STATE OF MICHIGAN
CIRCUIT COURT FOR THE 30TH JUDICIAL CIRCUIT
INGHAM COUNTY

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY,

Plaintiff,

v

NORTHROP GRUMMAN SYSTEMS CORPORATION,

Defendant.

File No. 09-1658-CE

Honorable JOYCE DRAGANCHUK

CONSENT DECREE

INDEX

CONSENT DECREE

The Plaintiff is the Michigan Department of Environmental Quality (MDEQ).

NGSC is Northrop Grumman Systems Corporation.

This Consent Decree (Decree) requires the preparation and performance of a Remedial Action Plan (RAP) at the former Handy Things Manufacturing Company Facility in Ludington, Michigan (hereafter "Ludington Handy Things Facility") and the performance of certain response activities at the former Ludington Plating Company Facility in Ludington, Michigan (hereafter "LPC Facility"). NGSC and MDEQ (the Parties) agree not to contest (a) the authority or jurisdiction of the Court to enter this Decree or (b) any terms or conditions set forth herein.

The Parties agree, and the Court by entering this Decree finds, that the response activities set forth herein are necessary to abate the release or threatened release of hazardous substances into the environment, to control future releases, and to protect public health, safety, and welfare, and the environment.

NOW, THEREFORE, before the taking of any testimony, and without this Decree constituting an admission of any fact or any liability, or any of the allegations in the Complaint or as evidence of the same, and upon the consent of the Parties, by their attorneys, it is hereby ORDERED, ADJUDGED, AND DECREED:

I. JURISDICTION

1.1 This Court has jurisdiction over the subject matter of this action pursuant to MCL 324.3115; MCL 324.20137. This Court also has personal jurisdiction over NGSC. NGSC waives all objections and defenses that they may have with respect to jurisdiction of the Court or to venue in this Court.

1.2 The Court determines that the terms and conditions of this Decree are reasonable, adequately resolve the environmental issues raised, and properly protect the interests of the people of the State of Michigan.

1.3 The Court shall retain jurisdiction over the Parties and subject matter of this action to enforce this Decree and to resolve disputes arising under this Decree, including those that may be necessary for its construction, execution, or implementation, subject to Section XVII (Dispute Resolution).

II. DENIAL OF LIABILITY

The entry of this Decree by NGSC is neither an admission or denial of liability with respect to any issue dealt with in this Decree nor an admission or denial of any factual allegations or legal determinations stated or implied herein.

III. PARTIES BOUND

3.1 This Decree shall apply to and be binding upon the Parties and their successors and assigns. Any change in the ownership or corporate or legal status of NGSC, including, but not limited to, any transfer of assets or of real or personal property, shall not in any way alter NGSC's responsibilities under this Decree. To the extent that NGSC is the owner of a part or all of the Ludington Handy Things Facility, NGSC shall provide the MDEQ with written notice prior to the transfer of ownership of part or all of the Ludington Handy Things Facility and shall provide a copy of this Decree to any subsequent owners or successors prior to the transfer of any ownership rights. NGSC shall comply with the requirements of Section 20116 of the Natural Resources Environmental Protection Act (NREPA), MCL 324.20116, and the Part 201 Rules.

3.2 Notwithstanding the terms of any contract that NGSC may enter with respect to the performance of response activities pursuant to this Decree, NGSC is responsible for

compliance with the terms of this Decree and shall ensure that its contractors, subcontractors, laboratories, and consultants perform all response activities in conformance with the terms and conditions of this Decree.

3.3 The signatories to this Decree certify that they are authorized to execute this Decree and to legally bind the Parties they represent.

IV. STATEMENT OF PURPOSE

In entering into this Decree, it is the mutual intent of the Parties to: (a) require NGSC to conduct all work specified in the *Revised Monitored Natural Attenuation Work Plan for Chlorinated Volatile Organic Compound Impacts Downgradient of the Former Ludington Plating Company* dated October 9, 2007, prepared by ARCADIS G&M of Michigan, LLC on behalf of NGSC and approved by the MDEQ on October 17, 2007 (MNA Work Plan – Attachment D); (b) require NGSC to request the local unit of government to enact a local groundwater use ordinance, approved by MDEQ, that prohibits use of the groundwater to prevent unacceptable exposure to hazardous substances in the groundwater for the area described in Attachment E; (c) require NGSC to develop and submit to the MDEQ an approvable Remedial Action Plan for the Ludington Handy Things Facility that complies with Part 201; (d) require NGSC conduct all work specified in the MDEQ-approved Remedial Action Plan for the Ludington Handy Things Facility in accordance with its approved implementation schedule; (e) require NGSC to reimburse the State for Past and Future Response Activity Costs as described in Section XV (Reimbursement of Costs); and (f) minimize litigation.

V. DEFINITIONS

5.1 "Decree" means this Consent Decree and any attachment hereto, including any future modifications, and any reports, plans, specifications, and schedules required by the Consent Decree which, upon approval of the MDEQ, shall be incorporated into and become an enforceable part of this Consent Decree.

5.2 "Effective Date" means the date that the Court enters this Decree.

5.3 "Ludington Handy Things Facility" means any area of the Handy Things Property identified in Attachment A where a hazardous substance, in concentrations that exceed the requirements of Section 20120a(1)(a) or (17) of the NREPA, MCL 324.20120a(1)(a) or (17), or the cleanup criteria for unrestricted residential use under Part 213, Leaking Underground Storage Tanks, of the NREPA, has been released, deposited, or disposed of, or otherwise comes to be located; and any other area, place, or property where a hazardous substance, in concentrations that exceed these requirements or criteria, has come to be located as a result of the migration of the hazardous substance from the Handy Things Property. For purposes of this Decree the Ludington Handy Things Facility does not include the LPC Property or the LPC Facility, and as of the Effective Date of this Decree, it does not include the entire area depicted in Attachment E.

5.4 "LPC Facility" means any area of the LPC Property identified in Attachment B where a hazardous substance, in concentrations that exceed the requirements of Section 20120a(1)(a) or (17) of the NREPA, MCL 324.20120a(1)(a) or (17), or the cleanup criteria for unrestricted residential use under Part 213, Leaking Underground Storage Tanks, of the NREPA, has been released, deposited, or disposed of, or otherwise comes to be located; and any other area, place, or property where a hazardous substance, in concentrations that exceed these

requirements or criteria, has come to be located as a result of the migration of the hazardous substance from the LPC Property.

5.5 "Future Response Activity Costs" means costs incurred by the State that are not included in the attached Summary Reports (Attachment C) to develop, oversee, enforce, monitor, and document compliance with this Decree, and to perform response activities required by this Decree, including, but not limited to, costs incurred to: monitor response activities at the Ludington Handy Things Facility, observe and comment on field activities, review and comment on Submissions, collect and analyze samples, evaluate data, purchase equipment and supplies to perform monitoring activities, attend and participate in meetings, prepare and review cost reimbursement documentation, and perform response activities pursuant to Paragraph 7.12 (The MDEQ's Performance of Response Activities) and Section X (Emergency Response). Contractor costs are also considered Future Response Activity Costs.

5.6 "MDEQ" means the Michigan Department of Environmental Quality, its successor entities, and those authorized persons or entities acting on its behalf. Environmental functions formerly assigned to the Michigan Department of Natural Resources (MDNR) were transferred to the MDEQ by Executive Order 1995-18, effective October 1, 1995.

5.7 "O&M Costs" means monitoring, operation and maintenance, oversight, and other costs that are determined by the MDEQ to be necessary to assure the effectiveness and integrity of the remedial action as set forth in an MDEQ-approved RAP for the Ludington Handy Things Facility.

5.8 "Part 201" means Part 201, Environmental Remediation, of the NREPA, 1994 PA 451, as amended, MCL 324.20101 *et seq*, and the Part 201 Administrative Rules.

5.9 "Part 201 Rules" means the Administrative Rules promulgated under Part 201.

5.10 "Party" means either NGSC **or** the State. "Parties" means NGSC and the State.

5.11 "Past Response Activity Costs" means response activity costs that the State incurred and paid during the dates set forth in the attached Summary Reports (Attachment C).

5.12 "Handy Things Property" means the property located at 814 North Rowe Street, Ludington, Michigan and described in the legal description provided in Attachment A.

5.13 "LPC Property" means the property located at 902 North Harrison Street, Ludington, Michigan and described in the legal description provided in Attachment B.

5.14 Ludington Handy Things Facility "Remedial Action Plan" or "RAP" means a plan for the Ludington Handy Things Facility that satisfies the requirements of Part 201, including, but not limited to, Sections 20118, 20120a, 20120b, and 20120d of the NREPA; and the Part 201 Rules.

5.15 "RRD" means the Remediation and Redevelopment Division of the MDEQ and its successor entities.

5.16 "State" or "State of Michigan" means the Michigan Department of Attorney General (MDAG) and the MDEQ, and any authorized representatives acting on their behalf.

5.17 "Submissions" means all plans, reports, schedules, and other submittals that NGSC is required to provide to the State or the MDEQ pursuant to this Decree. "Submissions" does not include the notifications set forth in Section XI (*Force Majeure*).

