monitoring well MW-B7-015.

2.5 University of Minnesota Rosemount Research Center NPL/PLP Site

The UMRRC Superfund Site was comprised of the following three University tenant sites – George's Used Equipment (GUE), Porter Machine and Electric Co. (PE), and US Transformer–and a burn pit operated by the University. The UMRRC Site was added to the Minnesota Permanent List of Priorities (PLP) in 1984 and the National Priorities List (NPL) in 1986 as a result of releases of hazardous substances (including PCBs and heavy metals) to soil from the GUE, PE, and US Transformer sites and to groundwater from the University burn pit (USEPA, 2012). These four CERCLA sites comprise approximately 10 acres in the north-central portion of the UMore East subarea (Figure 12).

A Record of Decision (ROD) was signed in June 1990 and a soil remedy that included thermal soil treatment and the establishment of institutional controls was implemented before the UMRRC Site was delisted from the PLP and NPL in 2001. Because the remedy selected by the USEPA included managing treated soil on site, the UMRRC Site is subject to the five-year review process. The USEPA completed the fourth five-year review in 2012 and concluded that the ROD remedies remain protective in the short term (USEPA, 2012).

Further investigation of the UMRRC Site was not included in this RI because it is not part of the Site for which this RI is being performed; it is an administratively closed Superfund site and is the subject of USEPA's ongoing five-year review process. Reports and analytical data from recent response action activities completed by the University at UMRRC as part of the most recent (2012) five-year review are available on the University's UMore Park webpage or at the MPCA.

3.0 Investigation Activities

The 2016 RI activities were conducted in two stages and are graphically illustrated on Figure 13. Stage 1 included sampling to define/refine the source, magnitude, and extent of identified releases at the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1), the 154th Street Disturbed Area (AOC 6), the Steam Plant and Associated 26.7 Acres (AOC 7), the Temporary Shops Area, the Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump, the Acid Plant Area, and the Coal Ash Pond and Drainage Way (Category 1 sites). Stage 1 sampling was also conducted at the Northern Disturbed Areas, Building 237G, and at the outlet of the LWBS (Category 2 sites) to determine if releases of hazardous substances or petroleum had occurred due to past use. Additionally, the LWBS was video-inspected for the purpose of identifying locations to collect soil samples beneath the sewer line during Stage 2. During Stage 2, additional soil samples were collected to further define the magnitude and extent of the releases that were identified or not fully defined during Stage 1.

The following sections describe the RI investigation activities.

3.1 Field Investigation

The RI field investigation activities were conducted by Barr staff and subcontractors under the oversight of Barr field management staff. The field methods were consistent with the planning documents (Barr, 2016a, 2016b, 2016c, 2016d, 2016e, and 2016f) with the exception of the minor (non-material) deviations described in Appendix B.

Stage 1 field activities were conducted between June 6 and June 23, 2016, and involved collecting soil samples from mechanical soil borings, test trenches, hand auger borings, and surface sample locations in areas of known or suspected releases, collecting groundwater samples at and downgradient of the RI sub-sites, collecting soil vapor samples at one RI sub-site, and performing other components of the investigation as described below. Direct push and hollow-stem auger borings were used to evaluate soil conditions at depth and provide information on geology, provided evidence of soil impacts, and collect groundwater samples at selected locations. Test trenches were used to evaluate shallow subsurface soils and investigate sites with potential buried debris. Hand auger borings were used to collect soil samples in the upper four feet in locations that were inaccessible by the direct push drill rig. Surface soil samples were collected using hand tools to assess COPC concentrations in the upper six inches of the soil profile below the rooting zone. Groundwater samples were collected to broaden Stage 1 investigation coverage at and downgradient of RI sub-sites. Soil vapor samples were collected at Building 237G to follow up on reported odors noted during previous drilling activities at that sub-site (ProSource, 2008).

The Stage 2 investigation activities were conducted between October 10 and November 22, 2016, and primarily included collecting step-out samples to assess the lateral extent of releases identified during Stage 1 and to complete the field work that was deferred from Stage 1.

The Stage 1 and 2 field investigation components are collectively summarized below:

- Prior to sampling, the ingress/egress routes for each soil boring and test trench location were inspected by an MDH certified asbestos inspector for the presence of ACM and to identify health or safety issues per the Asbestos Emission Control Plan (Barr, 2016h). In addition, a staff member from the University's Facilities Management – Hazardous Materials Program inspected each site to verify that ACM was not present in the access/egress routes including areas where trees were cleared to gain access to the investigation locations. No ACM was observed on the ground surface;
- Direct-push soil borings were placed at 106 locations by Dakota Technologies of New Hope, Minnesota;
- Test trenches were excavated at 76 locations by Stevens Drilling and Environmental of Maple Plain, Minnesota;
- Soil samples were collected from 44 surface soil sampling locations, 11 hand auger boring locations, and 10 background sampling locations. Composite soil samples were collected using the ISM across three areas in the Temporary Shops Area;
- Video of approximately 11,300 feet of the LWBS was collected to view the integrity of sewer and select locations for soil sampling;
- Background soil samples were collected from 10 locations. The data were pooled with previously collected background soil sample data and used to calculate Site-Specific Background Threshold Values (SBTVs; Appendix B);
- Soil gas samples were collected from two soil borings at Building 237G; and
- Groundwater samples were collected from eight existing monitoring wells, temporary wells placed in four direct push boreholes, and temporary wells placed in three hollow-stem auger boreholes to assess groundwater quality at and downgradient of selected RI sub-sites.

The investigation locations for each of the RI sub-sites are summarized in Table 1 and shown on Figures 14 through 24. Field documentation including soil boring and well logs, test trench logs, a photo log showing field investigation components, and a copy of the MPCA Spatial Data Reporting Form are provided in Appendix B.

3.2 Sample Collection and Analysis

The sample collection and analysis methods used in the RI were consistent with those described in the RI planning documents (Barr, 2016a, 2016b, 2016c, 2016d, 2016e, and 2016f) with the exception of the minor (non-material) deviations described in Appendix B.

3.2.1 Collection Methods

Barr staff collected soil samples from mechanical soil borings, test trenches, hand auger borings, and surface soil sampling locations. At each location, soils were screened in the field and classified in

accordance with the methods in the Field Sampling Plan (FSP; Barr, 2016c) and QAPP (Barr, 2016d and 2016f). Field screening included examining the soil samples and recording observations of moisture, odor, and discoloration. The samples were screened for the presence of organic vapors with a photoionization detector (PID) equipped with a 10.6 electron volts (eV) lamp. Soils were classified using the visual and manual test methods described in ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual/Manual). A sample of surface soil (0-0.5 feet) was collected at nearly every location due to the prevalence of COPC detections in surface soils during past investigations (Barr, 2012a) and the site-wide surface release assumptions described in the Work Plan (Barr, 2016a). If a release was suspected to subsurface soils based on field screening, a sample was collected from the interval judged to be the most impacted and at least one additional sample was collected at a greater depth to delineate the vertical extent of the possible release. Due to the magnitude of the investigation, the samples to define vertical and/or lateral extent were not necessarily placed to define the edge of the identified releases at each site. Future sampling to support land use changes will be conducted to provide greater delineation of the identified releases, if needed. Soil descriptions and field screening observations and measurements are included on the boring and test trench logs in Appendix B.

Groundwater samples were collected from existing monitoring wells, temporary wells completed in soil boreholes, and a retractable groundwater sampling screen placed in selected geoprobe borings. An electrical submersible pump was used to purge and collect groundwater samples from the existing wells and the two-inch diameter temporary wells and a check valve was used for the retractable screens. Depth to groundwater and stabilization parameter readings are included on sampling forms in Appendix B.

Soil gas samples were collected from borings advanced using a geoprobe post run tubing (PRT) system. The samples were collected at depth by advancing the PRT system to the target interval and pulling the drill rod back several inches. Two times the volume of the tubing and sampling train was purged prior to collecting a soil gas sample. The samples for VOC analysis were collected in six-liter evacuated canisters and the sample for SVOC screening was collected with a sorbent tube. The soil gas sampling forms are included in Appendix B.

3.2.2 Constituents of Potential Concern

The COPC in the RI were described in the Work Plan (Barr, 2016a) and sample analytes were provided in the FSPs for Stage 1 and Stage 2 of the field work (Barr, 2016b, 2016c, 2016d, and 2016f). Soil COPC identified for each sub-site were based on site use information and previous investigation results, the PHA (MDH, 2014), and comments received on the RI planning documents (Barr, 2016a, 2016b, 2016c, 2016d, 2016e, and 2016f). The primary COPC at the Site are arsenic, lead, mercury, PAHs, and PCBs in areas of past PCB use and in the sewers. Accordingly, the majority of the soil samples were analyzed for RCRA metals (which include arsenic, lead, and mercury) and PAHs. Soil samples collected in areas of known historical PCB use or areas of identified PCB releases were also analyzed for PCBs. If elevated organic vapor measurements, chemical odors, staining, or other indication of a potential petroleum release were identified, samples for VOCs and SVOCs were collected. At selected locations or at specific portions of a sub-site, additional soil analytes were included based on past investigation results, historical land use, or comments received on the planning documents, as appropriate. These additions included:

- Boron was added to the analyte list for samples collected from the Coal Ash Pond due to the presence of coal ash from GOW operations, based on comments from the MPCA;
- Approximately 10% of the Stage 1 soil samples collected from the GOW Burning Grounds were analyzed for the extended list of PAHs due to historical powder and building material burning activities during GOW operations, based on comments from the MPCA; and
- DNT was included as an analyte in AOC 1, based on past investigation results and SLERA results (USACE, 2009c and 2009d).

Specific uses varied across sub-sites such as the Acid Plant and the Temporary Shops Area. At these and similar sub-sites, the extent of some of the known releases were adequately delineated during the previous RI work and were not subject to further investigation under this RI. At other sites, such as AOC 1, the soil analyte list was reduced after the initial round(s) of sampling to delineate a previously identified release. Examples of this include:

- The Stage 1 sampling plan included broad sampling coverage throughout Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) for RCRA metals, PAHs, and DNT. Combined with prior investigations, more than 100 samples had been collected at this sub-site prior to the Stage 2 investigation. With the exception of four isolated detections of arsenic and one detection of lead, mercury was the only parameter that exceeded the soil screening criteria and was detected throughout the northern portion of AOC 1 and the Primary Settling Pond (Barr, 2016e). Based on the Stage 1 and prior investigation results, the Stage 2 investigation focused on delineating mercury concentrations in the northern portion of AOC 1 and the Primary Settling Pond;
- A release of lead to soils was identified at and around Building 303A in the Acid Plant Area during prior investigations (Barr, 2012; Peer, 2003). Based on previous investigation results, lead was the focus of the investigation of Building 303A in this RI. Investigation in other portions of the Acid Plant Area involved the primary COPC; and
- Sixty-five of the pre-RI soil samples collected at the Steam Plant and Associated 26.7 Acres (AOC 7) were analyzed for VOCs. Naphthalene, which is included in the SVOC parameter list, was the only VOC detected above Tier 1 SRVs. Due to the lack of VOC detections during past investigations, VOCs were not included in the RI parameter list for AOC 7.

Similar to soil COPC, the groundwater COPC were selected based on sub-site use information, past investigation results, recommendations in the PHA (MDH, 2014), and comments received from the MPCA and Dakota County on the RI planning documents. Soil gas analytes were VOCs and SVOCs.

This Report identifies the COPC for each of the 10 sub-sites included in this RI and the sites studied during previous investigations.

3.2.3 Analytical Methods

Laboratory analyses were conducted by Legend Technical Services, Inc. of St. Paul, Minnesota (Legend), ALS Environmental of Kelso, Washington (ALS-Kelso), and ALS Environmental of Simi Valley, California (ALS-Simi Valley). The laboratory methods were as described in the QAPP (Barr, 2016d and 2016f) with the exception of the minor deviations described in Appendix B. The soil and groundwater sampling programs are summarized in Tables 2 and 3, respectively. The sample collection and analysis activities involved:

- Collecting and analyzing approximately 480 soil samples. The soil sample analytes (with approximate counts in parentheses) included: RCRA metals (including arsenic, barium, cadmium, chromium, lead, mercury, selenium, and zinc; 373 samples); PAHs (282 samples including eight samples analyzed for the extended list PAHs); SVOCs (57 samples); VOCs (21 samples); PCBs (95 samples); DNT (only; 75 samples); mercury (only; 68 samples); boron (56 samples); lead (only; 11 samples); thallium (24 samples); and antimony (24 samples);
- Legend and ALS-Kelso analyzed the soil and groundwater samples. Legend analyzed soil and groundwater samples for metals, SVOCs, PAHs, PCBs, VOCs, and general groundwater chemistry parameters. ALS-Kelso analyzed groundwater samples for 1,4-dioxane and background soil samples for SVOCs, and the ISM soil samples for SVOCs and metals;
- ALS-Simi Valley analyzed the soil gas samples for VOCs. The soil gas samples were also screened for SVOCs using EPA method TO-17;
- Soil samples were reported to the laboratory reporting limits (RLs) except for the samples collected from AOC 1 and background sampling locations, which were reported to the method detection limits (MDLs). The samples from AOC 1 and the background sampling locations were reported to the MDLs in the event lower detection limits are needed for future background or ecological risk evaluations; and
- Reporting groundwater sample results to MDLs that are equal to or less than the groundwater criteria for most of the analytes, at the request of the MPCA.

Copies of the 2016 laboratory analytical reports are included in Appendix C.

3.3 Quality Assurance Review

Quality control data were evaluated to assess the integrity and validity of the analytical data generated during the RI. The analytical data were reviewed in accordance with the QAPP (Barr, 2016d and 2016f). The areas covered by the validation process were:

- Overall assessment;
- Holding times, preservation and storage;
- Method, trip and field blank analysis;
- Accuracy and precision;

- Surrogate recoveries; and
- Completeness.

Overall, the RI data and quality control complied with the project's data quality objectives as measured by the quality control samples. The data reported by the laboratories are considered useable subject to the data qualifiers assigned during the data evaluation process. Additional discussion of the analytical quality control review is provided in Appendix C.

3.4 Other Activities

The following other activities were also completed as a part of the RI in accordance with the Work Plan, FSP, and Supplemental FSP (SFSP; Barr, 2016a, 2016c, 2016e).

3.4.1 Borehole Sealing

The soil borings and temporary monitoring well boreholes were installed and decommissioned in accordance with the Dakota County Well Ordinance and the Minnesota Well Code. Sealing records are included in Appendix B.

3.4.2 Surveying

Soil boring, test trench, and surface sampling locations were surveyed using a differential Global Positioning System (GPS) receiver. Survey coordinates for each location are in Table 1.

3.4.3 Investigation Derived Waste Management

Investigation derived waste (IDW) was managed in accordance with the Work Plan (Barr, 2016a). No grossly impacted soil, visible product, primary threat wastes, or containers with liquid were encountered. Soil cuttings were thin spread on the ground in the vicinity of the drilling location. Excavated soil was segregated at each test trench excavation and was placed back in the test trench in the reverse order it was removed (*e.g.*, topsoil was placed on top) and compacted with the excavator bucket. Groundwater and decontamination water were irrigated to the ground surface. Personal protective equipment was disposed of as municipal solid waste.

4.0 Source, Nature and Extent of Impacts

This section summarizes the results from the RI and previous investigations for the 10 sub-sites investigated in this RI. Tables 4 through 14 provide soil sample analytical results for the parameters that were detected in at least one sample at the sub-site, as described in the subsections below. Sample locations are shown on Figures 14 through 24. Tables with the complete soil data set for these and previously investigated sub-sites are provided in Appendix D. MPCA Tier 1 SRVs for unrestricted use (MPCA, 2009) were the screening criteria used to identify and define the extent of releases to soil and are included in Tables 4 through 14. SRVs are risk-based soil concentrations based on land use assumptions and target risk levels (MPCA, 1998b). Tier 1 SRVs were selected as screening criteria in consultation with the MPCA and their use is conservative.

Groundwater results are compared to MCLs and MDH Human Health-Based Water Guidance criteria including HRLs in Table 14. Soil gas results are shown in Table 15 and are compared to MPCA's Intrusion Screening Values (ISVs) for residential land use. Groundwater and soil gas sampling locations are shown on Figure 25.

4.1 Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1)

The Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) was constructed in 1943 for the Army by DuPont to serve as an extension of the GOW sewer system. The Waste Disposal Ditch was used to transmit GOW process waste water that discharged from the end of the LWBS to the south through the Primary and Secondary Settling Ponds located in Vermillion Highlands, and ultimately to the Vermillion River. AOC 1 was designed to handle 100 million gallons per day of process waste water including GOW effluent, surface water from the shipping buildings, and surface water runoff and drainage from the GOW. Lime powder was used to neutralize the GOW industrial process waste water prior to being discharged. The Waste Disposal Ditch appeared to generally follow the natural drainage pattern but was reportedly enlarged to have sides up to 20+ feet high in areas south of 170th Street.

The Waste Disposal Ditch was taken offline by June 1946 during GOW decommissioning and the flow was re-routed to the Coal Ash Pond. Large quantities of hot, caustic water were reportedly flushed through the sewers to neutralize acidic process water present in the sewer lines (Hutchinson, 1946). According to GOW decommissioning records, soil was removed from the sides and bottom of the Waste Disposal Ditch near the LWBS outlet during decommissioning and was taken to the Burning Grounds and burned to remove nitrocellulose. The Waste Disposal Ditch was then backfilled from the LWBS outfall to a point approximately 200 feet south of 160th Street. The University did not discharge waste water to the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1).

The "M"-Street Dump (a.k.a., the Coates Dump) was located in a portion of the Waste Disposal Ditch located south of 170th Street and was first used during GOW decommissioning. The construction and use of the "M"-Street Dump likely followed the discontinuation of discharge to AOC 1. Disposal at the "M"-Street Dump continued until it was voluntarily closed by the University in 1988 (University, 1988). The RI included sampling two wells located northeast of "M"-Street Dump as described below.

A total of 81 surface or near surface soil samples (<4 feet below ground surface [bgs]) and 15 subsurface soil samples (>4 feet bgs) were collected in AOC 1 during the RI and analyzed for one or more of the following parameters: PAHs, RCRA metals, DNT, mercury, thallium, and/or antimony. Soil sample locations are shown on Figure 14 and analytical soil results are presented in Table 4.

Results for the Waste Disposal Ditch (AOC1N), Primary Settling Pond (AOC1M), and Secondary Settling Pond (AOC1S) investigation are discussed below by section (north, middle, and south).

North Section of the Waste Disposal Ditch (AOC1N)

- GOW process waste water flowed from the outfall of the LWBS through the north section of the Waste Disposal Ditch (AOC1N) before discharging to the Primary Settling Pond (AOC1M).
- Six soil samples were collected from the center of the Waste Disposal Ditch during previous investigations. Mercury exceeded Tier 1 SRVs of 0.5 mg/kg in three surface soil samples (AOC1N-GP1, AOC1N-GP102, and AOC1N-SS1) with a maximum concentration of 11 mg/kg (estimated).
- During this RI, 12 surface soil samples, six hand auger borings, and two test trenches were completed to evaluate the extent of the mercury release along the base of the Waste Disposal Ditch and up the sidewalls. No elevated headspace readings, other indications of soil impacts, or layered surface water deposits were observed.
- Twenty-six soil samples were collected during this RI and analyzed for one or more of the following parameters: RCRA metals, PAHs, DNT, and/or mercury. Mercury exceeded the Tier 1 SRV in three surface soil samples (AOC1N-HA1, 0-0.5'; AOC1N-HA2, 0-0.5'; AOC1N-HA3, 0-0.5') collected from the base/center of the Waste Disposal Ditch, with a maximum concentration of 0.89 mg/kg. No other analytes were detected above Tier 1 SRVs. Additional samples were collected from the sidewalls of the Waste Disposal Ditch to measure mercury concentrations around the mercury exceedance during the Stage 2 investigation. Mercury concentrations were below the Tier 1 SRV in all samples.

A release of mercury was identified in AOC1N. The extent of the release is limited to the base/center of the Waste Disposal Ditch, but was not detected in every base sample. The University did not discharge to AOC 1, so the source of the mercury release is attributed to the discharge of process waste water during GOW operations and/or decommissioning. The samples collected within AOC1N provide a basis to estimate the magnitude and extent of impacts for the purposes of the RI.

Middle Section of Waste Disposal Ditch and Primary Settling Pond (AOC1M)

- GOW process water from the northern portion of the Waste Disposal Ditch (AOC1N) flowed into the Primary Settling Pond (AOC1M) and continued past a berm and into an approximately 5,000-foot-long ditch segment located upstream of the Secondary Settling Pond during GOW operations.
- Twenty-nine soil samples were collected from AOC1M during previous investigations. Mercury exceeded the Tier 1 SRV in two surface soil samples from the Primary Settling Pond (AOC1M-GP1,

0-0.5' and AOC1M-GP101, 0-0.5') and two surface soil samples from the ditch between the Primary and Secondary Settling Ponds (AOC1M-SS2, 0-0.5'and AOC1M-GP3, 0-0.5') with a maximum concentration of 4.9 mg/kg (estimated).

- During this RI, nine surface soil samples were collected and one hand auger boring, two mechanical soil borings, and 15 test trenches were completed. No elevated headspace readings, other indications of soil impacts, or layered surface water deposits were observed.

- Forty-four soil samples were collected during this RI and analyzed for one or more of the following: PAHs, RCRA metals, DNT, and/or mercury. Mercury exceeded the Tier 1 SRV in nine surface soil samples (AOC1M-SB2, 0-0.5'; AOC1M-TT1, 0-0.5'; AOC1M-TT2, 0-0.5'; AOC1M-TT3, 0-0.5'; AOC1M-TT4, 0-0.5'; AOC1M-TT5, 0-0.5'; AOC1M-TT6, 0-0.5'; AOC1M-TT7, 0-0.5'; and AOC1M-TT8, 0-0.5') with a maximum concentration of 1.9 mg/kg. No other analytes were detected above Tier 1 SRVs. Additional samples were collected around the mercury exceedances during the Stage 2 investigation to more completely delineate the extent of the release. Concentrations of mercury were below the Tier 1 SRV in all samples. Elevated mercury concentrations are present throughout much of the Primary Settling Pond including the lower portions of the Primary Settling Pond sidewalls (Figure 14). Two of the 13 surface soil samples collected from the ditch between the Primary and Secondary Settling Ponds had mercury concentrations above the Tier 1 SRV.

A release of mercury was identified in surface soils (0-0.5') in AOC1M. The lateral extent of the mercury release is delineated to the edges of the Primary Settling Basin with two isolated exceedances present in the ditch located downstream of the Primary Settling Basin. The University did not discharge to AOC 1, so the mercury release is attributed to the discharge of process waste water during GOW operations and/or decommissioning. The samples collected within AOC1M provide a basis to estimate the magnitude and extent of impacts for the purposes of the RI.

<u>South Section of Waste Disposal Ditch and Secondary Settling Pond (AOC1S)</u>

- Process water from the Primary Settling Pond (AOC1M) and 5,000-foot-long ditch discharged to the Secondary Settling Pond (AOC1S) prior to flowing over the detention dam and into the Vermillion River.

- Thirty-one soil samples were collected from AOC1S during previous investigations. Arsenic was detected at or slightly above the Tier 1 SRV of 9 mg/kg at two locations, AOC1S-GP1 and AOC1S-GP2, at concentrations of 9.5 mg/kg or less. Lead was detected slightly above the Tier 1 SRV of 300 mg/kg at one location, AOC1S-SS2, at a concentration of 320 mg/kg. B(a)Pe was detected above the Tier 1 SRV of 2 mg/kg at one location, AOC1S-S110, which was collected near the detention dam that was constructed with treated wood.

- During this RI, 18 surface soil samples, two hand auger borings, and two soil borings were completed. No elevated headspace readings, other indications of soil impacts, or layered surface water deposits were observed.

- Twenty-six soil samples were collected during this RI and analyzed for one or more of the following: PAHs, RCRA metals, DNT, antimony, and/or thallium. Arsenic was detected above the Tier 1 SRV in two surface soil samples (AOC1S-SS201, 0-0.5' and AOC1S-SS205, 0-0.5') at concentrations of 9.5 mg/kg and 16 mg/kg, respectively. No other analytes were detected above the Tier 1 SRVs. Additional samples were collected around the arsenic exceedance during the Stage 2 investigation to determine the extent of the release and concentrations of arsenic were below the Tier 1 SRV in all samples.

Arsenic and lead were detected in isolated samples at concentrations that slightly exceeded the Tier 1 SRVs. B(a)Pe was detected above the Tier 1 SRV in one sample that was collected near the detention dam that was constructed of treated wood.

The University did not discharge to AOC 1; therefore, the source of the mercury release attributed to the discharge of process waste water during GOW operations, decommissioning, or other operations. The B(a)Pe detection is attributed to the treated wood used to construct the detention dam. The samples collected within AOC1S provide a basis to estimate the magnitude and extent of impacts for the purposes of the RI.

Two groundwater samples were collected from existing monitoring wells 513925 and 539514 located along 170th Street E (Figure 25). The groundwater samples were analyzed for VOCs, 1,4-dioxane, metals, thallium, and antimony. No analytes were detected above groundwater screening criteria (Table 14).

4.2 154th Street Disturbed Area (AOC 6)

The USACE designated the 154th Street disturbed area as AOC 6 as part of a PA (USACE, 2006) and investigated it as part of the Final Focused Site Inspection (USACE, 2009b) and the Final Expanded Site Inspection (USACE, 2009c). AOC 6 is a land surface depression located in the western portion of the UMore East subarea (Figure 15). AOC 6 has been concluded to have been a sand and gravel borrow pit during the construction of GOW that was later used during GOW operations and/or during decommissioning activities for disposal of demolition debris (Figure 15, 1945 aerial photo background). Additional filling appears to have taken place in limited areas in and/or around this sub-site after the GOW was decommissioned. Soil sampling locations are shown on Figure 15, and the results are in Table 5.

Fill and debris have been observed at the ground surface to depths greater than five feet (USACE, 2009c). The debris includes concrete, rebar, asphalt, metal, wire, and transite. A total of 30 soil samples have been collected during previous investigations and ten of the soil samples exceeded the Tier 1 SRV for PAHs, arsenic, and/or mercury.

Three soil borings, AOC6-SB3 through AOC6-SB5, were placed along the north boundary of the depression to verify the northern extent of the area of concern AOC 6 during the RI to collect soil samples, and two borings, AOC6-SB1 and AOC6-SB2, were placed downgradient of the land surface depression to collect groundwater samples with a retractable sampling screen (Figure 25). No elevated headspace reading, debris, or other indications of soil impacts were observed at these locations. Soil samples were

analyzed for PAHs and RCRA metals and no analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

Based on the results of the RI, the extent of debris and the magnitude and extent of the PAH and metals impacts are limited to the debris and immediate underlying soils in the land surface depression. Based on the historic use of the area, the source of the debris and PAH and metal impacts is associated with filling/disposal that primarily occurred during GOW operations and/or decommissioning, but reportedly continued for some period post-GOW. The samples collected within AOC 6 provide a basis to estimate the magnitude and extent of impacts for the purposes of the RI.

Two groundwater samples were collected from existing monitoring wells downgradient of AOC 6 (Figure 25). The groundwater samples were analyzed for SVOCs, metals, and thallium. No analytes were detected above groundwater screening criteria (Table 14).

4.3 Steam Plant and Associated 26.7 Acres (AOC 7)

As part of a PA (USACE, 2009a), the USACE designated the Steam Plant and the Associated 26.7 Acres as AOC 7 and divided it into quadrants (Northwest, Southwest, Northeast, and Southeast). The USACE investigated AOC 7 during the Final Focused Site Inspection (USACE, 2009b) and the Final Expanded Site Inspection (USACE, 2009c). The University first acquired the Steam Plant and Associated 26.7 Acres from the federal government in 1948, after the GOW was decommissioned. The University was directed to convey AOC 7 back to the federal government for national security reasons in 1951. The federal government then sold the Steam Plant and Associated 26.7 Acres back to the University in 1961, after the equipment and infrastructure had largely been cannibalized for public sale or use at other federal installations. The University did not operate AOC 7 for the production of steam. Additional details regarding the operational history of AOC 7 are provided in the USACE reports (USACE, 2009a, 2009b, and 2009c).