5.18 Unless otherwise stated herein, all other terms used in this Decree, which are defined in Part 3, Definitions, of the NREPA, MCL 324.301; Part 201; or the Part 201 Rules shall have the same meaning in this Decree as in Parts 3 and 201 and the Part 201 Rules. Unless otherwise specified in this Decree, "day" means a calendar day.

VI. COMPLIANCE WITH STATE AND FEDERAL LAWS

6.1 All actions required to be taken pursuant to this Decree shall be undertaken in accordance with the requirements of all applicable or relevant and appropriate state and federal laws, rules, and regulations, including, but not limited to, Part 201, the Part 201 Rules, and laws relating to occupational safety and health. Other agencies may also be called upon to review the performance of response activities under this Decree.

6.2 This Decree does not obviate NGSC's obligation to obtain and maintain compliance with any permits.

VII. PERFORMANCE OF RESPONSE ACTIVITIES

7.1 NGSC shall perform the response activities set forth herein as necessary to achieve the applicable performance objectives:

(a) NGSC shall implement the MNA Work Plan (Attachment D).

(b) NGSC shall request that the local unit of government enact a local groundwater use ordinance that if approved by MDEQ, complies with the requirements of Part 201, and that effectively prevent unacceptable exposure to hazardous substances as the result of the use of the groundwater for drinking water and as the result of dermal contact with the groundwater in the area described in Attachment E.

(c) NGSC shall perform all necessary response activities to address the Ludington Handy Things Facility in compliance with the requirements of Part 201, including the development, and upon MDEQ approval, the implementation of a RAP for the Ludington Handy Things Facility that achieves the following performance objectives:

(i) Meet and maintain compliance with the cleanup criteria as established under Section 20120a(1)(a)-(j) or 20120a(2), and Sections 20120a(15) and (17) of the NREPA.

(ii) Comply with all applicable requirements of Sections 20118, 20120a, 20120b, and 20120d of the NREPA, and the Part 201 Rules.

(iii) Assure the ongoing effectiveness and integrity of the remedial action specified in an MDEQ-approved RAP for the Ludington Handy Things Facility.

(iv) Allow for the continued use of the Ludington Handy Things Facility consistent with local zoning pursuant to Section 20120a(6) of the NREPA.

7.2 In accordance with this Decree, NGSC shall assure that all work plans for conducting response activities are designed to achieve the performance objectives identified in Paragraphs 7.1(a) through (c). NGSC shall develop each work plan and perform the response activities contained in each MDEQ-approved work plan in accordance with the requirements of Part 201 and this Decree. Upon MDEQ approval, each component of each work plan and any approved modifications shall be deemed incorporated into this Decree and made an enforceable part of this Decree. If there is a conflict between the requirements of this Decree and any MDEQ-approved work plan, the requirements of this Decree shall prevail.

7.3 Quality Assurance

Sampling and analytical activities shall be developed and performed in accordance with the United States Environmental Protection Agency's (USEPA's or EPA's) "EPA Requirements for Quality Assurance Project Plans," EPA QA/R-5, March 2001; "Guidance for Quality Assurance Project Plans," EPA QA/G-5, December 2002; and American National Standard ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental

Data Collection and Environmental Technology Programs." NGSC shall utilize the recommended guidance for determination of sampling locations, collection methods, parameters, detection limits, and analytical methods specified in "MDEQ RRD Operational Memorandum No. 2, Sampling and Analysis" (dated October 24, 2004) and all its attachments. NGSC shall utilize the MDEQ 2002 Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria (S^3TM) to determine the number of samples required to verify the cleanup and to determine sampling strategy. NGSC shall comply with the above documents or documents that supersede or amend these documents, and may utilize other methods demonstrated by NGSC to be appropriate as approved by the MDEQ.

7.4 Health and Safety Plan (HASP)

Within sixty (60) days of the Effective Date of this Decree, NGSC shall submit to the MDEQ a HASP that is developed in accordance with the standards promulgated pursuant to the National Contingency Plan, 40 CFR 300.150; the Occupational Safety and Health Act of 1970, 29 CFR 1910.120; and the Michigan Occupational Safety and Health Act, 1974 PA 154, as amended, MCL 408.1001 *et seq.* Response activities performed by NGSC pursuant to this Decree shall be in accordance with the HASP. The HASP is not subject to the MDEQ's approval under Section XIV (Submissions and Approvals) of this Decree.

7.5 Monitored Natural Attenuation Work Plan

Within sixty (60) days of the Effective Date, NGSC shall undertake the first quarterly sampling event as specified in the MDEQ-approved MNA Work Plan in Attachment D. NGSC shall complete all activities in the MNA Work Plan in accordance with the requirements, procedures, and schedule specified therein.

Data Collection and Environmental Technology Programs." NGSC shall utilize the recommended guidance for determination of sampling locations, collection methods, parameters, detection limits, and analytical methods specified in "MDEQ RRD Operational Memorandum No. 2, Sampling and Analysis" (dated October 24, 2004) and all its attachments. NGSC shall utilize the MDEQ 2002 Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria (S^3TM) to determine the number of samples required to verify the cleanup and to determine sampling strategy. NGSC shall comply with the above documents or documents that supersede or amend these documents, and may utilize other methods demonstrated by NGSC to be appropriate as approved by the MDEQ.

7.4 Health and Safety Plan (HASP)

Within sixty (60) days of the Effective Date of this Decree, NGSC shall submit to the MDEQ a HASP that is developed in accordance with the standards promulgated pursuant to the National Contingency Plan, 40 CFR 300.150; the Occupational Safety and Health Act of 1970, 29 CFR 1910.120; and the Michigan Occupational Safety and Health Act, 1974 PA 154, as amended, MCL 408.1001 *et seq.* Response activities performed by NGSC pursuant to this Decree shall be in accordance with the HASP. The HASP is not subject to the MDEQ's approval under Section XIV (Submissions and Approvals) of this Decree.

7.5 Monitored Natural Attenuation Work Plan

Within sixty (60) days of the Effective Date, NGSC shall undertake the first quarterly sampling event as specified in the MDEQ-approved MNA Work Plan in Attachment D. NGSC shall complete all activities in the MNA Work Plan in accordance with the requirements, procedures, and schedule specified therein.

7.6 Local Groundwater Use Ordinance

(a) Within ninety (90) days of the Effective Date, NGSC shall conduct a survey of existing wells in the area described in Attachment E. The survey shall take the form of a door-to-door personal inquiry or mailer which questions each occupant about the existence of wells on the occupant's property. NGSC may satisfy its requirements to conduct a survey under this Paragraph by sending such a mailer in the United States mail or attempting to make a personal inquiry within the time specified, or by arranging for the local unit of government to send such a mailer in the United States mail or attempt to make such a personal inquiry within the time specified. If a mailer is used and there is no response to the mailer, a personal inquiry at the address must be attempted.

(b) Within one hundred twenty (120) days of the Effective Date, NGSC shall provide to the MDEQ the following documentation regarding the area described in Attachment E:

(i) Copies of well logs maintained by the local unit of government.

(ii) A summary of any addresses not receiving water bills based on a review of municipal water billing records.

(iii) A summary of the survey results required in Paragraph 7.6(a) of this Decree.

(iv) A plan and schedule for abandonment of any existing wells identified pursuant to Paragraph 7.6(a) for MDEQ review and approval and implement the plan upon MDEQ approval.

(c) Within one hundred fifty (150) days of the Effective Date, NGSC shall:

(i) Submit a draft groundwater use ordinance to the MDEQ for review and approval.

(ii) Request the local unit of government to enact an ordinance substantially like the ordinance submitted. The ordinance shall prohibit use of the groundwater in the area described in Attachment E and effectively prevent unacceptable exposure to hazardous substances as the result of the use of the groundwater for drinking water and as the result of dermal contact with the groundwater. The ordinance shall comply with applicable requirements of Part 201. The form and content of the groundwater use ordinance must be approved by the MDEQ.

7.7 Remedial Action Plan (RAP)

(a) Within one hundred and eighty (180) days of the Effective Date, NGSC shall submit a RAP for the Ludington Handy Things Facility to the MDEQ for review and approval to address the Ludington Handy Things Facility. The Ludington Handy Things Facility RAP shall provide for the following:

(i) All technical and administrative components required by Sections 20118, 20120a, 20120b, and 20120d of the NREPA; and the Part 201 Rules. The proposed RAP shall include, subject to MDEQ review and approval, a definition or depiction of the contaminated groundwater associated with the Ludington Handy Things Facility that is being addressed by the Ludington Handy Things Facility RAP. MDEQ recognizes, based on conditions that exist as of the Effective Date of this Decree, that this area is not the entire area depicted in Attachment E. If an ordinance is not approved as set forth in Paragraph 7.6, NGSC shall propose an alternate RAP for the Ludington Handy Things Facility that meets all the

requirements of Part 201 and that addresses the contaminated groundwater associated with the Ludington Handy Things Facility.

(ii) A detailed description of the specific work tasks to be conducted pursuant to the RAP, a description of how these work tasks will meet the performance objectives described in Paragraph 7.1(c), and a description and supporting documentation of how the results of any remedial investigations, and other response activities that have been performed at the Ludington Handy Things Facility, support the selection of the remedial action contained in the RAP.

(iii) Implementation schedules for conducting the response activities identified in the RAP and for submission of progress reports.