Post-GOW activities in AOC 7 included the use of University Building A, located near the north end of Steam Plant (a.k.a., Power House A or Building 401A), for the temporary storage of hazardous waste. University Building A was closed in accordance with an MPCA-approved closure plan in the 1990s. The International Union of Operating Engineers – Local 49 also used an area east of the Water Reservoir (Building 402A) for training and stockpiled topsoil south of the Steam Plant (Building 401A). In October 2016, the University demolished the aboveground portion of the Steam Plant (Building 401A) in October 2016 and placed the crushed concrete from the demolition in the Water Reservoir (Building 402A). The demolition was completed after notice to the MPCA and local units of government and in accordance with applicable rules and regulations.

A total of 32 surface or near surface soil samples (<4 feet bgs) and 31 subsurface soil samples (>4 feet bgs) were collected in this AOC during the RI and analyzed for one or more of the following parameters: SVOCs/PAHs, RCRA metals, and/or PCBs (Table 2). RI and pre-RI soil sampling locations are shown on Figure 16; analytical soil results are provided in Table 6.

Results for AOC 7 are discussed below by quadrant.

Northwest Quadrant (AOC7A)

- The former Water Reservoir (Building 402A) is located in the northwest quadrant (AOC7A). During GOW operations, the water reservoir was used to store river water and groundwater used to generate steam required for smokeless powder production. The University did not use the Water Reservoir (Building 402A).
- Twenty-nine soil samples were collected during previous investigations and analyzed for one or more of the following parameters: PCBs, VOCs, SVOCs/PAHs, and/or metals. PAHs, metals, and PCBs exceeded screening criteria in samples around the Water Reservoir (Building 402A).
- Eleven soil borings and four test trenches were placed around the Water Reservoir (Building 402A) to further investigate the potential for releases and delineate the extent of identified releases. No elevated headspace readings or other indications of soil impacts were observed at these locations.
- Thirty soil samples were collected from the soil borings and test trenches installed in AOC7A during this RI. Samples were analyzed for RCRA metals and PAHs and, at select locations, were also analyzed for PCBs. No analytes were detected above the Tier 1 SRVs in the 30 samples with the exception of B(a)Pe, which exceeded Tier 1 SRVs in one soil sample (AOC7A-SB6, 0-0.5') collected west of the reservoir settling basin. Additional soil samples collected in AOC7A provide a basis to estimate the extent of impacts for the purpose of this RI.

Releases of PCBs, PAHs, and metals were identified in soils around Building 402A in AOC7A. Based on the land use history, the source of releases is the construction, operation, and/or partial decommissioning of GOW building 402A. Samples collected in AOC7A provide adequate data to estimate the magnitude and extent of the releases for the purpose of the RI.

Northeast Quadrant (AOC7B)

- During GOW operations, the northeast quadrant of AOC 7(AOC7B) was used for chemical storage and also included railroad tracks and a salt dissolving pit. After the GOW was decommissioned, this area was used by the International Union of Operating Engineers – Local 49 for earthwork training.
- During previous investigations, seven soil samples were collected from three soil borings placed in the AOC7B. Samples were analyzed for RCRA metals, SVOCs, VOCs, and diesel range organics (DRO). No analytes were detected above screening criteria.
- Three test trenches were excavated near the former chemical storage building (which is labeled as EAA of Figure 16) in AOC7B. No elevated headspace reading or other indications of soil impacts were observed.

- Soil samples were collected at the surface and at depth at each test trench location excavated during this RI and analyzed for RCRA metals and PAHs. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

No release of hazardous substances above the Tier 1 SRVs has been identified in AOC7B.

Southeast Quadrant (AOC7C)

- The southeast quadrant of AOC 7(AOC7C) included GOW coal storage, handling, and conveyance infrastructure.
- Fourteen soil samples were collected from surface soil sampling locations and soil borings during previous investigations and analyzed for metals, SVOCs, VOCs, and nitrocellulose. Five surface soil samples were analyzed for nitrocellulose only. No analytes were detected above Tier 1 SRVs. This area was not investigated during this RI.

No release of hazardous substances above the Tier 1 SRVs has been identified in AOC7C.

Southwest Quadrant (AOC7D)

- The Steam Plant (Building 401A) was located in the Southwest Quadrant (AOC7D) and was used during GOW operations to generate steam required for powder production. The Steam Plant (Building 401A) had five steam generating units that included boilers, coal pulverizers, pulverized coal burners, oil burners, forced and induced draft fans, and air preheater infrastructure. An electrical substation that was used during GOW operations was located southwest of the Steam Plant (Building 401A). After the GOW was decommissioned, University Building A was located north of the Steam Plant (Building 401A).
- Seventy-five soil samples were collected during previous investigations, and analyzed for one or more of the following parameters: metals, SVOCs, VOCs, and/or PCBs. Exceedances of Tier 1 SRVs for arsenic, lead, mercury, B(a)Pe, and PCBs were detected south, east, and west of the Steam Plant (Building 401A). B(a)Pe, arsenic and eight other SVOCs were detected above the Tier 1 SRVs at test trench WWTP-TP-12, placed near the Steam Plant (Building 401A).
- Ten soil borings and three test trenches were completed in AOC7D for this RI. No elevated headspace readings or other indications of soil impacts were observed at these locations.
- A total of 26 soil samples were collected from soil borings and test trenches placed at step-out locations in the AOC7D during this RI (Figure 16). Samples were analyzed for RCRA metals, PAHs, and PCBs. VOCs were also analyzed at select locations based on field screening results. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI with the exception of B(a)Pe in one sample (AOC7D-TT3, 0-0.5'), arsenic in two samples (AOC7D-SB7, 0-0.5' and AOC7D-SB8, 0-0.5') and lead in one sample (AOC7D-SB8, 0-0.5'). Soil samples collected during this RI provide a basis to estimate extent of this release for the purpose of the RI.

Releases of arsenic, lead, mercury, B(a)Pe, SVOCs, and PCBs were identified around the Steam Plant (Building 401A) in AOC7D. Based on the land use history, the sources of the releases are the construction, operation, and/or partial decommissioning of GOW building 401A. Samples collected in AOC7D provide a basis to estimate the magnitude and extent of the releases around Building 401A for the purpose of the RI.

A groundwater sample was collected from existing monitoring well MW-B7-015 located northeast (downgradient) of AOC7 to evaluate potential leaching of COPC to the groundwater (Figure 25). The groundwater sample was analyzed for VOCs, SVOCs, and metals. No analytes were detected above groundwater screening criteria (Table 14).

In summary, releases to the soil of metals (arsenic, lead, and mercury), PAHs, PCBs, and limited other SVOCs exceeding the Tier 1 SRVs were identified and delineated near the GOW water reservoir (Building 402A in AOC7A) and Power House A (Building 401A in AOC7D). Based on the historic use of the area, the sources of these impacts are GOW construction, operation, and/or partial decommissioning of these GOW buildings. Soil and groundwater samples indicate that these impacts are limited in extent. The samples collected within AOC 7 provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

4.4 Temporary Shops Area

The GOW Temporary Shops Area was constructed during the operation of the GOW to support construction and operation activities. Individual buildings are listed in the UMore East RI (Barr, 2012a). The structures in this area were dismantled as part of the GOW decommissioning and the area has subsequently been used for agriculture by the University. During previous investigations, lead was detected above the Tier 1 SRV of 300 mg/kg at the Lead Burners Shop (Building 46T, which is reported as a separate site in the 2012 RI [Barr, 2012]); mercury was detected above the Tier 1 SRV of 0.5 mg/kg at the Auto Repair Shop (Building 32T); and arsenic was detected above the Tier 1 SRV of 9 mg/kg at the Machine Shop (Building 16T). Other areas that have been investigated include the Crane Repair Shop (Building 24T), the Drinking Water Pump House and Storage Tank (Building 411B), Pipe Shop (Buildings 229T and 230T), Oil Storage House (Building 29T) and the Gas Pumps (Building MSA8). No analytes were detected above Tier 1 SRVs at these areas.

A total of 11 surface or near surface soil samples (<4 feet bgs) and 11 subsurface soil samples (>4 feet bgs) were collected around specific GOW temporary shops. Three area-wide composite samples were collected in areas used for storage and miscellaneous offices. The composite samples were used to characterize parameter concentrations in these areas of similar former uses, which were tilled for agriculture after the GOW was decommissioned. The samples collected from the Temporary Shops Area during this RI were analyzed for one or more of the following parameters: PAHs, RCRA metals, PCBs, and/or VOCs as described below. Soil sample locations are shown on Figures 17 and 18 and analytical soil results are in Tables 7 and 8.

Individual sample results for the Temporary Shops are discussed below, by former building areas, and the composite soil samples in the GOW office and storage areas are discussed separately (see Figures 17 and 18 with 1945 aerial photo backgrounds).

Machine Shop (16T)

- This building was used as a machine shop during GOW construction and operations. The building was dismantled as part of the decommissioning of the GOW and the University subsequently used the area for agriculture.
- Six samples were collected during previous investigations and analyzed for RCRA metals and/or SVOCs. Arsenic was detected slightly above the Tier 1 SRV in one sample (16T-TT2, 1'). No other analytes were detected above their respective Tier 1 SRVs.
- Four soil borings were completed near the former Machine Shop during this RI. No elevated headspace reading or other indications of soil impacts were observed at these locations.
- Eight soil samples were collected during this RI and analyzed for PAHs and RCRA metals during this RI. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

A release of arsenic was identified at the former Machine Shop. Based on the land use history, former GOW operations and decommissioning activities are the source of this release. Samples collected around the exceedance provide a basis to estimate the magnitude and extent of the release for the purpose of the RI.

Electrical Shop (MSA-23TC)

- This building was used as an electrical shop during GOW construction and operations. The building was dismantled as a part of the decommissioning of the GOW and the University subsequently used the area for agriculture.
- No previous investigations have been completed at the former Electrical Shop.
- Two soil borings were placed near the former Electrical Shop during this RI. No elevated headspace reading or other indications of soil impacts were observed at these locations.
- Four soil samples were collected during this RI and analyzed for RCRA metals, PAHs, and PCBs. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

No release of hazardous substances above the Tier 1 SRVs has been identified at the former Electrical Shop.

Auto Repair Shop (32T)

- This building was used as an auto repair shop during GOW construction and operations. The building was dismantled as part of GOW decommissioning and the University subsequently used the area for agriculture.
- Ten soil samples were collected and analyzed for RCRA metals and/or SVOCs during previous investigations. One surface soil sample (32T-SS1, 0.5') exceeded the Tier 1 SRV for mercury and three samples (32T-SS3, 0.5'; 32T-TT2, 0.5'; and 32T-TT3, 3') exceeded the Tier 1 SRV for arsenic.
- Four soil borings were completed at the former Auto Repair Shop during this RI. No elevated headspace readings or other indications of soil impacts were observed at these locations with the exception of one location (32T-SB4) where headspace readings were slightly above background (5.8 ppm).
- Ten soil samples were collected at the surface and at depth from the borings during this RI. Samples were analyzed for PAHs and RCRA metals. One sample, 32T-SB4, 6-6.5', was also analyzed for VOCs due to the soil screening results. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

Mercury and arsenic exceedances have been identified at the former Auto Repair Shop. Based on the land use history, the sources of the releases were GOW operations and decommissioning activities. Samples collected around the exceedances provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

GOW Office and Storage Areas

- Three large areas within the Temporary Shops Area were identified based on specific historical use during the operation of the GOW. The buildings in these areas were dismantled during GOW decommissioning and the University subsequently used the areas for agriculture. Due to the similar history (temporary buildings removed during decommissioning) and subsequent row-crop farming that resulted in the mixing of surface soil, these areas were subjected to composite sampling using ISM. The area identified as TSA-ISM1 is located on the west end of the Temporary Shops Area and included carpentry shops and the drinking water tank and pump house. Area TSA-ISM2 is located in the central portion of the site and included field offices, storage buildings, and a laydown area. Area TSA-ISM3 is located in the eastern end and comprised of primarily truck storage and offices.
- No previous investigations have occurred in these areas.
- A summary of the field sampling approach, laboratory sample preparation, and statistical data analysis for these ISM samples is included in the SFSP (Barr, 2016e) and is provided in Appendix B.
- The ISM samples were analyzed for PAHs and RCRA metals. No analytes were detected above the Tier 1 SRVs in the ISM samples collected during this RI.

No release of hazardous substances above the Tier 1 SRVs has been identified in this area of the SOC.

Groundwater samples were collected from two existing monitoring wells, MW-A6-006 and MW-B7-013, located downgradient of the Temporary Shops Area to evaluate potential leaching of COPC to the groundwater (Figure 25). Groundwater samples were analyzed for VOCs, SVOCs, and metals. No analytes were detected above groundwater screening criteria (Table 14).

In summary, releases of arsenic and mercury exceeding the Tier 1 SRVs were previously identified in soils at buildings 32T and 16T. Based on the historic use of the area, the source of the releases is GOW operations and decommissioning activities. The samples collected within the Temporary Shops Area provide a basis to estimate the magnitude and extent of the releases in this area for the purpose of the RI.

4.5 Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump

The Burning Grounds were constructed by DuPont between 1942 and 1944 and operated through GOW decommissioning activities until March 1948. This area was used to burn smokeless powder, nitro body-containing building materials, impacted soil, and other potentially highly flammable materials. Powder canister/drum tops are present in the wooded area north of the Burning Grounds (Barr, 2012a). After the burning activities conducted during the decommissioning of the GOW, the top two inches of soil in the Burning Grounds were reportedly removed, burned on wooden platforms, and thin spread in an unknown area, presumably within the Burning Grounds.

This Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump was included in the land the University purchased from the federal government in 1948. The University leased over 500 acres of this area to the Air Force for ammunition storage and related activities from 1954 to 1958. In 1962, the Navy leased a portion of this sub-site and constructed a Satellite Operations Center which included a service garage, equipment maintenance shop, onsite/offsite housing, and recreational facilities. The Navy also reportedly operated a recreational trap shooting and firing range along the eastern edge of the site during this time. The Navy demolished the Satellite Operations Center buildings in the late 2000s and identified and addressed releases of lead, petroleum, and PCBs to soils (Versar, 2010). Previous environmental investigations have included the sample collection and analysis in the vicinity of the GOW Burning Grounds, Air Force Building 12, Rosemount Ammunition Storage Bunkers Area, the Navy Firing and Shooting Ranges, the 10th Street Dump, and the GOW Aniline Spread Area (Barr, 2012; Versar, 2010; Peer, 2003). The University has not used these areas.

Fifty-seventy surface or near surface soil samples (<4 feet bgs) and 27 subsurface soil samples (>4 feet bgs) were collected at Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump during the RI and analyzed for one or more of the following parameters: SVOCs/PAHs/extended list PAHs, RCRA metals, VOCs, and/or lead. Soil sample locations are shown on Figure 19 and analytical soil results are presented in Table 9.

Results for the Burning Grounds and 10th Street Dump are discussed below. Tables and figures with data from Air Force Building 12, Rosemount Ammunition Storage Bunkers Area, and the Navy Firing and Shooting Ranges are included in Appendix D.

GOW Burning Grounds

The GOW Burning Grounds were constructed during the GOW period to burn off-spec smokeless powder and were later used to burn powder and nitro-body containing building materials and soil. The GOW Burning Grounds have not been used by the University.

Fifty-two soil samples were collected during previous investigations and analyzed for one or more of the following parameters: RCRA metals, SVOCs, nitrate, sulfate, VOCs, DRO, PCBs, and explosives. Lead, mercury, B(a)Pe and/or SVOCs were detected at concentrations above Tier 1 SRVs in eight samples. No other analytes were detected above Tier 1 SRVs (Peer, 2003; Barr, 2012a).

Four surface soil samples, two hand auger borings, and 25 soil borings were placed in this SOC during the RI. Sixty soil samples were collected during the RI and analyzed for one or more of the following parameters: PAHs (including eight samples analyzed for extended list PAHs), SVOCs, RCRA metals, and/or lead. Elevated headspace readings were observed at eight locations (BG-HA1, BG-HA2, BG-SB12, BG-SB13, BG-SB17, BG-SB18, BG-SB23, and BG-SB25). The source of the elevated headspace readings was suspected to be pine needles (as previously observed at UMore Park [Barr, 2012]), but VOC samples were collected at these locations to verify that a release of organics had not occurred. No VOCs were detected. Eight samples were analyzed for extended list PAHs in accordance with the FSP due to past burning activities (Barr, 2016c). No extended list PAH compounds were detected. Lead was detected above the Tier 1 SRV of 300 mg/kg in four samples (BG-HA1, 0-0.5'; BG-SB8, 0-0.5'; BG-SB17, 0-0.5'; and BG-SB21, 0-0.5') at concentrations up to 3,600 mg/kg. Additional samples were collected around the lead exceedances during the Stage 2 investigation and concentrations of lead were below the Tier 1 SRV in all samples. No other analytes were detected above their respective Tier 1 SRV in samples collected during this RI.

Releases of lead, mercury, and B(a)Pe (or other SVOCs) have been identified at the GOW Burning Grounds. The source of the releases is GOW operations and decommissioning activities. Samples collected around the GOW Burning Grounds provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

10th Street Dump

The 10th Street Dump appears to have initially been used as a borrow pit and, based on metal debris with smokeless gun powder labeling (see photo log in Appendix B), it is assumed the area was also used for disposal during the GOW operations and/or decommissioning. The University leased this area to the Air Force/Navy after the GOW was decommissioned and it is possible the Air Force or Navy may have also used this site for waste disposal.

During a previous investigation, 32 soil samples were collected and analyzed for one or more of the following parameters: RCRA metals, SVOCs, and/or VOCs. Dump materials including slag, metal, and concrete with dark gray to black discolored soil was observed in test trenches 10SD-TT3, 10SD-TT3A, and 10SD-TT16. Minor amounts of surficial debris were also observed at the ground surface along the hillside near these test trench locations. Lead was detected above the Tier 1 SRV in two samples of dump material (10SD-TT3-0.5' and 10SD-TT16A-1.5'). No other analytes were detected above their respective Tier 1 SRVs.

Eight test trenches and four soil borings were placed at step-out locations around the 10th Street Dump during the RI. No elevated headspace readings or other indication of soil impacts were observed at these locations. Twenty-four soil samples were collected and analyzed for PAHs and RCRA metals. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

In summary, the releases of lead and mercury to soil were identified at the 10th Street Dump. The lead and mercury releases identified at test trenches 10SD-TT3-0.5' and 10SD-TT16A-1.5' are associated the dump material encountered at those locations. The source of the dump material appears to be related to activities that occurred during the GOW operations, activities that occurred while the area was leased by the Air Force, Navy, or both. Samples collected around the 10th Street Dump provide a basis to estimate the magnitude extent of the releases for the purpose of the RI.

One groundwater sample was collected from existing monitoring well MW-A5-018 located downgradient of the GOW Burning Grounds and 10th Street Dump sites to evaluate potential leaching of COPC to the groundwater (Figure 25). The groundwater samples were analyzed for SVOCs and metals. No analytes were detected above groundwater screening criteria (Table 14).

4.6 Acid Plant Area

The Acid Plant Area was constructed by DuPont as part of the GOW to produce nitric and sulphuric acid. Nitric acid was manufactured from liquid nitrogen and sulphuric acid was added to the nitric acid to remove water and concentrate the acid. During GOW operations, Building 303A was lined with lead to protect the structure from acid corrosion. Portions of the Acid Plant Area were subsequently used by the University for temporary hazardous waste storage and an aeronautical research laboratory. University tenant operations included explosives manufacturing and storage, research labs, plastics/equipment production, plastic mold dye production, and storage of antifreeze (Barr, 2011). In fall 2016, the University dismantled the aboveground components of the former Anhydrous Ammonia Storage Building (Building 301A; *a.k.a., the Eight Ball*). The demolition activities were completed after notice to the MPCA and local units of government, and in accordance with applicable rules and regulations.

Forty-one surface or near surface soil samples (<4 feet bgs) and 59 subsurface soil samples (>4 feet bgs) were collected in this sub-site during the RI and analyzed for one or more of the following parameters: PAHs, RCRA metals, PCBs, SVOCs, VOCs, and/or lead. Soil sample locations are shown on Figure 20 and analytical soil results are in Table 10.

Results for each area of the Acid Plant Area that was investigated during this RI are discussed below.

Nitric Acid and Sulphuric Acid Concentrator Building (Building 303A)

- Operations in Building 303A involved the use of sulphuric acid to concentrate nitric acid during the GOW period. Due to the corrosive nature of the acids, Building 303A was lined with lead to protect the structure from the acids. After the GOW was decommissioned, the University renamed Building 303A as Hazardous Waste Building F and used it for the temporary storage of hazardous wastes including flammable liquids, corrosive materials (alkaline and organic acids), and toxic materials. Hazardous Waste Building F was closed in accordance with an MPCA-approved plan (Peer, 1996).

- Nineteen soil samples were collected from surface soil and test trench locations around Building 303A during previous investigations. Buried building materials and gray discolored soil were observed to depths of up 10 feet bgs. B(a)Pe concentrations were detected in soil above the Tier 1 SRV in one sample (TT-56-303A, 0-1') and lead was detected above the Tier 1 SRV in 11 soil samples. The samples that exceeded the Tier 1 SRV were collected at the ground surface with the exception of sample 303A-TT3, 9', which was collected at nine feet bgs. A sample of native soil was collected at 10 feet bgs from location 303A-TT3and the concentration of lead was below the Tier 1 SRV.

- Seven soil borings and four test trenches were completed around Building 303A during this RI. No elevated headspace readings or indications of impacts were observed.

- Twenty-two step-out soil samples were collected around Building 303A and were analyzed for one or more of the following parameters: RCRA metals, VOCs, SVOCs, and/or lead. Lead concentrations exceeded the Tier 1 SRVs in two surface soil samples (303A-SB3, 0-0.5'; 303A-SB6, 0-0.5'). No other analyte concentrations exceeded Tier 1 SRVs in the samples collected during this RI. Additional soil samples were collected during the Stage 2 investigation of this RI to refine the extent of the identified release. Lead concentrations were below the Tier 1 SRV in all samples collected during this RI.

Releases of lead and B(a)Pe to the soil were identified around Building 303A. Based upon past use, the source of the lead release is likely the use of acids in the lead-lined GOW building 303A. The samples collected around Building 303A provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

Nitric Acid and Sulphuric Acid Concentrator Building (303-A2)

- During the GOW period, operations in this building involved the use of sulphuric acid to concentrate nitric acid. The building was dismantled during the decommissioning of the GOW and the University has subsequently left the area dormant.

- Seven soil samples were collected and analyzed for RCRA metals and one sample was analyzed for SVOCs during a previous investigation. Cadmium was detected above the Tier 1 SRV in one soil sample (Peer, 2006b). No other analytes were detected above Tier 1 SRVs.

- Six soil borings were placed around this building during the RI due to similar use of this building to Building 303A. No elevated headspace readings or other indications of soil impacts were measured at the sample locations.
- Twelve soil samples were collected and analyzed for RCRA metals and PAHs during the RI. No analytes were detected above their respective Tier 1 SRV in the samples collected during this RI.

An isolated release of cadmium to the soil was identified around Building 303-A2. The source of the cadmium release was likely related to the construction, operation, and/or decommissioning of the GOW building. The samples collected around Building 303-A2 provide a basis to estimate the magnitude and extent of the release for the purpose of the RI.

Building F-103 Possible Transformer

- Building F-103 is located in the eastern portion of the Acid Plant Area and is the site of a possible transformer during the GOW period. No previous investigations have been conducted around this building.
- One soil boring was advanced. No elevated headspace readings or other indication of soil impacts were observed during the RI.
- Two soil samples were collected during this RI and analyzed for PAHs, RCRA metals, and PCBs. No analytes were detected above the Tier 1 SRVs in the samples collected during this RI.

No release of hazardous substances above the Tier 1 SRVs has been identified at Building F-103.

Ammonia Oxidation Plant (Building 302A) and Nitric Acid Storage Tanks

- Building 302A was used to oxidize ammonia to produce nitrous oxide and later nitric acid during GOW operations. Nitric acid was stored in a tank farm area west of Building 302A. University tenants subsequently used Building 302A as a research lab and to store and manufacture explosives during the post-GOW period. The building reportedly burned down in the 1970s. The tank farm area has not been used since the GOW decommissioning.
- Five surface soil samples were collected during previous investigations and mercury was detected above the Tier 1 SRV in one sample (TT-51-302A, 0-1'; Peer, 2006b).
- Fourteen test trenches and 11 soil borings were completed during the RI around Building 302A and acid storage tanks area. Concrete slab/footings were encountered west of the former building at test trenches 302A-TT1, 302A-TT2, 302A-TT3, 302A-TT4, 302A-TT7, 302A-TT8, 302A-TT9, 302A-TT10, and 302A-TT11. Discolored soil, ash, transite tiles, and building debris were observed surrounding the concrete slab at these locations.
- Forty-two soil samples were collected during this RI and analyzed for one or more of the following parameters: PAHs, RCRA metals, and/or PCBs. Mercury concentrations exceeded the

Tier 1 SRV in four samples (302A-TT4, 4-4.5'; 302A-TT8, 5-6'; 302A-TT10, 4-4.5'; and 302A-TT11, 4-4.5'). Lead, cadmium, and chromium exceeded the Tier 1 SRVs in sample 302A-TT4, 4-4.5'. These samples were collected from the debris and intermixed soil to characterize the release from past use, burning, and debris burial at Building 302A. Additional soil samples were collected during this RI to define the extent of this release. PCB concentrations exceeded the Tier 1 SRV in samples from five RI investigation locations (302A-SB3, 302A-TT2, 302A-TT5, 302A-TT6, and 302A-TT7) between the Building 302A footprint and the GOW electrical substation (Building 501F1). Despite the sample IDs (e.g., 302A-##), the PCB release is attributed to the GOW electrical substation and is discussed below.

Releases of hazardous substances, including mercury, lead, cadmium, and chromium, were identified in debris and intermixed soils that was encountered near Building 302A and the nitric acid storage tanks. Existing foundations, ash, building debris, and ACM building materials are present within the previous building footprint at approximately four feet bgs. Based on field observations and land use history, the releases are likely the result of GOW and post-GOW activities (*i.e.*, the fire). Samples collected around Building 302A provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

Substation (501F1)

- Building 501F1 was an electrical substation in the Acid Plant Area. The area east of Buildings 501F1 (and 302A) was identified as an oil fire smothering pit on a 1955 plan sheet (Barr, 2011).
- Twelve test trenches were completed in this area during previous investigations. PCBs were detected at concentrations above Tier 1 SRVs in two samples (501F1-TT2-2' and 501F1-TT3-0.5').
- Two soil borings (302A-SB3 and 501F1-SB1) and nine test trenches (302A-SB3, 302A-TT2, 302A-TT5, 302A-TT6, 302A-TT7, 501F1-TT12, 501F1-TT13, 501F1-TT14, and 501F1-TT15) were completed in this area during this RI. No elevated headspace readings or indications of a release were observed at the sampling locations. Concrete debris was observed in test trench 501F1-TT14 at 3 feet bgs. Two samples (501F1-TT14, 6-6.5' and 8.5-9') were collected below the concrete debris.
- Twenty soil samples were collected during the RI and analyzed for one or more of the following parameters: PAHs, RCRA metals, and PCBs. One sample (501F1-TT12, 6-6.5') exceeded the Tier 1 SRVs for B(a)Pe. PCB concentrations were detected above the Tier 1 SRVs in five samples (302A-SB3, 0-0.5'; 302A-TT2, 0-0.5'; 302A-TT5, 0-0.5'; 302A-TT6, 0-0.5'; and 302A-TT7, 0-0.5'). Based on the location of the samples, these exceedances are likely associated with the former oil fire smothering pit located east of Buildings 501F1 and 302A. No analytes were detected above Tier 1 SRVs in the soil samples collected below the concrete debris encountered in test trench 501F1-TT14.