(iv) A plan for obtaining access to any properties not owned or controlled by NGSC that is needed to perform the response activities contained in the RAP. If the remedial action provided for in the RAP relies on the cleanup criteria established under Section 20120a(1)(b)-(j) or (2) of the NREPA and that RAP provides for land and resource use restrictions, monitoring, operation and maintenance, or permanent markers as prescribed by Sections 20120b(3)(a)-(d) of the NREPA, the RAP shall include documentation from property owners, easement holders, or local units of government that the necessary access to these properties has been or will be obtained and that any proposed land or resource use restrictions can or will be placed or enacted.

(v) A description of the nature and amount of waste materials expected to be generated during the performance of response activities and the name and location of the facilities NGSC proposes to use for the off-site transfer, storage, and treatment or disposal of those waste materials.

(vi) A description of how soil relocation will be in compliance with Section 20120c of the NREPA and the Part 201 Rules.

(vii) Identification of the conditions, including the performance standards, which may be used to define construction completion (if applicable) and voidance or nullification of the MDEQ's approval of the RAP.

(b) Within thirty (30) days of receiving the MDEQ's approval of the RAP, NGSC shall undertake the RAP activities and perform the activities in accordance with the MDEQ-approved implementation schedule and submit progress reports in accordance with the MDEQ-approved RAP. All technical and administrative requirements submitted to the MDEQ, which in combination constitute an MDEQ-approved RAP, shall become incorporated into this Decree, and become an enforceable part of this Decree. The technical and administrative components of an MDEQ-approved RAP are required under Section 20120b of the NREPA and Rules 524 and 532 of the Part 201 Rules. Those components may include, but are not limited to, the following: (i) notices of approved environmental remediation (NAER), restrictive covenants, institutional controls, and land use restrictions (for the purpose of this Decree collectively referred to as "Land and Resource Use Restrictions") and (ii) financial assurance mechanisms.

(i) Land and Resource Use Restrictions

If the remedial action provided for in the MDEQ-approved RAP relies on the cleanup criteria established under Sections 20120a(1)(b)-(e) of the NREPA; or the cleanup criteria established under Section 20120a(1)(f)-(j) or (2) of the NREPA, and the RAP requires the placement of Land and Resource Use Restrictions, NGSC shall file for recording, or cause to be filed for recording, the appropriate Land and Resource Use Restrictions required by the RAP, with the Mason County Register of Deeds within twenty-one (21) days after the MDEQ's approval of the

RAP or within twenty-one (21) days after completion of construction of the remedial action provided for in the RAP, as appropriate to the circumstances. The Land and Resource Use Restrictions shall comply with applicable requirements of Part 201. The form and content of the Land and Resource Use Restrictions must be approved by the MDEQ. NGSC shall provide documentation acceptable to the MDEQ that demonstrates that the twenty-one (21)-day statutory time frame for recording the Land and Resource Use Restrictions was met (e.g., a date-stamped receipt from the Register of Deeds Office). Such documentation shall be submitted to the MDEQ within seven (7) days of the date the Land and Resource Use Restrictions were delivered to the Mason County Register of Deeds for recording. NGSC shall also provide a true copy of the recorded Land and Resource Use Restrictions and the liber and page numbers to the MDEQ within ten (10) days of NGSC's receipt of a copy from the Register of Deeds. Further, if the remedial action provided for in the MDEQ-approved RAP relies on the cleanup criteria established under Section 20120a(1)(b)-(j) or (2) of the NREPA and the RAP relies upon Land and Resource Use Restrictions, within thirty (30) days of the MDEQ's approval of the RAP, NGSC shall provide notice of the Land and Resource Use Restrictions to the zoning authority of the local unit of government within which the Ludington Handy Things Site is located. Land and Resource Use Restrictions shall comply with applicable requirements of Part 201.

(ii) Financial Assurance

If the remedial action provided for in the MDEQ-approved RAP relies on the cleanup criteria established under Section 20120a(1)(f)-(j) or (2) of the NREPA, NGSC shall be responsible for providing and maintaining financial assurance in a mechanism (FAM) acceptable to the MDEQ that will assure NGSC's ability to pay for monitoring, operation and maintenance, oversight, and other costs (collectively referred to as "O&M Costs") that are determined by the MDEQ to be

necessary to assure the effectiveness and integrity of the remedial action as set forth in an MDEQ-approved RAP. The cost of activities covered by the FAM shall be documented on the basis of an annual estimate of maximum costs for the activity as if they were to be conducted by a person under contract to the state, not employees of NGSC. The proposed FAM shall be submitted to the MDEQ as part of the RAP pursuant to Paragraph 7.7(a) and shall be in an amount sufficient to cover O&M Costs at the Ludington Handy Things Facility for a thirty (30)-year period. If a FAM is a component of the MDEQ-approved RAP, every five (5) years after the MDEQ's initial approval of the FAM, NGSC shall provide to the MDEQ an update of the thirty (30)-year O&M Costs estimate. The updated cost estimate shall include documentation of O&M Costs for the previous five (5)-year period and be signed by an authorized representative of NGSC who shall confirm the validity of the data. NGSC shall revise the amount of funds secured by the FAM in accordance with that updated five (5)-year cost estimate unless otherwise directed by the MDEQ. If, at any time, the MDEQ determines that the FAM does not adequately secure sufficient funds, NGSC shall capitalize or revise the existing FAM or establish a new FAM acceptable to the MDEQ. After a FAM has been established, if NGSC can demonstrate that the FAM provides funds in excess of those needed to cover O&M Costs for the Ludington Handy Things Facility, NGSC may submit a request to the MDEQ to reduce the amount of funds secured by the FAM. NGSC shall maintain the FAM in perpetuity or until NGSC can demonstrate to the MDEQ that such FAM is no longer necessary to protect the public health, safety, or welfare, or the environment, and is no longer necessary to assure the effectiveness and integrity of the remedial action as set forth in the MDEQ-approved RAP. Any modification of a FAM will be considered to be a modification of a RAP, and any such modifications must be made in accordance with Section XXIII (Modifications).

(c) NGSC shall notify the MDEQ within ten (10) days of completion of construction of the remedial action in the MDEQ-approved RAP that relies on the cleanup criteria established under Sections 20120a(1)(b)-(j) of the NREPA.

7.8 Modification of a Response Activity Work Plan

(a) If the MDEQ determines that a modification to a response activity work plan for the Ludington Handy Things Facility is necessary to meet and maintain the applicable performance objectives specified in Paragraph 7.1, to comply with Part 201, or to meet any other requirement of this Decree, the MDEQ may require that such modification be incorporated into a response activity work plan previously approved by the MDEQ under this Decree. If extensive modifications are necessary, the MDEQ may require NGSC to develop and submit a new response activity work plan. Any work plan modifications or any new work plans shall be developed in accordance with the applicable requirements of this Section and shall be submitted to the MDEQ for review and approval in accordance with the procedures set forth in Section XIV (Submissions and Approvals).

(b) Upon receipt of the MDEQ's approval, NGSC shall perform the response activities specified in a modified response activity work plan or a new work plan in accordance with the MDEQ-approved implementation schedules.

7.9 Public Notice and Public Meeting Requirements Under Section 20120d of the NREPA

If the MDEQ determines there is significant public interest in the proposed RAP required by this Decree; if NGSC proposes a RAP pursuant to Section 20120a(1)(f)-(j) or (2) of the NREPA; or if Section 20118(5) or (6) of the NREPA applies to the proposed RAP, the MDEQ will make the proposed RAP available for public comment. When the MDEQ determines that the proposed RAP is acceptable for public review, a public notice regarding the availability of

the proposed RAP will be published, and the proposed RAP shall be made available for review and comment for a period of not less than thirty (30) days. The dates and length of the public comment period shall be established by the MDEQ. If the MDEQ determines there is significant public interest or the MDEQ receives a request for a public meeting, the MDEQ will hold such public meeting in accordance with Sections 20120d(1) and (3) of the NREPA. Following the public review and comment period or a public meeting, the MDEQ may refer the proposed RAP back to NGSC for any revision required by Part 201 to address public comments and the MDEQ's comments. The MDEQ will prepare the final responsiveness summary document that explains the reasons for the selection or approval of a RAP in accordance with the provisions of Sections 20120d(5) and (6) of the NREPA. Upon the MDEQ's request, NGSC shall provide information to the MDEQ for the final responsiveness summary document or NGSC shall prepare portions of the draft responsiveness summary document.

7.10 Voidance and Nullification of the MDEQ's Approval of a RAP

(a) If the remedial action provided for in the MDEQ-approved Ludington Handy Things Facility RAP relies on the cleanup criteria established under Section 20120a(1)(f)-(j) or (2) of the NREPA and a lapse occurs, or the provisions of Section 20120b(3) of the NREPA as provided for in this Decree or the MDEQ-approved RAP or other requirements specified below are not complied with, the MDEQ's approval of the RAP is void from the time of the lapse or violation until the lapse or violation is corrected in accordance with Paragraph 7.10(c) and to the satisfaction of the MDEQ. With respect to a land or resource use restriction, a lapse of or noncompliance with this Decree or an MDEQ-approved RAP includes the following:

(i) A court of competent jurisdiction determines that a land use or resource use restriction necessary to address the Ludington Handy Things Facility is unlawful.