Releases of PCBs and B(a)Pe exceeding the Tier 1 SRVs were identified near the Building 501F1 in the Acid Plant Area. Based on the land use history, the likely sources of the releases are GOW and post-GOW

activities. Samples collected around the substation provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

Oleum Plant Tanks (1501)

- These former tanks were used to store spent acid during GOW operations. No previous investigations have occurred at this location.
- Four soil borings were completed at this location. No elevated headspace readings or indications of soil impacts were observed at the sampling locations.
- Eight soil samples were collected and analyzed for PAHs and RCRA metals. No analytes were detected above the Tier 1 SRVs in samples collected during this RI.

Summary: No release of hazardous substances above the Tier 1 SRVs has been identified at the Oleum Plant Tanks area.

One groundwater sample was collected from existing monitoring well MW-B7-014, located downgradient of the Acid Plant Area (Figure 25), to evaluate potential leaching of COPC to the groundwater. The groundwater sample was analyzed for SVOCs and metals. No analytes were detected above groundwater screening criteria (Table 14).

4.7 GOW Coal Ash Pond, Drainage Way and Oxidation Pond

The Coal Ash Pond and Drainage Way were constructed to dispose of coal ash waste generated by Power Plant A (Building 401A) during operation of the GOW. As part of the GOW decommissioning, the ash was reportedly removed from the Coal Ash Pond and Drainage Way (Barr, 2011). The University did not operate Power Plant A or discharge to the Coal Ash Pond and Drainage Way. In 1946, the Army rerouted the sewer discharge from the LWBS to the Coal Ash Pond. By 1959, the University constructed an oxidation pond near the southwest edge of the former Coal Ash Pond to treat sewage (Figure 21).

Forty surface or near surface soil samples (<4 feet bgs) and seven subsurface soil samples (>4 feet bgs) were collected from the Coal Ash Pond, Drainage Way, and Oxidation Pond during the RI and analyzed for mercury. Boron was also analyzed for in most of the samples at the request of the MPCA. Two samples, CAP-TT27a 3-3.5' and 5-5.5', were analyzed for VOCs and SVOCs to follow up on Stage 1 soil screening results. Soil sample locations are shown on Figure 21 and soil analytical results are in Table 11. Results for GOW Coal Ash Pond and Drainage Way and Oxidation Pond are discussed below.

Coal Ash Pond and Drainage Way

During a prior investigation, mercury was reported at concentrations up to 590 mg/kg in samples of buried coal ash collected from the Coal Ash Pond (Peer, 2003). These mercury concentrations are significantly higher than mercury concentrations typically detected in coal ash (Withum et al., 2005) and mercury concentrations detected elsewhere at UMore Park/GOW. As a follow-up to the 2003 investigation, test trenches were excavated adjacent to the 2003 sampling locations during the UMore

East RI (Barr, 2012a) and samples of the coal ash and underlying soils were collected to see if the mercury concentrations were comparable to the concentrations from the 2003 investigation. Mercury was detected at concentrations up to 7.3 mg/kg in coal ash samples collected during the UMore East RI, but significantly lower (by two orders of magnitude) than the 2003 investigation results.

Coal ash was not observed in the test trenches placed in the Drainage Way during the UMore East RI (Barr, 2012a). Arsenic was detected in surface soil at concentrations up to 11 mg/kg. No additional sampling was conducted in the Drainage Way during the 2016 RI.

During this RI, soil sampling was completed at three test trenches (CAP-TT27, CAP-TT29, and CAP-TT35) to vertically profile mercury concentrations in the soil and coal ash at locations adjacent to the 2003 sample locations where mercury was detected at significantly higher concentrations in 2003. Additional samples were collected elsewhere in the Coal Ash Pond and Oxidation Pond to further refine the extent of the coal ash at this site. The RI activities and results are discussed below:

- Samples were collected at six-inch increments from the ground surface to the native deposits below the coal ash at test trenches CAP-TT27, CAP-TT29, and CAP-TT35 to evaluate mercury concentrations on a vertical profile. A layer of gray coal ash and dark soil discoloration were observed from 0 to 3.5 feet bgs at test trenches CAP-TT27 and CAP-TT29. An elevated headspace reading (52.4 ppm) was measured at test trench CAP-TT27 from 3-3.5 feet bgs. Surficial glass debris was noted at test trench CAP-TT35, but no coal ash was observed. Eight vertical profile samples were collected from each test trench and analyzed for mercury and boron. Mercury was detected at concentrations ranging from 0.54 to 2.5 mg/kg in the three samples of coal ash (CAP-TT27, 2-2.5'; CAP-TT29, 0.5-1'; and CAP-TT29, 1.5-2'). These concentrations were consistent with the 2012 RI results (*e.g.*, mercury was detected in coal ash at concentrations of 0.12 to 2.7 mg/kg during the 2012 RI) and were significantly lower than the 2003 investigation results. Boron concentrations were below Tier 1 SRVs in these samples.
- No VOCs or SVOCs were detected in samples collected from test trench CAP-TT27a.
- Soil samples were collected from seven additional test trenches within the Coal Ash Pond to delineate extent of ash deposits and impacts during this RI. Coal ash and dark discoloration were observed at test trenches CAP-TT28, CAP-TT30, CAP-TT31, and CAP-TT36. No elevated headspace readings were observed at these locations. Eighteen soil samples were collected and analyzed for mercury and boron. Mercury and boron concentrations were below Tier 1 SRVs in these samples.

Coal ash from GOW operations is present beneath surface soils in portions of the GOW Coal Ash Pond. Mercury concentrations in the coal ash are above Tier 1 SRVs but substantially lower than the highest concentrations reported in the investigation conducted in 2003. Based on more recent investigation results, the mercury concentrations for samples WWTP-TP19, 2' (420 mg/kg) and WWTP-TP-20, 2' (590 mg/kg) from the 2003 investigation (Peer, 2003) are not representative of existing conditions as characterized by the 2012 and 2016 RIs. The 2003 mercury concentration data for samples WWTP-TP19, 2' and WWTP-TP-20, 2' will be retained in the UMore Park environmental database but assigned an "**" qualifier to indicate the data have been rejected. Mercury concentrations from other samples collected

during the 2003 investigation that had higher than expected mercury concentrations (*i.e.*, WWTP-TP-22, 0-2'; and WWTP-TP13, 0-1'), but significantly lower than the rejected data described above, will remain in the database but will be re-evaluated/verified by additional investigation prior to land use change.

Based on the land use history, the source of the mercury release in the Coal Ash Pond and Drainage Way is burning of coal land disposal of coal ash during GOW operations. The samples of coal ash and surrounding soils provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

Oxidation Pond

The Oxidation Pond was constructed in the southwest corner of the Coal Ash Pond in or before 1959, after the University acquired the Site (Figure 21). Flow was directed to the Oxidation Pond through a pipe that was connected to the LWBS. The Oxidation Pond was used to treat sewage until it was closed and individual septic systems were installed for individual buildings at the Site in the 1980s (Barr, 2011).

During previous investigations, 21 soil samples were collected and analyzed for one or more of the following: RCRA metals, SVOCs, PCBs, and/or OC pesticides. PCBs and OC pesticide analyses were included based on results from an investigation conducted in 1985 (Barr, 2011). No elevated headspace readings or other indications of soil impacts were identified. Fill soils containing coal ash, white/gray granular material, and pea gravel were beneath the surface soils in the Oxidation Pond. Yellow to rusty orange discolored soil was also observed in test trenches through the bottom of the Oxidation Pond. Mercury exceeded the Tier 1 SRVs in one sample (OP-TT1, 2') collected in a layer of coal ash. No other analytes were detected above Tier 1 SRVs.

Four test trenches (CAP-TT33, CAP-TT34, OP-TT15, and OP-TT16) were completed during this RI in the Oxidation Pond. Coal ash deposits and dark discoloration were observed at test trench OP-TT15 from 0.5-1 foot bgs. Nine soil samples were collected from the four test trenches and analyzed for mercury. Mercury was detected above the Tier 1 SRV in two samples of coal ash (CAP-TT34, 0-0.5'; and OP-TT15, 0.5-1'). No other analytes were detected above Tier 1 SRVs in the samples collected during this RI.

The source of mercury in samples OP-TT1-2' and OP-TT15, 0.5-1' is attributed to coal ash from GOW operations. The presence of coal ash in the shallow subsurface indicates that the coal ash from GOW operations was not fully removed during GOW decommissioning. The samples from the Oxidation Pond provide a basis to estimate the magnitude and extent of the releases for the purpose of the RI.

In addition to soil samples, one groundwater sample was collected from existing monitoring well MW-C7-016, located downgradient of Coal Ash Pond and Oxidation Pond (Figure 25), to evaluate potential leaching of COPC to the groundwater. The groundwater sample was analyzed for boron and metals. No analytes were detected above screening criteria (Table 14).

4.8 Building 237G

The GOW Tray Dryer/Circulation Houses were constructed and used during GOW operations. There were 17 buildings in the 237 series at the GOW. The powder was placed on trays and heated air was used to dry the powder until the desired moisture content was reached. Equipment at these building include: a water jet, blower, hoppers, shakers, and fans. The post-GOW decommissioning procedures by the Army included washing the walls and ceilings with water and removing and burning wooden trays and air ducts. The University has not used the land in the immediate vicinity of former 237 series building slabs and has farmed the surrounding area.

Soil samples were collected around selected 237 series buildings during prior investigations (Peer, 2003; Barr, 2012a). The data from prior investigations are discussed in the 2012 RI and included in Appendix D.

During a geological gravel resource assessment, a frothy liquid that smelled of mothballs was noted in soil boring SS1400 from 24 to 45 feet bgs (ProSource, 2008), but no soil samples were collected at that time. During the 2012 RI, one soil boring (237G-SB1) was installed adjacent to soil boring SS1400 and no frothy liquid, mothball odors, or other indications of a release of hazardous substances were observed. One soil sample (237G-SB1, 30') was collected and analyzed for RCRA metals, SVOCs, and VOCs. No SVOCs or VOCs were detected and RCRA metals were below Tier 1 SRVs.

Four soil borings were installed at Building 237G during the RI for the purpose of collecting groundwater and soil gas samples in the vicinity and downgradient of the reported mothball odor (Figure 22). During soil boring installation, no elevated headspace readings or other indications of impacts were observed at these locations. Groundwater results are presented in Table 14 and soil gas results are presented in Table 15.

The groundwater samples were collected from temporary wells screened at the groundwater table in borings 237G-SB2, 237G-SB3, and 237G-SB4 (Figure 25). The groundwater samples were analyzed for metals, VOCs, and SVOCs. No analytes were detected above screening criteria. Low (estimated) concentrations of VOCs were reported below reporting limits but above the method detection limits in the groundwater samples (Table 14). Low (estimated) concentrations of 1,4-dioxane were reported in a method blank and in the associated groundwater sample collected at 237G-SB3. As described in the data quality assurance review summary (Appendix C), the 1,4-dioxane result for sample 237G-SB3 was qualified with a "b" indicating low-level contamination was detected in the associated method blank. The presence of this compound in the method blank, above the method detection limit but below the laboratory reporting limit, suggests a source of low-level contamination in the analytical system. The detection in sample 237G-SB3 is considered a false positive (*i.e.*, not representative of groundwater conditions).

Soil gas samples were collected at two locations near Building 237G (Figure 25). Boring 237G-SB2A was installed near the previously reported mothball odor and was analyzed for VOCs via EPA method TO-15 and screened SVOCs via EPA method TO-17. Soil gas sample 237G-SB4 was inadvertently collected east of the previously reported mothball odor and was screened for SVOCs. Both soil gas samples were collected from a depth of 35 feet bgs. VOCs were below MPCA residential 33xISVs in sample 237G-SB2A. SVOCs were not detected in either sample.

Based on the results of this RI, no release of hazardous substances to soil gas or groundwater above screening criteria was identified at or downgradient of the location of the previously reported frothy liquid and mothball odor near Building 237G. The low (estimated) VOC concentrations detected in the groundwater samples and low VOC concentrations detected in the soil gas sample are *de-minimis* for the purposes of this RI.

4.9 Laminex Wood Box Sewer (LWBS)

The LWBS was constructed and used during GOW operations to transmit process water from the ABC Line and support areas with sewers to the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1). During the GOW decommissioning, large quantities of hot, caustic water were reportedly flushed through the sewers to neutralize any acid or acidic process water that might have been present in the sewer lines (Hutchinson, 1946). During a field inspection of GOW by the Army, it was determined that work conducted during the GOW decommissioning did not remove all hazards in the sewers (Jefferds, 1947). The LWBS remained in place after the GOW was decommissioned and the University used portions of it to transmit sewer flows to the Oxidation Pond. The University discontinued any further use of the LWBS when individual septic tanks and drain fields were installed in the 1980s.

Approximately 330 feet of the LWBS along the eastern portion of the Site was video-logged during the UMore East RI (Barr, 2012a). Three samples of sediment were collected from inside the LWBS and five soil samples were collected from soil borings below the LWBS. The portions of the LWBS that were video-logged were in good condition. Mercury, arsenic, PAHs, and PCBs exceeded the Tier 1 SRVs in the sediment samples from inside the LWBS. No analytes exceeded the Tier 1 SRVs in soil samples collected below the LWBS.

During this RI, soil samples and a groundwater sample were collected at the LWBS outfall, the accessible portions of the LWBS were video-logged to view the integrity of the sewer and select locations for follow-up sampling beneath the LWBS, and samples of soil beneath voids observed in the LWBS were collected with angled borings. Soil sampling locations are shown on Figure 23 and the groundwater sampling location is shown on Figure 25. Soil and groundwater results are presented in Tables 12 and 14, respectively. A summary of these activities is provided below:

- One soil boring (LWBD7-SB1) was completed at the sewer outfall to collect soil and groundwater samples. The LWBS was encountered during the initial attempted soil boring (LWBD7-SB1A). The soil boring was completed during a second attempt at a location approximately 10 feet to the south of the planned location. Two soil samples were collected from the soil boring and analyzed for RCRA metals, PAHs, and PCBs. Naphthalene exceeded Tier 1 SRVs in sample LWBD7-SB1, 0-0.5'. The naphthalene detection may be the result of cross contamination of the sampler from hitting the treated wood from the LWBS. Three additional step-out surface soil samples, LWBS-SS1 through SS3, were collected around the location of the naphthalene exceedance to define the extent of the release. No analytes exceeded Tier 1 SRVs in the step-out samples.