(ii) A land use or resource use restriction necessary to address the Ludington Handy Things Facility is not filed or enacted in accordance with this Decree or the MDEQ-approved RAP.

(iii) A land use or resource use restriction necessary to address the Ludington Handy Things Facility is violated or is not enforced by the controlling entity.

(iv) A land use or resource use restriction necessary to address the Ludington Handy Things Facility expires or is modified or revoked without the MDEQ's approval.

(b) If any of the circumstances listed in Rules 299.5520(11) and (12) occur, the MDEQ's approval of the Ludington Handy Things Facility RAP shall be nullified until the lapse or violation is corrected to the satisfaction of the MDEQ.

(c) Within thirty (30) days of NGSC becoming aware of a lapse or violation under Paragraph 7.10(a) or (b), NGSC shall provide to the MDEQ, for review and approval, a written notification of such lapse or violation. This notification shall include a description of the nature of the lapse or violation, an evaluation of the impact or potential impact of the lapse or violation on the effectiveness and integrity of the RAP, and one of the following:

(i) If NGSC has corrected the lapse or violation, a written demonstration of how and when NGSC corrected the lapse or violation.

(ii) If NGSC has not yet corrected the lapse or violation, a work plan and implementation schedule for addressing the lapse or violation.

(iii) If NGSC believes it will not be able to correct the lapse or violation without modifying the MDEQ-approved RAP, a work plan and implementation schedule outlining the response activities NGSC will take to comply with Part 201 and to assure

that the Ludington Handy Things Facility does not pose a threat to public health, safety, or welfare, or the environment.

The work plan and implementation schedule identified in Paragraphs 7.10(c)(ii) and (iii) shall provide for the development of any response activity work plans and associated implementation schedules that are necessary to assure protection of public health, safety, and welfare, and the environment, including work plans for IRA, an RI to provide additional information to support the selection and approval of an alternative RAP, and an approvable alternative RAP that meets the applicable performance objectives specified in Paragraph 7.1 and complies with Part 201. NGSC shall submit and the MDEQ will review and approve plans and schedules submitted pursuant to this Section in accordance with the procedures set forth in Section XIV (Submissions and Approvals). Upon receipt of the MDEQ's approval, NGSC shall perform the response activities in accordance with the MDEQ-approved work plans.

(d) If NGSC does not comply with all of the requirements of Paragraph 7.10(c) or does not comply with the provisions of Section XIV (Submissions and Approvals), and independent of the statutory consequences of nullification of the MDEQ's approval of a RAP pursuant to Part 201, stipulated penalties as specified in Paragraph 16.2 shall begin to accrue the day the violation under Paragraph 7.10(c) or Section XIV occurred and continue to accrue until the violation is corrected.

(e) The provisions in Sections 7.10(a) and (b) are not subject to the dispute resolution procedures set forth in Section XVII (Dispute Resolution).

7.11 Progress Reports

(a) NGSC shall provide to the MDEQ Project Coordinator written progress reports regarding response activities and other matters at the Ludington Handy Things Facility related to the implementation of this Decree. These progress reports shall include the following:

(i) A description of the activities that have been taken toward achieving compliance with this Decree during the specified reporting period.

(ii) All results of sampling and tests and other data that relate to the response activities performed pursuant to this Decree received by NGSC, its employees, or authorized representatives during the specified reporting period.

(iii) The status of any access issues that have arisen, which affect or may affect the performance of response activities, and a description of how NGSC proposes to resolve those issues and the schedule for resolving the issues.

(iv) A description of the nature and amount of waste materials that were generated and the name and location of the facilities that were used for the off-site transfer, storage, and treatment, or disposal of those waste materials, including copies of all waste manifests.

(v) A description of data collection and other activities scheduled for the next reporting period.

(vi) Any other relevant information regarding other activities or matters at the Ludington Handy Things Facility that affect or may affect the implementation of the requirements of this Decree.

(b) The first progress report shall be submitted to the MDEQ within ninety (90) days following the Effective Date of this Decree. Thereafter, progress reports shall be

submitted quarterly unless otherwise specified in the MDEQ-approved work plans. Pursuant to Paragraph 7.8, either the MDEQ may modify the schedule or NGSC may request modification of the schedule for the submittal of progress reports contained in an MDEQ-approved work plan.

7.12 The MDEQ's Performance of Response Activities

If NGSC ceases to perform the response activities required by this Decree, is not performing response activities in accordance with this Decree, or is performing response activities in a manner that causes or may cause an endangerment to human health or the environment, the MDEQ may, at its option and upon providing thirty (30) days prior written notice to NGSC, take over the performance of those response activities. The MDEQ, however, is not required to provide thirty (30) days written notice prior to performing response activities that the MDEQ determines are necessary pursuant to Section X (Emergency Response). If the MDEQ finds it necessary to take over the performance of response activities that NGSC is obligated to perform under this Decree, NGSC shall reimburse the State for its costs to perform these response activities, including any accrued interest. Interest, at the rate specified in Section 20126a(3) of the NREPA, shall begin to accrue on the State's costs on the day the State begins to incur costs for those response activities. Costs incurred by the State to perform response activities pursuant to this Paragraph shall be considered to be "Future Response Activity Costs" and NGSC shall provide reimbursement of these costs and any accrued interest to the State in accordance with Paragraphs 15.3, 15.5, and 15.6 of Section XV (Reimbursement of Costs).

VIII. ACCESS

8.1 NGSC does not currently own any of the property associated with the Ludington Handy Things Facility. To the extent that the Ludington Handy Things Facility, or any other property where the response activities are to be performed by NGSC under this Decree, is owned

or controlled by persons other than NGSC, NGSC shall use reasonable and lawful efforts to secure from such persons access rights for the Parties and their authorized employees, agents, representatives, contractors, and consultants. NGSC shall provide the MDEQ with a copy of any document granting such access rights secured pursuant to this Section. For purposes of this Paragraph, "reasonable and lawful efforts" may include, but is not limited to, offering reasonable compensation to the owner of the property for which access is necessary. If access is not secured from the owner, then, to the extent permitted by law, NGSC shall file a petition for access pursuant to Section 20135a of Part 201 of the NREPA and provide documentation to the MDEQ that such judicial action has been filed in a court of appropriate jurisdiction no later than ninety (90) days after NGSC's receipt of the MDEQ's approval of the work plan for which such access is needed. If NGSC has not been able to obtain access within sixty (60) days after filing a judicial action, NGSC shall promptly notify the MDEQ of the status of its efforts to obtain access and shall describe how any delay in obtaining access may affect the performance of response activities for which the access is needed. Any delay in obtaining access shall not be an excuse for delaying the performance of response activities, unless the State determines that the delay was caused by a *Force Majeure* event pursuant to Section XI (*Force Majeure*). To the extent NGSC is subject to the requirements of Section 20114 of the NREPA, NGSC's failure to secure access or petition the court within one (1) year of having reason to believe that access to another person's property is necessary to comply with Section 20114 of the NREPA or within one (1) year of the Effective Date, whichever is later in time, subjects NGSC to stipulated penalties pursuant to Paragraph 16.3 of Section XVI (Stipulated Penalties).

8.2 Any person granted access to the Ludington Handy Things Facility pursuant to this Decree shall comply with all applicable health and safety laws and regulations.

IX. SAMPLING AND ANALYSIS

9.1 All sampling and analysis conducted pursuant to this Decree shall be in accordance with the quality assurances procedures specified in Paragraph 7.3 and the MDEQ-approved work plans.

9.2 NGSC, or its consultants or subcontractors, shall provide the MDEQ a ten (10)-day notice prior to any sampling activity to be conducted pursuant to this Decree to allow the MDEQ Project Coordinator, or his or her authorized representative, the opportunity to take split or duplicate samples or to observe the sampling procedures. In circumstances where a ten (10)-day notice is not possible, NGSC, or its consultants or subcontractors, shall provide notice of the planned sampling activity as soon as possible to the MDEQ Project Coordinator and explain why earlier notification was not possible. If the MDEQ Project Coordinator concurs with the explanation provided, NGSC may forego the ten (10)-day notification period for that particular sampling event.

9.3 NGSC shall provide the MDEQ with the results of all environmental sampling, and other analytical data generated in the performance or monitoring of any requirement under this Decree. These results shall be included in the progress reports set forth in Paragraph 7.11.

9.4 For the purpose of quality assurance monitoring, NGSC shall assure that the MDEQ and its authorized representatives are allowed access to any laboratory used by NGSC in implementing this Decree.

X. EMERGENCY RESPONSE

10.1 If during the course of NGSC performing response activities conducted pursuant to this Decree, an act or the occurrence of an event causes a release or threat of release of a hazardous substance at or from the Ludington Handy Things Facility or the LPC Facility, or

causes exacerbation of existing contamination at the Ludington Handy Things Facility or the LPC Facility, and the release, threat of release, or exacerbation poses or threatens to pose an imminent and substantial endangerment to public health, safety, or welfare, or the environment, NGSC shall immediately undertake all appropriate actions to prevent, abate, or minimize such release, threat of release, or exacerbation; and shall immediately notify the MDEQ Project Coordinator. In the event of the MDEQ Project Coordinator's unavailability, NGSC shall notify the Pollution Emergency Alerting System (PEAS) at 1-800-292-4706. In such an event, any actions taken by NGSC shall be in accordance with all applicable health and safety laws and regulations and with the provisions of the HASP referenced in Paragraph 7.4.

10.2 Within ten (10) days of notifying the MDEQ of such an act or event, NGSC shall submit a written report setting forth a description of the act or event that occurred and the measures taken or to be taken to mitigate any release, threat of release, or exacerbation caused or threatened by the act or event and to prevent recurrence of such an act or event. Regardless of whether NGSC notifies the MDEQ under this Section, if an act or event causes a release, threat of release, or exacerbation, the MDEQ may: (a) require NGSC to stop response activities at the Ludington Handy Things Facility or LPC Facility for such period of time as may be needed to prevent or abate any such release, threat of release, or exacerbation; (b) require NGSC to undertake any actions that the MDEQ determines are necessary to prevent or abate any such release, threat of release, or exacerbation; or (c) undertake any actions that the MDEQ determines are necessary to prevent or abate such release, threat of release, or exacerbation. This Section is not subject to the dispute resolution procedures set forth in Section XVII (Dispute Resolution).

XI. *FORCE MAJEURE*

11.1 NGSC shall perform the requirements of this Decree within the time limits established herein, unless performance is prevented or delayed by events that constitute a "*Force Majeure.*" Any delay in the performance attributable to a *Force Majeure* shall not be deemed a violation of this Decree in accordance with this Section.

11.2 For the purposes of this Decree, a *Force Majeure* event is defined as any event arising from causes beyond the control of and without the fault of NGSC, of any person controlled by NGSC, or of NGSC's contractors that delays or prevents the performance of any obligation under this Decree despite NGSC's "best efforts to fulfill the obligation." The requirement that NGSC exercise "best efforts to fulfill the obligation" includes NGSC using best efforts to anticipate any potential *Force Majeure* event and to address the effects of any potential *Force Majeure* event during and after the occurrence of the event, such that NGSC minimizes any delays in the performance of any obligation under this Decree to the greatest extent possible. *Force Majeure* includes an occurrence or nonoccurrence arising from causes beyond the control of and without the fault of NGSC, such as an act of God, untimely review of permit applications or submissions by the MDEQ or other applicable authority, and acts or omissions of third parties that could not have been avoided or overcome by the diligence of NGSC and that delay the performance of an obligation under this Decree. *Force Majeure* does not include, among other things, unanticipated or increased costs, changed financial circumstances, or failure to obtain a permit or license as a result of actions or omissions of NGSC.

11.3 NGSC shall notify the MDEQ by telephone within seventy-two (72) hours of discovering any event that causes a delay in its compliance with any provision of this Decree. Verbal notice shall be followed by written notice within ten (10) calendar days and shall

describe, in detail, the anticipated length of delay for each specific obligation that will be impacted by the delay, the cause or causes of delay, the measures taken by NGSC to prevent or minimize the delay, and the timetable by which those measures shall be implemented. NGSC shall use its best efforts to avoid or minimize any such delay.

11.4 Failure of NGSC to comply with the notice requirements of Paragraph 11.3 above shall render this Section XI void and of no force and effect as to the particular incident involved. The MDEQ may, at its sole discretion and in appropriate circumstances, waive the notice requirements of Paragraph 11.3.

11.5 If the parties agree that the delay or anticipated delay was beyond the control of NGSC, this may be so stipulated and the parties to this Decree may agree upon an appropriate modification of this Decree. If the parties to this Decree are unable to reach such agreement, the dispute shall be resolved in accordance with Section XVII (Dispute Resolution) of this Decree. The burden of proving that any delay was beyond the control of NGSC, and that all the requirements of this Section have been met by NGSC, is on NGSC.

11.6 An extension of one compliance date based upon a particular incident does not necessarily mean that NGSC qualifies for an extension of a subsequent compliance date without providing proof regarding each incremental step or other requirement for which an extension is sought.

XII. RECORD RETENTION/ACCESS TO INFORMATION

12.1 NGSC shall preserve and retain, for a period of five (5) years after completion of operation and maintenance and long-term monitoring at the Ludington Handy Things Facility, all records, sampling and test results, charts, and other documents relating to the release or threatened release of hazardous substances, and the storage, generation, disposal, treatment, and

handling of hazardous substances at the Ludington Handy Things Facility; and any other records that are maintained or generated pursuant to any requirement of this Decree, including records that are maintained or generated by representatives, consultants, or contractors of NGSC. However, if NGSC chooses to perform a remedial action from an MDEQ-approved RAP that relies on the cleanup criteria established under Section 20120a(1)(f)-(j) or (2) of the NREPA and the RAP provides for land use or resource use restrictions, NGSC shall retain any records pertaining to those land use or resource use restrictions until the MDEQ determines that land use and resource use restrictions are no longer needed. After the five (5)-year period of document retention following completion of operation and maintenance and long-term monitoring at the Ludington Handy Things Facility, NGSC shall notify MDEQ at least ninety (90) days prior to the destruction of any documents that are not required to be held in perpetuity and upon request by the MDEQ, NGSC shall deliver any such documents to MDEQ. In the alternative, NGSC may make a written commitment, with the MDEQ's approval, to continue to preserve and retain the documents for a specified period of time. NGSC's notification shall be accompanied by a copy of this Decree and sent to the address listed in Section XIII (Project Coordinators and Communications/Notices) or to such other address as may subsequently be designated in writing by the MDEQ.

12.2 Upon request, NGSC shall provide to the MDEQ copies of all documents and information within its possession, or within the possession or control of its employees, contractors, agents, or representatives, relating to the performance of response activities or other requirements of this Decree, including, but not limited to, records regarding the collection and analysis of samples, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing forms, or other correspondence, documents, or information related to response

activities. Upon request, NGSC shall also make available to the MDEQ, upon reasonable notice, NGSC's employees, contractors, agents, or representatives with knowledge of relevant facts concerning the performance of response activities.

12.3 If NGSC submits documents or information to the MDEQ that NGSC believes are entitled to protection as provided for in Section 20117(10) of the NREPA, NGSC may designate in that submittal the documents or information which it believes are entitled to such protection. If no such designation accompanies the information when it is submitted to the MDEQ, the information may be made available to the public by the MDEQ without further notice to NGSC. Information described in Sections 20117(11)(a)-(h) of the NREPA shall not be claimed as confidential or privileged by NGSC. Information or data generated under this Decree shall not be subject to Part 148, Environmental Audit Privilege and Immunity, of the NREPA, MCL 324.14801 *et seq.*

XIII. PROJECT COORDINATORS AND COMMUNICATIONS/NOTICES

13.1 Each Party shall designate one or more Project Coordinators. Whenever notices, progress reports, information on the collection and analysis of samples, sampling data, work plan submittals, approvals, or disapprovals, or other technical submissions are required to be forwarded by one Party to the other Party under this Decree, or whenever other communications between the Parties is needed, such communications shall be directed to the designated Project Coordinator at the address listed below. If any Party changes its designated Project Coordinator, the name, address, and telephone number of the successor shall be provided to the other Party, in writing, as soon as practicable.

A. As to the MDEQ:

(1) For all matters pertaining to this Decree, except those specified in Paragraphs 13.1A(2), (3), and (4) below:

John Vanderhoof, Project Coordinator
Cadillac District Office
Remediation and Redevelopment Division
Michigan Department of Environmental Quality
120 West Chapin Street
Cadillac, MI 49601-2158
Phone: 231-876-4459
Fax: 231-775-1511
E-mail Address: vanderhoofj@michigan.gov

This Project Coordinator will have primary responsibility for the MDEQ for overseeing the performance of response activities at the Ludington Handy Things Facility and other requirements specified in this Decree.

(2) For all matters specified in this Decree that are to be directed to the Remediation and Redevelopment Division (RRD) Chief:

Chief, Remediation and Redevelopment Division
Michigan Department of Environmental Quality
P.O. Box 30426
Lansing, MI 48909-7926
Phone: 517-335-1104
Fax: 517-373-2637

Via courier:
Chief, Remediation and Redevelopment Division
Michigan Department of Environmental Quality
Constitution Hall, 4th Floor, South Tower
525 West Allegan Street
Lansing, MI 48933-2125

A copy of all correspondence that is sent to the Chief of the RRD shall also be provided to the MDEQ Project Coordinator designated in Paragraph 13.1A(1).

(3) For providing a true copy of a recorded restrictive covenant and documentation that an institutional control has been enacted pursuant to Section VII (Performance of Response Activities); for Record Retention pursuant to Section XII (Record Retention/Access to Information); and for questions concerning financial matters pursuant to Section VII (Performance of Response Activities), including financial assurance mechanisms associated with a RAP:

Chief, Compliance and Enforcement Section
Remediation and Redevelopment Division
Michigan Department of Environmental Quality
P.O. Box 30426
Lansing, MI 48909-7926
Phone: 517-373-7818
Fax: 517-373-2637

Via courier:
Chief, Compliance and Enforcement Section
Remediation and Redevelopment Division
Michigan Department of Environmental Quality
Constitution Hall, 4th Floor, South Tower
525 West Allegan Street
Lansing, MI 48933-2125

A copy of all correspondence that is sent to the Chief of the Compliance and Enforcement Section, RRD, shall also be provided to the MDEQ Project Coordinator designated in Paragraph 13.1A(1).