- A total of 11,352 feet of the LWBS was video-logged and the bottom was generally found to be in good condition with the exception of two breaks that were identified for follow-up sampling

beneath the LWBS with angled boreholes. The clay pipe that was reportedly installed to carry post-GOW sewage was not observed in the LWBS video. A memorandum summarizing the LWBS inspection and findings is included in Appendix B. A copy of the sewer video log was provided to the University and the MPCA and is available for review by request.

- The soils beneath the two breaks in the bottom of the LWBS observed during sewer video log were sampled with angled soil borings LWBC5-SB1 and LWBC6-SB1. Based on the drilling angles and depths, it is estimated the samples were collected approximately five feet below the base of the LWBS. No elevated headspace readings or other indications of impacts were observed. Soil samples were collected beneath the voids in the LWBS and analyzed for RCRA metals, PCBs, and DNT. No analytes were detected above Tier 1 SRVs in the samples collected beneath the LWBS.

One groundwater sample was collected from a temporary well installed at the outfall of the LWBS to evaluate potential leaching of COPC to the groundwater (Figure 25). The groundwater sample was analyzed for SVOCs and metals. No analytes were detected above screening criteria (Table 14).

No evidence of a release from the LWBS to underlying soil or groundwater was identified during the RI. Data from previous investigations have documented that the sediments within the LWBS may contain arsenic, mercury, SVOCs (including B(a)Pe), and/or PCBs at concentrations above Tier 1 SRVs. Based on the historic use, impacts to the sediments in the LWBS are likely the result of GOW and, to a lesser extent based upon the substantially lower flowage, post-GOW sewer use. The samples collected near the LWBS outlet provide a basis to estimate the magnitude and extent of the release for the purpose of the RI.

After notice to the MPCA and local units of government, and in accordance with applicable rules and regulations, the University sealed the LWBS manholes in late 2016 to prevent unauthorized access and address potential physical hazards associated with the LWBS.

4.10 Northern Disturbed Area

The Northern Disturbed Area is located in the northwestern portion of Vermillion Highlands and was identified as an area of disturbed soil in a 1945 aerial photograph (Figure 24, 1945 photo background). After the GOW was decommissioned, portions of this area were returned to agriculture use and other portions were planted with trees. The northwestern portion of this SOC is elevated above the surrounding area and concrete debris was observed on the ground surface during past field reconnaissance visits (Barr, 2010a). No previous investigations have taken place in this SOC.

Five test trenches were completed at the Northern Disturbed Area during this RI and 10 soil samples were collected and analyzed for RCRA metals and SVOCs. Soil sampling locations are shown on Figure 24 and the soil analytical results are presented in Table 13. No buried debris was identified and no elevated headspace reading or other indications of soil impacts were observed at these locations. No analytes were detected above the Tier 1 SRVs in the soil samples.

No release of hazardous substances has been identified at the Northern Disturbed Area during this RI.

5.0 Baseline Risk Evaluation

This section includes the evaluation of the potential risks that identified releases pose to human health and the environment in the absence of any remedial action (USEPA, 1988). Results of the evaluation are used as a basis to determine whether remedial action is necessary to reduce the potential risks that impacts may have on human health and the environment. This section presents the results of a baseline screening level risk assessment (SLRA) of soil conditions at UMore Park/GOW. The SLRA includes a screening level HHRA of the 10 sub-sites included in the RI and a cursory evaluation of the identified releases at other sites at UMore Park/GOW. The screening level HHRA was performed following MPCA risk-based guidance for human health pathways (MPCA, 1998b). A separate screening level HHRA and SLERA for the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) is provided in Appendix E.

5.1 Data Evaluation

5.1.1 Data Quality Management

The data collected during the RI were validated according to the QAPP as described in Appendix C. For the purposes of this SLRA, it was assumed that existing data collected by the USACE and others were validated as part of the previous investigations and that the data were acceptable for use in the SLRA.

5.1.2 Data Set Development

Following data validation, the RI data was pooled with prior existing data from each SOC presented in the following reports:

- Preliminary Environmental Investigation, Former Gopher Ordnance Works, UMore Park, Rosemount, Minnesota (Peer, 2003);
- Concrete and Soil Assessment, UMore Park, Rosemount, Minnesota, (Peer, 2006b);
- Final Focused Site Inspection Report, Former Gopher Ordnance Works, Rosemount, Minnesota (USACE, 2009b);
- Final Expanded Site Inspection Report, Former Gopher Ordnance Works, Rosemount, Minnesota (USACE, 2009c);
- Phase II Investigation Report, Sites of Concern 1-3 and 6-8, UMore Mining Area, Dakota County, Minnesota (Barr, 2009b);
- Supplemental Site Investigation (SOC 4) and Remedial Investigation (SOC 5) Report, UMore Mining Area, Dakota County, Minnesota (Barr, 2010b); and
- Remedial Investigation Report, UMore East, Dakota County, Minnesota (Barr, 2012a);

A list of COPC was developed from the pooled data following the process described in USEPA's Risk Assessment Guidance for Superfund (RAGS Part A; USEPA, 1989). The COPC were those chemicals that

were: 1) positively detected in at least one sample (including chemicals with no data qualifiers and chemicals with data qualifiers indicating known identities but estimated concentrations, for example, "J"-qualified data; and 2) detected above associated blank sample concentrations. The list of COPC was then further refined as described below.

5.1.2.1 Duplicate Samples

Duplicate samples were included in the SLRA data set. If statistical analysis was necessary to refine the SLRA, the duplicate samples were treated as quality assurance/quality control (QA/QC) samples for the purpose of data validation and were removed from the SLRA data set.

5.1.2.2 Detection Limits Greater than Screening Levels

To ensure that elevated method detection limits did not result in inappropriate exclusion of COPC from further evaluation, when the method detection limit for a COPC was higher than the screening value, the COPC was considered for further evaluation in the SLRA if the COPC was known or suspected to be related to a release. When the method detection limit for a COPC was lower than the screening value and the COPC was not detected, the COPC was eliminated from further consideration in the SLRA. When B(a)Pe concentrations were calculated for PAHs, zero was substituted for a non-detect result.

5.2 Exposure Assessment

In Section 4.0, MPCA Tier 1 SRVs for unrestricted use (MPCA, 2009) were used to define the nature and extent of impacts in the SOCs. For the baseline screening level HHRA of the sub-sites at the GOW (except AOC 1), Tier 2 SRVs for commercial/industrial land use were used to identify potential risks to human health in the absence of any remedial action. The use of Tier 2 commercial/industrial SRVs is conservative because "exposures in most areas where contaminants are found are expected to be limited to the occasional trespasser or University staff" (MDH, 2014). As described in Appendix E, a recreational land use scenario was evaluated for AOC 1.

5.2.1 Exposure Pathways

Potential exposure pathways listed in the MPCA Risk-Based Site Evaluation Manual (MPCA, 1998b) were assessed to determine whether they were complete in the SOCs. Table 16 provides a summary of this exposure pathway evaluation which identified the following human exposure pathways as complete for the SOCs (excluding AOC 1 which is addressed in Appendix E):

- Inhalation, dermal contact, and ingestion of soil; and
- Inhalation of outdoor air.

Inhalation exposures of soil vapors and re-suspended soil particulates (airborne dust) in outdoor air are incorporated into the calculation of MPCA Tier 2 SRVs. The soil leaching and groundwater ingestion exposure pathways are incomplete because the RI and previous investigations have documented that GOW and post-GOW activities at the RI project area have not resulted in groundwater impacts above groundwater criteria. The surface water and sediment exposure pathways are incomplete and/or

insignificant because surface water is not present at the sites. Food chain exposures are incomplete because previous agricultural land exhibiting impact from GOW or post-GOW activities is no longer in agricultural use. The indoor air pathway is incomplete because no occupied buildings are present at the sites and VOCs are not prevalent at UMore Park/GOW.

Consistent with the approach used by the MDH in the Public Health Assessment of the GOW (MDH, 2014), baseline exposures to soil under current conditions were evaluated by assessment of COPC in surface soil. COPC concentrations in subsurface (deeper than six inches) soil samples are also identified for future reference. As portions of the GOW are slated for redevelopment, additional evaluation of potential exposures to these subsurface soils may be needed.

5.2.2 Screening Levels

To determine whether COPC concentrations warrant further consideration with regard to potential human health risk, surface soil data from each site were compared to Tier 2 commercial/industrial SRVs developed by the MPCA (2009). The Tier 2 commercial/industrial SRVs are based on default exposure parameters and factors that represent reasonable maximum exposure (RME) conditions for long-term/chronic commercial/industrial exposures through inhalation, dermal contact, and ingestion. The Tier 2 commercial/industrial SRVs are based on the methods outlined in Minnesota risk-based guidance (MPCA, 1998a, 1998b). It is important to note that the SRVs are for screening purposes only and do not represent values to be used in a site-specific HHRA or as remedial action cleanup levels.

5.2.3 Exposure Concentrations

The concentrations of COPC in each discrete surface soil sample were compared to the 2009 Tier 2 commercial/industrial SRVs. This approach allowed an evaluation of both the prevalence of concentrations greater than SRVs in surface soil (i.e., samples of 0-0.5 feet) and the spatial distribution of concentrations greater than SRVs in surface soil.

5.3 Toxicity Assessment

This screening level HHRA used the default human health toxicity values used by MPCA when deriving the Tier 2 commercial/industrial SRVs. The Tier 2 commercial/industrial SRVs were calculated for both carcinogenic and non-carcinogenic endpoints. COPC-specific toxicity issues are discussed below.

5.3.1 Chromium

Chromium is typically reported as total chromium, which includes both trivalent and hexavalent chromium. Hexavalent chromium is the more toxic form. Previous investigation at UMore Park/GOW included analytical speciation of chromium (Barr, 2009b) and documented that the chromium present in soil at the UMore Park/GOW is the less toxic trivalent form. Therefore, the Tier 2 commercial/industrial SRVs used to screen chromium concentrations in the screening level HHRA were the toxicity values for trivalent chromium.

5.3.2 Mercury

Mercury is typically reported as total mercury; however, mercury can exist in the environment as elemental mercury, methyl mercury, or mercury salts (*e.g.*, mercuric chloride). The screening level HHRA used the default toxicity values recommended by the MPCA and used in the calculation of Tier 2 commercial/industrial SRVs for total mercury.

5.3.3 Polychlorinated Biphenyls (PCBs)

The screening level HHRA used the default toxicity values recommended by the MPCA and used in the calculation of Tier 2 commercial/industrial SRVs for total PCBs.

5.3.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The screening level HHRA evaluated the PAHs according to MPCA guidelines for Tier 2 commercial/industrial SRVs, which included calculation of benzo(a)pyrene potency equivalents using the following relative potency factors (RPFs; MPCA, 2009):

PAHs	MPCA RPF
benzo(a)pyrene	1
benzo(a)anthracene	0.1
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.1
Chrysene	0.01
dibenz(a,h)anthracene	0.56
indeno(1,2,3-c,d) pyrene	0.1

5.4 Risk Screening Results

This section describes the results of the baseline screening level HHRA for each SOC. The following risk thresholds were used in the calculation of the Tier 1 and Tier 2 SRVs and account for potential cumulative risk from multiple chemicals:

- For carcinogenic COPC, an excess cancer risk of one additional cancer case in 100,000 people above background cancer rates in individuals exposed over a lifetime (1×10^{-5}); and
- For noncarcinogenic COPC, a hazard quotient of 0.2 per COPC for chronic exposure.

A discussion of the risk screening results for the sub-sites included in the RI and the site-wide dataset is provided below. The baseline screening level HHRA and SLERA for the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) is provided in Appendix E.

5.4.1 Remedial Investigation Sub-Sites

5.4.1.1 154th St. Disturbed Area (AOC 6)

The 154th Street Disturbed Area (AOC 6) is a land surface depression previously used for disposal of demolition debris. A total of 36 investigative soil samples have been collected from AOC 6 at depths ranging from 0-0.5 feet to 10-10.5 feet. These samples were analyzed for one or more of the following parameters: VOCs, SVOCs, and/or metals. Soil sample locations are shown on Figure 15 and analytical soil results are in Table 5.

The analytical soil results for each discrete soil sample from AOC 6 were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. B(a)Pe was detected in surface soil samples in the land surface depression at concentrations greater than Tier 2 commercial/industrial SRVs. Naphthalene and B(a)Pe were detected in subsurface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs. The locations of the samples exhibiting these exceedances are also shown on Figure 26.

5.4.1.2 Steam Plant and Associated 26.7 Acres (AOC 7)

The Steam Plant (a.k.a., Power House A or Building 401A) had five steam generating units that included boilers, coal pulverizers, pulverized coal burners, oil burners, forced and induced draft fans, and air preheater infrastructure. Almost 200 investigative soil samples were collected from AOC 7 at depths ranging from 0 feet to 16-18 feet. These samples were analyzed for one or more of the following parameters: VOCs, SVOCs, PCBs, metals, DRO, and/or nitrocellulose. Soil sample locations are shown on Figure 16 and analytical soil results are in Table 6.

The analytical soil results for each discrete soil sample from AOC 7 were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. The following parameters were detected in surface soil samples from AOC 7 at concentrations greater than Tier 2 commercial/industrial SRVs: B(a)Pe, PCBs, and/or lead. Arsenic, lead, mercury, naphthalene, B(a)Pe, and other SVOCs were detected in subsurface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs. The locations of the samples exhibiting these exceedances are also shown on Figure 26.