(4) For all payments pursuant to Section XV (Reimbursement of Costs) and Section XVI (Stipulated Penalties):

Revenue Control Unit
Financial and Business Services Division
Michigan Department of Environmental Quality
P.O. Box 30657
Lansing, MI 48909-8157

Via courier:
Revenue Control Unit
Financial and Business Services Division
Michigan Department of Environmental Quality
Constitution Hall, 5th Floor, South Tower
525 West Allegan Street
Lansing, MI 48933-2125

To ensure proper credit, all payments made pursuant to this Decree must reference the Ludington Handy Things Facility, Court Case Number, and the RRD Account Number RRD2257.

A copy of all correspondence that is sent to the Revenue Control Unit shall also be provided to the MDEQ Project Coordinator designated in Paragraph 13.1A.(1), the Chief of the Compliance and Enforcement Section designated in Paragraph 13.1A.(3), and the Assistant Attorney General in Charge designated in Paragraph 13.1B.

B. As to the MDAG:

Assistant Attorney General in Charge
Environment, Natural Resources, and Agriculture Division
Michigan Department of Attorney General
G. Mennen Williams Building, 6th Floor
525 West Ottawa Street
Lansing, MI 48933
Phone: 517-373-7540
Fax: 517-373-1610

C. As to NGSC:

Joseph P. Kwan
Corporate Director, Environmental Remediation
Northrop Grumman Corporation
1840 Century Park East
Los Angeles, CA 90067-2199
Phone: 310-556-4514
Fax: 310-556-4905
E-mail Address: Joe.Kwan@ngc.com

With copy to:

Gabriel Calvo
Senior Counsel – Environmental Law
Northrop Grumman Corporation
7555 Colshire Drive
M/S C-4S1
McLean, VA 22102
Phone: 703-556-2942
Fax: 703-556-2964
E-mail Address: Gabriel.Calvo@ngc.com

13.2 NGSC's Project Coordinator shall have primary responsibility for overseeing the performance of the response activities at the Ludington Handy Things Facility and other requirements specified in this Decree for NGSC.

13.3 The MDEQ may designate other authorized representatives, employees, contractors, and consultants to observe and monitor the progress of any activity undertaken pursuant to this Decree.

XIV. SUBMISSIONS AND APPROVALS

14.1 All Submissions required by this Decree shall comply with all applicable laws and regulations and the requirements of this Decree and shall be delivered to the MDEQ in accordance with the schedule set forth in this Decree. All Submissions delivered to the MDEQ pursuant to this Decree shall include a reference to the Ludington Handy Things Facility and Court Case Number. All Submissions delivered to the MDEQ for approval shall also be marked "Draft" and shall include, in a prominent location in the document, the following disclaimer: "*Disclaimer: This document is a DRAFT document that has not received approval from the Michigan Department of Environmental Quality (MDEQ). This document was prepared pursuant to a court consent decree. The opinions, findings, and conclusions expressed are those of the authors and not those of the MDEQ.*"

14.2 With the exception of the submittal of a RAP, after receipt of any Submission relating to response activities that is required to be submitted for approval pursuant to this Decree, the MDEQ District Supervisor will in writing: (a) approve the Submission; (b) approve the Submission with modifications; or (c) disapprove the Submission and notify NGSC of the deficiencies in the Submission. Upon receipt of a notice of approval or approval with modifications from the MDEQ, NGSC shall proceed to take the actions and perform the response activities required by the Submission, as approved or as modified, and shall submit a new cover page and any modified pages of the Submission marked "Approved."

14.3 Upon receipt of a notice of disapproval from the MDEQ pursuant to Paragraph 14.2(c), NGSC shall correct the deficiencies and provide the revised Submission to the MDEQ for review and approval within sixty (60) days, unless the notice of disapproval specifies a longer time period for resubmission. Unless otherwise stated in the MDEQ's notice of disapproval, NGSC shall proceed to take the actions and perform the response activities not directly related to the deficient portion of the Submission. Any stipulated penalties applicable to the delivery of the Submission shall accrue during the sixty (60)-day period or other time period specified for NGSC to provide the revised Submission, but shall not be payable unless the resubmission is also disapproved. The MDEQ will review the revised Submission in accordance with the procedure set forth in Paragraph 14.2. If the MDEQ disapproves a revised Submission, the MDEQ will so advise NGSC and, as set forth above, stipulated penalties shall accrue from the date of the MDEQ's disapproval of the original Submission and continue to accrue until NGSC delivers an approvable Submission.

14.4 Within six (6) months of receipt of a RAP, the RRD Chief will make a decision regarding the RAP and will in writing: (a) approve the RAP; (b) reject the RAP as insufficient if

the RAP lacks any information necessary or required by the MDEQ to make a decision regarding RAP approval; or (c) deny approval of the RAP. The time period for a decision regarding the submitted RAP may be extended by the mutual consent of the Parties. Upon receipt of a notice of approval from the MDEQ, NGSC shall proceed to take the actions and perform the response activities required by the MDEQ-approved RAP and shall submit a new cover page marked "Approved."

14.5 Within ninety (90) days of receipt of a rejection or denial of approval of a RAP from the MDEQ pursuant to Paragraph 14.4(b) or (c), NGSC shall submit the revised RAP to the MDEQ for review and approval. The time period for resubmission may be extended by the MDEQ. If the MDEQ does not approve the RAP upon resubmission, the MDEQ will so advise NGSC. Any stipulated penalties applicable to the delivery of the RAP shall accrue during the ninety (90)-day period or other time period specified for NGSC to submit another RAP, but shall not be payable unless the revised RAP is also rejected or approval is denied. The MDEQ will review the revised RAP in accordance with the procedure stated in Paragraph 14.4. If the MDEQ rejects or denies a revised RAP, the MDEQ will so advise NGSC and, as set forth above, stipulated penalties shall accrue from the date of the MDEQ's disapproval of the original RAP Submission and continue to accrue until NGSC delivers an approvable RAP.

14.6 If any initial Submission, including a RAP, contains significant deficiencies such that the Submission is not in the judgment of the MDEQ a good faith effort by NGSC to deliver an acceptable Submission that complies with Part 201 and this Decree, the MDEQ will notify NGSC of such and will deem NGSC to be in violation of this Decree. Stipulated penalties, as set forth in Section XVI (Stipulated Penalties), shall begin to accrue on the day after the Submission was due and continue to accrue until an approvable Submission is provided to the MDEQ.

14.7 Upon approval by the MDEQ, any Submission and attachments to Submissions required by this Decree shall be considered part of this Decree and are enforceable pursuant to the terms of this Decree. If there is a conflict between the requirements of this Decree and any Submission or an attachment to a Submission, the requirements of this Decree shall prevail.

14.8 An approval or approval with modifications of a Submission shall not be construed to mean that the MDEQ concurs with any of the conclusions, methods, or statements in any Submission or warrants that the Submission comports with law.

14.9 Informal advice, guidance, suggestions, or comments by the MDEQ regarding any Submission provided by NGSC shall not be construed as relieving NGSC of its obligation to obtain any formal approval required under this Decree.

XV. REIMBURSEMENT OF COSTS

15.1 Within sixty (60) days of the Effective Date of this Decree, NGSC shall pay the MDEQ five hundred twenty-five thousand two hundred sixty dollars and sixty-eight cents ($525,260.68) to resolve all State claims against NGSC for Past Response Activity Costs relating to the Ludington Handy Things Facility, the Past and Future Response Activity Costs relating to the LPC Facility and any Part 201 liability relating to the LPC Facility only. Payment shall be made pursuant to the provisions of Paragraph 15.5.

15.2 NGSC shall also pay response activity costs the State has incurred for the Ludington Handy Things Facility between the end date specified in the Summary Report in Attachment C and the effective date of this Decree. These costs include, but are not limited to, the staff costs to negotiate and prepare settlement documents with NGSC and to oversee response activities at the Ludington Handy Things Facility prior to the Effective Date of this Decree. These costs shall be considered to be Future Response Activity Costs and shall be

documented and included in a demand for Future Response Activity Costs pursuant to Paragraph 15.3.

15.3 NGSC shall reimburse the State for all Future Response Activity Costs incurred by the State associated with the Ludington Handy Things Facility. Following the Effective Date of this Decree, the MDEQ will periodically provide NGSC with a written demand for payment and summary report that identifies all Future Response Activity Costs that have been lawfully incurred by the State through the dates specified in the summary report. Any such demand will set forth, with reasonable specificity, the nature of the costs incurred. Except as provided by Section XVII (Dispute Resolution), NGSC shall reimburse the MDEQ for such costs within sixty (60) days of NGSC's receipt of a written demand from the MDEQ.

15.4 NGSC shall have the right to request a full and complete accounting of all MDEQ demands made hereunder, including time sheets, travel vouchers, contracts, invoices, and payment vouchers as may be available to the MDEQ. The MDEQ's provision of these documents to NGSC may result in the MDEQ incurring additional Future Response Activity Costs, which will be included in the annual demand for payment of Future Response Activity Costs.

15.5 All payments made pursuant to this Decree shall be by certified check, made payable to the "State of Michigan – Environmental Response Fund," and shall be sent by first-class mail, overnight delivery, or hand delivery to the Revenue Control Unit at the address listed in Paragraph 13.1A.(4) of Section XIII (Project Coordinators and Communications/Notices). The Ludington Handy Things Facility, the Court Case Number, and the RRD Account Number RRD2257 shall be designated on each check. A copy of the transmittal letter and the check shall be provided simultaneously to the MDEQ Project Coordinator at the address listed in Paragraph

13.1A.(1), the Chief of the Compliance and Enforcement Section, RRD, at the address listed in Paragraph 13.1A.(3), and the Bureau Chief at the address listed in Paragraph 13.1B. Costs recovered pursuant to this Section and payment of stipulated penalties pursuant to Section XVI (Stipulated Penalties) shall be deposited into the Environmental Response Fund in accordance with the provisions of Section 20108(3) of the NREPA.

15.6 If NGSC fails to make full payment to the MDEQ for Past Response Activity Costs or Future Response Activity Costs as specified in Paragraphs 15.1 and 15.3, interest, at the rate specified in Section 20126a(3) of the NREPA, shall begin to accrue on the unpaid balance on the day after payment was due until the date upon which NGSC makes full payment of those costs and the accrued interest to the MDEQ. In any challenge by NGSC to an MDEQ demand for reimbursement of costs, NGSC shall have the burden of establishing that the MDEQ did not lawfully incur those costs in accordance with Section 20126a(1)(a) of the NREPA.

XVI. STIPULATED PENALTIES

16.1 NGSC shall be liable for stipulated penalties in the amounts set forth in Paragraphs 16.2 and 16.3 for failure to comply with the requirements of this Decree, unless excused under Section XI (*Force Majeure*) or Section XVII (Dispute Resolution). "Failure to Comply" by NGSC shall include failure to complete Submissions and notifications as required by this Decree and, failure to perform response activities in accordance with MDEQ-approved plans, this Decree, and all applicable requirements of law and this Decree within the specified implementation schedules established by or approved under this Decree.

16.2 The following stipulated penalties shall accrue per violation per day for any violation of Section VII (Performance of Response Activities):

Penalty Per Violation Per Day	Period of Noncompliance
$250	1st through 14th day
$500	15th through 30th day
$1,000	31st day and beyond

16.3 Except as provided in Paragraph 16.2 and Section XI (*Force Majeure*) and Section XVII (Dispute Resolution), if NGSC fails or refuses to comply with any other term or condition of this Decree, NGSC shall pay the MDEQ stipulated penalties of two hundred fifty dollars ($250.00) a day for each and every failure or refusal to comply.

16.4 All penalties shall begin to accrue on the day after performance of an activity was due or the day a violation occurs, and shall continue to accrue through the final day of completion of performance of the activity or correction of the violation. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Decree.

16.5 Except as provided in Section XVII (Dispute Resolution), NGSC shall pay stipulated penalties owed to the State no later than sixty (60) days after NGSC's receipt of a written demand from the State. Payment shall be made in the manner set forth in Paragraph 15.5 of Section XV (Reimbursement of Costs). Failure to pay the stipulated penalties within sixty (60) days after receipt of a written demand constitutes a further violation of the terms and conditions of this Decree. Under no circumstance shall interest accrue on or be assessed under any state or common law for the stipulated penalties or any unpaid balance of the stipulated penalties.

16.6 The payment of stipulated penalties shall not alter in any way NGSC's obligation to perform the response activities required by this Decree.

16.7 If NGSC fails to pay stipulated penalties when due, the State may institute proceedings to collect the penalties, as well as any accrued interest. However, the assessment of stipulated penalties is not the State's exclusive remedy if NGSC violates this Decree. For any failure or refusal of NGSC to comply with the requirements of this Decree, the State also reserves the right to pursue any other remedies to which it is entitled under this Decree or any applicable law including, but not limited to, seeking civil fines, injunctive relief, the specific performance of response activities, reimbursement of costs, exemplary damages pursuant to Section 20119(4) of the NREPA in the amount of three (3) times the costs incurred by the State as a result of NGSC's violation of or failure to comply with this Decree, and sanctions for contempt of court. MDEQ will not seek both stipulated penalties and statutory fines for the same violations.

16.8 Notwithstanding any other provision of this Section, the State may waive, in its unreviewable discretion, any portion of stipulated penalties and interest that has accrued pursuant to this Decree.

XVII. DISPUTE RESOLUTION

17.1 Unless otherwise expressly provided for in this Decree, the dispute resolution procedures of this Section shall be the exclusive mechanism to resolve disputes arising under or with respect to this Decree, except for Paragraphs 7.13(a) and (b) (Voidance and Nullification of the MDEQ's Approval of a RAP) of Section VII (Performance of Response Activities) and Section X (Emergency Response), which are not disputable. However, the procedures set forth in this Section shall not apply to actions by the State to enforce any of NGSC's obligations that have not been disputed in accordance with this Section. Engagement of dispute resolution

pursuant to this Section shall not be cause for NGSC to delay the performance of any response activity required under this Decree.

17.2 The State shall maintain an administrative record of any disputes initiated pursuant to this Section. The administrative record shall include the information NGSC provides to the State under Paragraphs 17.3 and 17.4 and any documents the MDEQ and the State rely on to make the decisions set forth in Paragraphs 17.3 and 17.4.

17.3 Except for undisputable matters identified in Paragraph 17.1 and disputes related to the RAP which are addressed under Paragraph 17.4, any dispute that arises under this Decree with respect to the MDEQ's disapproval, modification, or other decision concerning requirements of this Decree shall in the first instance be the subject of informal negotiations between the Project Coordinators representing the MDEQ and NGSC. A dispute shall be considered to have arisen on the date that a Party to this Decree receives a written Notice of Dispute from the other Party. The Notice of Dispute shall state the issues in dispute; the relevant facts upon which the dispute is based; factual data, analysis, or opinion supporting the Party's position; and supporting documentation upon which the Party bases its position. In the event, NGSC objects to any MDEQ notice of disapproval, modification, or decision concerning the requirements of this Decree that is subject to dispute under this Section, NGSC shall submit the Notice of Dispute within twenty (20) days of receipt of the MDEQ's notice of disapproval, modification, or decision. The period of informal negotiations shall not exceed twenty (20) days from the date a Party receives a Notice of Dispute, unless the time period for negotiations is modified by written agreement between the Parties. If the Parties do not reach an agreement within twenty (20) days or within the agreed-upon time period, the RRD District Supervisor will thereafter provide the MDEQ's Statement of Position, in writing, to NGSC. In the absence of

initiation of formal dispute resolution by NGSC under Paragraph 17.4, the MDEQ's position as set forth in the MDEQ's Statement of Position shall be binding on the Parties.

17.4 If NGSC and the MDEQ cannot informally resolve a dispute under Paragraph 17.3 or if the dispute involves a RAP, NGSC may initiate formal dispute resolution by submitting a written Request for Review to the RRD Chief, with a copy to the MDEQ Project Coordinator, requesting a review of the disputed issues. This Request for Review must be submitted within twenty (20) days of NGSC's receipt of the Statement of Decision issued by the MDEQ pursuant to Paragraph 17.3. If the dispute is in regard to a RAP, either Party may initiate formal dispute resolution by filing a Request for Review with the other Party. The Request for Review shall state the issues in dispute; the relevant facts upon which the dispute is based; factual data, analysis, or opinion supporting the Party's position; and supporting documentation upon which the Party bases its position. When the MDEQ issues a Request for Review, NGSC will have twenty (20) days to submit a written rebuttal to the RRD Chief, with copy to the MDEQ Project Coordinator. Within twenty (20) days of the RRD Chief's receipt of NGSC's Request for Review or NGSC's rebuttal, the RRD Chief will provide the MDEQ's Statement of Decision, in writing, to NGSC, which will include a statement of his/her understanding of the issues in dispute; the relevant facts upon which the dispute is based; factual data, analysis, or opinion supporting his/her position; and supporting documentation he/she relied upon in making the decision. The time period for the Parties' submission of documents pursuant to this Paragraph may be extended by written agreement between the Parties. The MDEQ's Statement of Decision shall be binding on the Parties unless NGSC files a motion pursuant to Paragraph 17.5.

17.5 The MDEQ's Statement of Decision pursuant to Paragraph 17.4 shall be binding on the Parties unless, within thirty (30) day after NGSC's receipt of the MDEQ's Statement of Decision, NGSC files with this Court a motion for resolution of the dispute, which sets forth the matter in dispute, the efforts made by the Parties to resolve it, the relief requested, and the schedule, if any, within which the dispute must be resolved to insure orderly implementation of this Decree. Within thirty (30) days of NGSC's filing of a motion asking the Court to resolve a dispute, MDEQ will file with the Court the administrative record that is maintained pursuant to Paragraph 17.2.

17.6 Any judicial review of the MDEQ's Statement of Decision shall be limited to the administrative record. In proceedings on any dispute relating to the selection, extent, or adequacy of any aspect of the response activities that are subject of this Decree, NGSC shall have the burden of demonstrating on the administrative record that the position of the MDEQ is arbitrary and capricious or otherwise not in accordance with law. In proceedings on any dispute, NGSC shall bear the burden of persuasion on factual issues under the applicable standards of review. Nothing herein shall prevent MDEQ from arguing that the Court should apply the arbitrary and capricious standard of review to any dispute under this Decree.