5.4.1.3 Temporary Shops Area

The Temporary Shops Area was used to support construction and operations at the GOW. Approximately 50 discrete investigative soil samples have been collected from the Temporary Shops Area at depths ranging from 0-0.5 feet to 7-7.5 feet. These discrete samples were analyzed for one or more of the following parameters: VOCs, SVOCs, and metals. Soil sample locations are shown on Figures 17 and 18 and analytical soil results are in Table 7. ISM sampling results were below Tier 2 commercial/industrial SRVs and are discussed in Section 4.4.

The analytical soil results for each discrete soil sample from the Temporary Shops Area were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2

commercial/industrial SRVs are identified on Table 17 and Figure 26. Arsenic and mercury were detected in surface soil samples from the Temporary Shops Area around the former Auto Repair Shop (Building 32T) at concentrations greater than Tier 2 commercial/industrial SRVs. There were no exceedances of Tier 2 commercial/industrial SRVs in subsurface soil samples from the Temporary Shops Area.

The concentrations of arsenic and mercury in the ISM replicates collected from the Temporary Shops area around former office and storage areas were much lower than the Tier 2 commercial/industrial SRVs. The ISM results provide a more representative exposure concentration than the discrete samples.

5.4.1.4 Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump

The Burning Grounds were used to burn smokeless gunpowder, nitro body-containing building materials, impacted soil, and other potential hazardous materials during GOW operations and decommissioning. More than 300 investigative soil samples have been collected from the Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump at depths ranging from 0-0.5 feet to 13-13.5 feet. These samples were analyzed for one or more of the following parameters: VOCs, SVOCs, PCBs, metals, nitrate, and/or sulfate. Soil sample locations are shown on Figure 19 and analytical soil results are in Table 9.

The analytical soil results for each discrete soil sample were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. The following parameters were detected in surface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs: lead, mercury, B(a)Pe, and a few other SVOCs. Lead was also detected in subsurface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs. The locations of the samples exhibiting these exceedances are also shown on Figure 26.

5.4.1.5 Acid Plant Area

Nitric acid and sulphuric acid were manufactured in the Acid Plant Area. More than 160 investigative soil samples have been collected from the Acid Plant Area at depths ranging from 0-0.5 feet to 10 feet. These samples were analyzed for one or more of the following parameters: VOCs, SVOCs, PCBs, metals, DRO, nitrate, and/or sulfate. Soil sample locations are shown on Figure 20 and analytical soil results are in Table 10.

The analytical soil results for each discrete soil sample from the Acid Plant Area were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. The following parameters were detected in surface soil samples from the Acid Plant Area at concentrations greater than Tier 2 commercial/industrial SRVs: lead, mercury, and/or B(a)Pe. Lead was also detected in subsurface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs. The locations of the samples exhibiting these exceedances are also shown on Figure 26.

5.4.1.6 Coal Ash Pond and Drainage Way

This SOC was used as a coal ash settling pond and, in 1946, the LWBS was re-routed to discharge to the Coal Ash Pond. More than 100 investigative soil samples have been collected from the Coal Ash Pond and Drainage Way at depths ranging from 0-0.5 feet to 7.5-8 feet. These samples were analyzed for one or more of the following parameters: SVOCs, pesticides, PCBs, metals, DRO, and/or sulfate. Soil sample locations are shown on Figure 21 and analytical soil results are in Table 11.

The analytical soil results for each discrete soil sample from the Coal Ash Pond and Drainage Way were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. Mercury was detected in surface soil samples from the Coal Ash Pond and Drainage Way at concentrations greater than Tier 2 commercial/industrial SRVs. Mercury was also detected in subsurface soil samples at concentrations greater than Tier 2 commercial/industrial SRVs. The locations of the samples exhibiting these exceedances are shown on Figure 26.

5.4.1.7 Building 237G

Building 237G was one of the Tray Dryer/Circulation Houses in which smokeless gun powder was dried. As described in Section 4.8, no release of hazardous substances to the subsurface in the area near the previously reported mothball odor or to the groundwater at concentrations above screening criteria has been identified in this SOC. Four soil samples have been collected near Building 237G at depths ranging from 0.5 feet to 30 feet. These samples were analyzed for VOCs, SVOCs, metals, and explosives. Soil sample locations are shown on Figure 22 and analytical soil results are in Appendix D.

The analytical soil results for each discrete soil sample from Building 237G were compared to Tier 2 commercial/industrial SRVs. There were no exceedances of Tier 2 commercial/industrial SRVs in surface or subsurface soil samples near Building 237G.

5.4.1.8 Laminex Wood Box Sewer

The LWBS was constructed to transport GOW process water for discharge to the Waste Disposal Ditch and the Primary and Secondary Settling Ponds (AOC 1). Three samples have been collected from inside the LWBS and 12 investigative soil samples have been collected outside of the LWBS at depths ranging from 0-0.5 feet to 20-25 feet. These samples were analyzed for one or more of the following parameters: VOCs, SVOCs, PCBs, metals, and/or DNT. The locations of the samples from inside and outside are shown on Figure 23 and analytical soil results are in Table 12.

The analytical soil results for each discrete soil sample near the LWBS were compared to Tier 2 commercial/industrial SRVs. Soil sample locations exhibiting concentrations greater than the Tier 2 commercial/industrial SRVs are identified on Table 17 and Figure 26. Naphthalene was detected in one surface soil sample near the LWBS at a concentration greater than the Tier 2 commercial/industrial SRV. As noted in Section 4.9, the naphthalene detection may be related to cross contamination of the sample. There were no exceedances of Tier 2 commercial/industrial SRVs in subsurface soil samples collected near (outside) the LWBS.

The concentrations of other parameters in sediments contained in the LWBS and other GOW sewers are included in Table 17 and the corresponding sampling locations are shown on Figure 26 for completeness purposes. Access points to the LWBS and GOW sewers were sealed by the University, thus the exposure pathway to these contained sediments is incomplete.

5.4.1.9 Northern Disturbed Area

This SOC is located in the northwestern portion of Vermillion Highlands and appeared disturbed in a 1945 aerial photograph. A total of 10 investigative soil samples have been collected from the Northern Disturbed Area at depths ranging from 0-0.5 feet to 7-7.5 feet. These samples were analyzed for metals. Soil sample locations are shown on Figure 24 and analytical soil results are in Table 13.

The analytical soil results for each discrete soil sample from the Northern Disturbed Area were compared to Tier 2 commercial/industrial SRVs. There were no exceedances of Tier 2 commercial/industrial SRVs in surface or subsurface soil samples from the Northern Disturbed Area.

5.4.2 Site-Wide

The locations of the detections above Tier 2 commercial/industrial SRVs are shown on Figure 26 and data are included in Table 17. The other sites at UMore Park with multiple samples with analyte concentrations above Tier 2 commercial/industrial SRVs include the DNT Storage Bunkers (AOC 5/SOC 5), the GOW Rifle Powder Water Dry House (Building 235A), the GOW Knife Grinding and Die Shop/Fluidyne (Building 217A), the Post-GOW Lab/Circuit Fabrication/Machine Shop (Building 707FFF), GOW Electrical Transformers (501 Buildings), the GOW Lead Burners Shop (Building 46T), the GOW Lab/Auto Shop (Building 706A), and the East 160th Street Dump.

The PHA (MDH, 2014) identified that there are limited areas at UMore Park/GOW with analyte concentrations in surface soil are above their respective Tier 2 commercial/industrial SRVs. The MDH indicated that additional investigation will be needed prior to developing certain areas of the property for unrestricted use and recommended the removal and disposal of impacted soils in those areas of UMore Park/GOW.

5.5 Uncertainties

Risk assessments are not precise estimates of risk, but conditional estimates given a considerable number of assumptions about exposure and toxicity. The purpose of this section is to clarify the assumptions and uncertainties inherent in the risk assessment to place the results in proper perspective. Uncertainty in all risk assessments is generally large and at least an order of magnitude (USEPA, 1989a). Consequently, it is more important to identify the key site-related variables and assumptions that contribute most to the uncertainty than to precisely quantify the degree of uncertainty in the risk assessment. Thus, the focus of the uncertainty assessment is on qualitative and semi-quantitative approaches rather than detailed quantitative approaches.

There are several categories of uncertainties associated with risk assessments. One is the initial selection of COPC used to characterize exposures and risk on the basis of the sampling data. Other sources of

uncertainty are inherent in the toxicity values for each COPC used to characterize risk. Additional uncertainties are inherent in the exposure assessment for individual substances and individual exposures. These uncertainties are due to uncertainty in the chemical monitoring data, uncertainty in the models used to estimate exposure concentrations in the absence of monitoring data, and uncertainty in estimates of population intake parameters. Additional uncertainties are incorporated in the risk assessment when exposures to several substances across multiple pathways are summed. The following sections describe the contributions to uncertainty from these sources.

5.5.1 Selection of Constituents of Potential Concern

The development of a risk assessment also depends on the reliability of the analytical data set used in the risk assessment. The reliability of the data is dependent on the operating procedures and techniques applied to the collection of environmental samples in the field and subsequent analysis of the samples in the laboratory. Analytical data must be sufficient to characterize the spatial distribution (both horizontal and vertical) of chemicals with regard to exposure. Soil samples were collected in accordance with approved sampling and analysis plans and with the objective of adequately characterizing the spatial distribution of chemicals. Given the sampling density in the SOCs, it is believed that these samples and the resulting data set provide an adequate representation of chemicals present within each SOC. However, if the samples do not provide an accurate representation of the distribution of chemicals within each SOC, then the SLRA could underestimate risks.

As described in Section 5.1, several steps were used to define the list of COPC to be carried through the risk assessment. This process results in the elimination of a few chemicals from consideration, whether through comparison with background, comparison with laboratory blanks, or frequency of detection. Chemicals which were not detected in soil were excluded from the risk assessment. These chemicals could be present at concentrations below detection limits and could add to the overall risk.

Section 6.0 identifies the constituents of concern (COC) for the Site.

5.5.2 Exposure Assessment

Investigative soil samples were biased toward areas believed to be contaminated (based on visual evidence and land use history) rather than random locations within each SOC. This approach contributes to an overestimate of exposure concentrations and the associated risks. Comparison of COPC concentrations in each discrete surface soil sample to the Tier 2 commercial/industrial SRVs also contributes to an overestimate of exposure concentrations and risk because average exposure concentrations in a SOC will be less than high concentrations in discrete samples.

Several exposure pathways were considered incomplete or insignificant and were not quantitatively evaluated in the screening level HHRA. If these exposure pathways are or were to become complete, then the HHRA could underestimate risks.

The Tier 2 commercial/industrial SRVs used in the screening level HHRA were derived by MPCA using conservative exposure assumptions that represent RME conditions for long-term/chronic commercial/industrial exposures through inhalation, dermal contact, and ingestion. The use of these

conservative SRVs is likely to overestimate risks posed by chemicals within each SOC because actual exposures (*e.g.*, frequency, duration) are likely to be less than the exposure assumptions used to derive the SRVs.

5.5.3 Toxicity Assessment

By using the Tier 2 commercial/industrial SRVs to screen the data from the SOCs, the screening level HHRA used the human health toxicity values that were used by MPCA in deriving the Tier 2 commercial/industrial SRVs. These SRVs were released in 2009 and may not utilize the most current toxicity data used by USEPA and other agencies. The use of outdated toxicity values could overestimate or underestimate risks.

All toxicity values used in risk assessment reflect the uncertainty associated with the database used to calculate these values. In general, higher uncertainty factors are applied when animal data are used in the determination of these values. The use of reliable human data is associated with lower uncertainty factors. Uncertainties associated with the extrapolation of animal toxicity data to human toxicity values are due to differences in chemical uptake, distribution, and metabolism; body weight; exposure duration; differences in enzyme subspecies and differences in relative surface area to body weight ratios; and extrapolation from relatively high doses used in animal studies to low human exposure doses. When human data are used to calculate reference doses, uncertainty factors are still applied to reflect the relative quantity or quality of the data or to protect from intraspecies variations, such as allergenic or hypersensitive responses. Uncertainty may also result from low confidence in laboratory experimental or epidemiological methodologies. The USEPA assigns a confidence level to reference doses based on these uncertainties in the toxicity information for each chemical. Additional uncertainties arise when toxicity values are extrapolated from one chemical to another based on similar chemical structure and activity (*e.g.*, PAHs).

Risks were not evaluated for some COPC because toxicity values were not available for these chemicals. The possibility therefore exists that the total risk has been underestimated for a limited number of chemicals. Slope factors calculated by USEPA for potential carcinogens have inherent uncertainty because they are calculations of lifetime cancer risks based on less-than-lifetime exposures and low-dose extrapolations.

5.5.4 Risk Characterization

The 2009 Tier 2 commercial/industrial SRVs incorporate the following risk thresholds: an excess cancer risk of one additional cancer case in 100,000 people above background cancer rates in individuals exposed over a lifetime (1×10^{-5}) and a hazard quotient of 0.2 per COPC for chronic exposures. These risk thresholds account for potential cumulative risk from exposure to multiple chemicals. This approach assumes that the toxic effects for individual chemicals are additive, which likely overestimates the actual risks because chemicals exert their toxic effects on different target organs (i.e., lung, liver, immune cells) through different biochemical mechanisms. However, this approach does not address potential antagonistic and synergistic effects of COPC. The possibility for health effects resulting from the exposure to the combination of two or more COPC also adds uncertainty to risk assessment.

5.6 Summary

Soil sample locations exhibiting concentrations greater than Tier 2 commercial/industrial SRVs are shown on Figure 26. Exceedances of Tier 2 commercial/industrial SRVs in surface soil samples are identified with a red symbol. As shown on Figure 26, localized areas of surface soils exhibiting exceedances of the Tier 2 commercial/industrial SRVs are present in several of the SOCs. These areas may warrant further evaluation or focused response action prior to redevelopment.

Exceedances of Tier 2 commercial/industrial SRVs in subsurface (*i.e.*, deeper than 0.5 feet) soil samples are identified with an orange symbol on Figure 26 for future reference. Additional evaluation of potential exposures to these subsurface soils should be considered prior to redevelopment or change in land use.

6.0 Constituents of Concern

The RI involved the collection of a significant amount of additional environmental data and other information for the RI project area. Section 4 focuses on the identification and delineation of releases at the 10 sub-sites investigated in 2016 and Section 5 assesses the risks of the identified releases based on current land use. This section provides a project area overview of the environmental data set and describes the distribution of the COC in the project area.

6.1 Data Set (2003 – 2016)

Appendix D includes tables with the soil data from this and prior RIs and previous investigations described in this report including the sites in the UMA, UMore East, and Vermillion Highlands (*i.e.*, the Site-wide data set). A series of index maps in Appendix D show the RI project area subareas, including the UMore East subarea presented and previous RI reports (Barr, 2012a), and locations of the investigated sites. Appendix D also includes detailed maps showing the RI and prior investigation sampling locations with color coded symbols depicting comparisons with Tier 1 SRVs for unrestricted use. Tables with groundwater, surface water, and sediment data collected at UMore Park/GOW are also included in Appendix D for completeness.

Table 18 summarizes the number of samples collected and analyzed for the primary COC from across UMore Park/GOW and the number of samples with concentrations at or above the Tier 1 SRVs for unrestricted use (Tier 1 SRV exceedances). A total of 341 Tier 1 SRV exceedances have been detected in the soil samples collected at UMore Park/GOW. Of these, arsenic, B(a)Pe, lead, mercury, and PCBs (primary COC) comprise 328 (~96%) of the Tier 1 exceedances. Only 12 other parameters have been detected at concentrations above their respective Tier 1 SRVs in soil samples, including:

- Naphthalene (7 exceedances)
- Cadmium (2 exceedances)
- 1,4-Dichlorobenzene (1 exceedance)
- Dieldrin (1 exceedance)
- Terbufos (1 exceedance)
- 2-Methylnaphthalene (2 exceedances)
- Acenaphthalene (1 exceedance)
- Carbazole (1 exceedance)
- Dibenzofuran (2 exceedances)
- Fluoroanthene (4 exceedances)
- Fluorene (1)
- Pyrene (4 exceedances

The Tier 1 SRV exceedance counts include samples from locations that were selected using a judgment-based sampling strategy (*i.e.*, locations based on knowledge or inferences of past land uses), composite sampling strategies, and samples that were collected from utilities and/or debris that were collected for waste characterization purposes. As a result of the sampling strategy and the sampling of waste materials, the environmental data set is intentionally biased high (compared to a data set generated from a random sampling strategy).

The distribution of COC concentrations above Tier 1 SRVs is discussed in the following section. DNT, a compound used during GOW operations, is also discussed, although DNT concentrations detected at UMore Park/GOW are orders of magnitude below the Tier 1 SRV.

6.2 Site-Wide Distribution

The subsections below discuss the arsenic, lead, mercury, B(a)Pe, and PCBs results from this RI and previous investigations conducted at UMore Park/GOW. DNT results are discussed for completeness. Please note that the numbers presented in this section are approximate and do not include quality assurance samples or samples collected from areas of the RI project area that have been redeveloped.

6.2.1 Arsenic

Arsenic is a naturally occurring element found in soil across Dakota County, Minnesota, and the United States. The potential release of arsenic across the GOW from the past use of arsenic-containing pesticides was identified as a REC in the RI project area (Barr, 2011). Arsenate pesticides have been used at other FUDS but their use at GOW has not been confirmed. Published arsenic concentrations in background shallow soil in Dakota County range from less than 1 to 12 mg/kg (Lively and Thorleifson, 2009) and published arsenic concentrations in surface soils generally range from 5 to 7 mg/kg (USGS, 1984). The Tier 1 SRV for arsenic is 9 mg/kg and the site-specific background arsenic concentration for topsoil/loess/clay is 8.9 mg/kg (Appendix B). Thus, the background concentration of arsenic at UMore Park/GOW is about equal to its Tier 1 SRV.

Arsenic concentrations are at or above the Tier 1 SRV in approximately 3% of the samples that were analyzed for arsenic (60 of 1692; Table 18). The arsenic sampling locations and Tier 1 SRV exceedances are shown on Figure 27. The majority of the arsenic exceedances are at or slightly above the Tier 1 SRV and background concentration. The greatest number of arsenic exceedances is in the vicinity of former GOW buildings in the ABC Lines and around the area of the Steam Plant and Associated 26.7 Acres (AOC 7). Five of the six arsenic exceedances in the Navy/Burning Grounds area were detected with XRF screening methods during the investigation of the former Navy firing ranges (Barr, 2010c). With a few exceptions, the extent of soils exceeding the Tier 1 SRV for arsenic is limited to distances on the order of feet to tens of feet (Barr, 2012a).

6.2.2 Lead

Lead was reportedly used during GOW operations to line floors and walls of some GOW buildings to protect against acid spray and help prevent sparking (Barr, 2011), in water pipe fittings at the GOW, and was at the Lead Burners Shop (Building 46T). Lead concentrations are at or above the Tier 1 SRV in

approximately 3% of the samples that were analyzed for lead (50 of 1696; Table 18). The lead sampling locations and Tier 1 SRV exceedances are shown on Figure 28. Multiple detections of lead above the Tier 1 SRV were found at the GOW Burning Grounds, the Acid Plant Area, the 10th Street Dump, the GOW Lead Burners Shop (Building 46T), and the Steam Plant and Associates 26.7 Acres (AOC 7).

6.2.3 Mercury

Mercury was used in laboratory equipment during GOW operations (Barr, 2011). Mercury is also associated with coal combustion ash and was commonly used in bearings and trickling filters at wastewater treatment plants. Mercury concentrations are at or above the Tier 1 SRV in approximately 5% of the samples that were analyzed for mercury (76 of 1653; Table 18). The mercury sampling locations and Tier 1 SRV exceedances are shown on Figure 29. Mercury concentrations are above the Tier 1 SRV in multiple samples from the GOW Coal Ash Pond, the GOW wastewater treatment plant, the Steam Plant and Associated 26.7 Acres (AOC 7), Acid Plant Area, GOW Burning Grounds, GOW laboratory buildings, in GOW process water and sanitary sewer lines, the LWBS, disposal areas, and in the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1). Mercury was also detected in soils in a ditch in AOC 5 (University Central Services Station/DNT-Storage Bunkers). Overall, the mercury exceedances in soils are present in areas of former GOW operations in the ABC Line and GOW East subareas, disposal areas, and sewers/wastewater ditches.

6.2.4 Benzo(a)pyrene Equivalent (B(a)Pe)

PAHs, reported collectively as B(a)Pe, are semi-volatile compounds commonly in tar-based materials, burned and treated wood, and coal. B(a)Pe concentrations are at or above the Tier 1 SRV in approximately 7% of the samples analyzed for PAHs (101 of 1359; Table 18). The B(a)Pe sampling locations and Tier 1 SRV exceedances for B(a)Pe are shown on Figure 30. B(a)Pe detections in soil above the Tier 1 SRV are most abundant in the ABC Lines near former GOW buildings and Main Shops Area, the East 160th Street Dump, the Steam Plant and Associated 26.7 Acres (AOC 7), around the Power House A (Building 401A) and Reservoir Settling Basin (Building 402A), in the LWBS, in the 154th Street Disturbed Area (AOC 6), and the University Central Services Station/DNT-Storage Bunkers (AOC 5).

A number of B(a)Pe exceedances are located in soils that are in close proximity to GOW buildings or in areas that have not been used by the University.

6.2.5 Polychlorinated Biphenyls (PCBs)

Oils containing PCBs were commonly used in electrical transformers and other industrial applications prior to 1979. PCB concentrations are at or above the Tier 1 SRV in approximately 12% of the samples analyzed for PCBs (42 of 362; Table 18). The PCB sampling locations and Tier 1 SRV exceedances are shown on Figure 31. PCB concentrations exceed the Tier 1 SRV in areas of known post-GOW PCB releases associated with the delisted UMRRC Superfund Site (GUE, US Transformer, and PE), near the former GOW electrical transformers, in the Acid Plant Area near Building 302A (which burned) and the oil smothering pit near Building 501F1, in GOW sewers, and near the GOW wastewater treatment plant. PCBs were not detected above the Tier 1 SRV in the Coal Ash Pond or the Oxidation Pond, which were used by the University after the GOW was decommissioned.

6.2.6 Dinitrotoluene

DNT was added to smokeless powder in the GOW Mixer Macerator Houses (Buildings 208) to slow the burn rate of the powder (Barr, 2011). The DNT soil sampling locations and detections are shown on Figure 32. The majority of DNT detections are in the soil along the former powder production line in the ABC Line subarea, down the production line starting at the GOW Mixer Macerator Houses (Buildings 208) where DNT was added to the powder, in the GOW sewers, and in the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1).

DNT has not been detected above Tier 1 SRVs but, due to the lack of use of DNT during post-GOW activities, the presence and distribution of DNT is evidence of the effects of GOW operations and/or decommissioning.

Groundwater sampling was conducted immediately downgradient of the GOW Mixer Macerator Houses (Barr, 2012a) and along the northeastern and eastern RI project area boundaries, in part, to assess DNT (and other parameter concentrations) in downgradient groundwater. DNT was not detected in groundwater at any of the groundwater monitoring locations. Based on these results, the low DNT concentrations in the soil are not affecting groundwater in and downgradient of the RI project area.

7.0 Summary

The University conducted this investigation to complete the RI process at UMore Park/GOW consistent with CERCLA, the NCP, and MERLA. The RI included sampling and analysis of soil and groundwater to determine the source, extent, and magnitude of releases of hazardous substances or petroleum at 10 sub-sites at UMore Park/GOW. The field and laboratory methods were conducted in accordance with the Work Plan, FSP, SFSP, and the QAPP (Barr, 2016a, 2016b, 2016c, 2016d, 2016e, and 2016f). The collected data met the project requirements and the data quality objectives and the results are considered valid and useable with the assigned data qualifiers.

Table 19 provides a summary of the results for each of the 10 sub-sites investigated during this RI and the sites investigated during previous investigations, and includes a list of analytes detected above the Tier 1 SRVs, conceptual releases models, and references to figures showing the sampling locations in Appendix D. Below is a summary of the results from the UMore Park/GOW RI:

- Releases of hazardous substances or petroleum that resulted in soil concentrations above Tier 1 SRVs were identified at eight of the 10 sub-sites investigated during this RI, including the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1), the 154th Street Disturbed Area (AOC 6), the Steam Plant and Associated 26.7 Acres (AOC 7), the Temporary Shops Area, the Burning Grounds/Air Force Lease Area/Navy Lease Area/10th Street Dump, the Acid Plant Area, the Coal Ash Pond and Drainage Way, and the LWBS. The low VOC concentrations detected in the groundwater and soil gas at Building 237G are below screening criteria and are considered *de-minimis*. No evidence of a release was identified at the Northern Disturbed Area. Overall, 76 sites have been investigated as part of the RI or previous investigations and releases of hazardous substances or petroleum have been identified at 41 of the sites (Table 19). With limited exceptions, the source of the releases of hazardous substances or petroleum identified in the RI and in past investigations is the construction, operation, decommissioning, and demolition of GOW by the federal government and DuPont.
- Five analytes – arsenic, lead, mercury, B(a)Pe, and PCBs – account for approximately 328 of the 341 analytes detections at concentrations above Tier 1 SRVs in soil samples collected during this and previous RI phases at UMore Park/GOW. The distributions of these analytes and DNT, a compound used during GOW operations, are shown on Figures 27 through 32 and discussed in Section 6 of this report. It is not uncommon to detect arsenic, lead, and B(a)Pe at brownfield redevelopment sites due to their association with a wide range of industrial activities and their persistence in the environment. Mercury and DNT were used at the Site during GOW operations. Investigations conducted to support future land use changes should, at a minimum, include sampling and analysis of arsenic, lead, mercury, and PAHs (for the calculation of B(a)Pe). PCB samples should be collected at sites with a historic use of electrical transformers and for former gravel roads where PCB oil may have been used for dust suppression. Additional analytes may be appropriate if past land uses indicate the potential for other releases (*e.g.*, VOCs should be included if a fuel tank was present).

- Groundwater quality monitoring results are consistent with past results. No analytes were detected above MCLs or MDH Human-Health Based criteria at or downgradient of the investigated sites.

- Buried debris was encountered near the former foundation of Building 302A in the Acid Plant Area, which was reportedly destroyed by a fire in the 1970s. The location of the building debris is shown on Figure 20. The location of other debris encountered at or below the ground surface during previous RI phases is included in previous reports (Barr, 2012a). As documented in the field notes and past reports, minor amounts of demolition debris and modern trash (as a result of fugitive roadside dumping) are present at several locations across UMore Park/GOW.

- The results of this RI and previous RI phases provide a basis to estimate the magnitude and extent of impacts for the purposes of scoping and developing potential response action alternatives. The RI results allow the University to identify data needs with changing land use for the investigated sites. As indicated in communications with the MPCA and in accordance with recommendations by the MDH in the draft PHA for the Former GOW (MDH, 2014), the University recognizes that additional investigation of specific areas of UMore Park/GOW will be needed in the future with land use changes in those areas.

- This Report provides tables and figures summarizing the RI project area-wide data set. Soil samples are compared to Tier 1 SRVs and groundwater samples are compared to MCLs and MDH Human Health-Based criteria in tables in Appendix D. Figures showing investigation locations and the locations of Tier 1 SRVs exceedances to delineate releases are also in Appendix D. The locations of Tier 2 Industrial SRV exceedances are shown on Figure 26. These data will be used to evaluate the need for future corrective actions in areas of UMore Park/GOW where releases have occurred, in conjunction with and/or prior to future land use changes.

- A SLRA, including a screening level HHRA and a SLERA of soil conditions in the Waste Disposal Ditch and Primary and Secondary Settling Ponds (AOC 1) is included in Appendix E. The screening level HHRA concluded that the mercury concentration in two soil samples collected from the base of the northern portion of the ditch could pose an unacceptable risk to recreational users of AOC 1. This portion of the ditch is not easily accessible due to dense vegetation and is not open to hunting. The decision regarding the potential need for response action activities will be made in conjunction with further ecological evaluation or as part of a feasibility study, if required. The SLERA indicated the presence of lead and mercury concentrations above background and Ecological Soil Screening Levels (ESSLs) and recommended further assessment.

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