17.7 Notwithstanding the invocation of a dispute resolution proceeding, stipulated penalties shall accrue from the first day of NGSC's failure or refusal to comply with any term or condition of this Decree, but payment shall be stayed pending resolution of the dispute. In the event, and to the extent that NGSC does not prevail on the disputed matters, the MDEQ may demand payment of stipulated penalties and NGSC shall pay stipulated penalties as set forth in Paragraph 16.5 of Section XVI (Stipulated Penalties). NGSC shall not be assessed stipulated penalties for disputes that are resolved in their favor. The MDAG, on behalf of the MDEQ, may

take civil enforcement action against NGSC to seek the assessment of civil penalties or damages pursuant to Sections 20119(4) and 20137(1) of the NREPA or other statutory and equitable authorities. MDEQ will not seek both stipulated penalties and statutory civil fines for the same violations.

17.8 Notwithstanding the provisions of this Section and in accordance with Section XV (Reimbursement of Costs) and Section XVI (Stipulated Penalties), NGSC shall pay to the MDEQ that portion of a demand for reimbursement of costs or for payment of stipulated penalties that is not the subject of an ongoing dispute resolution proceeding.

XVIII. INDEMNIFICATION AND INSURANCE

18.1 The State of Michigan does not assume any liability by entering into this Decree. This Decree shall not be construed to be an indemnity by the State for the benefit of NGSC or any other person.

18.2 NGSC shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, agents, employees, contractors, and representatives for any claims or causes of action to the extent that they arise from, or on account of, acts or omissions of NGSC, its officers, employees, agents, or any other person acting on its behalf or under its control, in performing the activities required by this Decree.

18.3 NGSC shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, agents, employees, contractors, and representatives for all claims or causes of action for damages or reimbursement from the State that arise from, or on account of, any contract, agreement, or arrangement between NGSC and any person for the performance of response activities at the Ludington Handy Things Facility or the LPC Facility, including any claims on account of construction delays.

18.4 The State shall provide NGSC notice of any claim for which the State intends to seek indemnification pursuant to Paragraph 18.2 or 18.3.

18.5 Neither the State of Michigan nor any of its departments, agencies, officials, agents, employees, contractors, or representatives shall be held out as a party to any contract that is entered into by or on behalf of NGSC for the performance of activities required by this Decree. Neither NGSC nor any contractor shall be considered an agent of the State.

18.6 NGSC waives all claims or causes of action against the State of Michigan and its departments, agencies, officials, agents, employees, contractors, and representatives for damages, reimbursement, or set-off of any payments made or to be made to the State that arise from, or on account of, any contract, agreement, or arrangement between NGSC and any other person for the performance of response activities at the Ludington Handy Things Facility or the LPC Facility, including any claims on account of construction delays.

18.7 Prior to commencing any response activities pursuant to this Decree and for the duration of this Decree, NGSC shall secure and maintain comprehensive general liability insurance with limits of one million dollars ($1,000,000) combined single limit, which names the MDEQ, the MDAG, and the State of Michigan as additional insured parties. If NGSC demonstrates by evidence satisfactory to the MDEQ that any contractor or subcontractor maintains insurance equivalent to that described above, then with respect to that contractor or subcontractor, NGSC needs to provide only that portion, if any, of the insurance described above that is not maintained by the contractor or subcontractor. Regardless of the insurance method used by NGSC, and prior to commencement of response activities pursuant to this Decree, NGSC shall provide the MDEQ Project Coordinator and the MDAG with certificates evidencing said insurance and the MDEQ, the MDAG, and the State of Michigan's status as additional

insured parties. In addition, and for the duration of this Decree, NGSC shall satisfy, or shall ensure that its contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of Workers' Disability Compensation Insurance for all persons performing response activities on behalf of NGSC in furtherance of this Decree.

XIX. COVENANTS NOT TO SUE BY THE STATE

19.1 In consideration of the actions that will be performed and the payments that will be made by NGSC under the terms of this Decree, and except as specifically provided for in this Section and Section XX (Reservation of Rights by the State), the State of Michigan hereby covenants not to sue or to take further administrative action against NGSC for:

(a) Performance of response activities related to the releases at and from the Ludington Handy Things Facility provided that the performance objectives of Paragraph 7.1(c) are being met by NGSC.

(b) With respect to the LPC Facility, future response activities other than the work set forth in the MNA Work plan, Past Response Activity Costs, Future Response Activity Costs, and any Part 201 liability associated with the LPC Facility.

(c) Reimbursement by NGSC of Past Response Activity Costs associated with the Ludington Handy Things Facility incurred and paid by the State as set forth in Paragraphs 15.1 and 15.6 of Section XV (Reimbursement of Costs) of this Decree.

(d) Reimbursement by NGSC of Future Response Activity Costs associated with the Ludington Handy Things Facility that are incurred and paid by the State as set forth in Paragraphs 15.2, 15.3, and 15.6 of Section XV (Reimbursement of Costs) of this Decree.

19.2 The covenants not to sue shall take effect under this Decree as follows:

(a) With respect to NGSC's liability for response activities related to the Ludington Handy Things Facility performed in compliance with MDEQ-approved work plans under this Decree, the covenant not to sue shall take effect upon the MDEQ's approval of the RAP submitted pursuant to Section VII (Performance of Response Activities).

(b) With respect to future response activities and Past Response Activity Costs and Future Response Activity Costs associated with the LPC Facility, the covenant not to sue shall take effect upon completion of all of the following:

(i) All the work set forth in the MNA Work Plan.

(ii) Payment of the costs set forth in Paragraph 15.1.

(iii) Compliance with Paragraph 7.6 of this Decree.

(c) With respect to NGSC's liability for Past Response Activity Costs and Future Response Activity Costs associated with the Ludington Handy Things Facility incurred and paid by the State, the covenants not to sue shall take effect upon the MDEQ's receipt of payments for those costs, including any applicable interest that has accrued in accordance with Paragraph 15.6 of this Decree.

19.3 The covenants not to sue extend only to NGSC and do not extend to any other person.

XX. RESERVATION OF RIGHTS BY THE STATE

20.1 The covenants not to sue apply only to those matters specified in Paragraph 19.1 of Section XIX (Covenants Not to Sue by the State). The State reserves, and this Decree is without prejudice to, all rights to take administrative action or to file a new action pursuant to any applicable authority against NGSC with respect to all other matters, including, but not limited to, the following:

(a) With respect to the Ludington Handy Things Facility, the performance of response activities that are required to comply with Part 201 and to achieve and maintain the performance objectives specified in Paragraph 7.1(c) of Section VII (Performance of Response Activities).

(b) With respect to the Ludington Handy Things Facility, Future Response Activity Costs that NGSC has not paid.

(c) The past, present, or future treatment, handling, disposal, release, or threat of release of hazardous substances that occur outside of the Ludington Handy Things Facility and the LPC Facility and that are not attributable to the Ludington Handy Things Facility or the LPC Facility.

(d) The past, present, or future treatment, handling, disposal, release, or threat of release of hazardous substances taken from the Ludington Handy Things Facility.

(e) Damages for injury to, destruction of, or loss of natural resources, and the costs for any natural resource damage assessment.

(f) Criminal acts.

(g) Any matters for which the State is owed indemnification under Section XVIII (Indemnification and Insurance) of this Decree.

(h) The release or threatened release of hazardous substances or violations of state or federal law that occur during or after the performance of response activities required by this Decree.

20.2 The State reserves the right to take action against NGSC if it discovers at any time that any material information provided by NGSC prior to or after entry of this Decree was false or misleading.

20.3 The MDEQ and the MDAG expressly reserve all of their rights and defenses pursuant to any available legal authority to enforce this Decree or to compel NGSC to comply with the NREPA.

20.4 In addition to, and not as a limitation of any other provision of this Decree, the MDEQ retains all of its authority and reserves all of its rights to perform, or contract to have performed, any response activities that the MDEQ determines are necessary.

20.5 In addition to, and not as a limitation of any provision of this Decree, the MDEQ and the MDAG retain all of their information gathering, inspection, access, and enforcement authorities and rights under Part 201 and any other applicable statute or regulation.

20.6 Failure by the MDEQ or the MDAG to enforce any term, condition, or requirement of this Decree in a timely manner shall not:

(a) Provide or be construed to provide a defense for NGSC's noncompliance with any such term, condition, or requirement of this Decree.

(b) Estop or limit the authority of the MDEQ or the MDAG to enforce any such term, condition, or requirement of the Decree, or to seek any other remedy provided by law.

20.7 This Decree does not constitute a warranty or representation of any kind by the MDEQ that the response activities performed by NGSC in accordance with the MDEQ-approved work plans required by this Decree will result in the achievement of the performance objectives stated in Paragraph 7.1 of Section VII (Performance of Response Activities) or the remedial criteria established by law, or that those response activities will assure protection of public health, safety, or welfare, or the environment.

20.8 Except as provided in Paragraph 19.1(a) of Section XIX (Covenants Not to Sue by the State), nothing in this Decree shall limit the power and authority of the MDEQ or the State of Michigan, pursuant to Section 20132(8) of the NREPA, to direct or order all appropriate action to protect the public health, safety, or welfare, or the environment; or to prevent, abate, or minimize a release or threatened release of hazardous substances, pollutants, or contaminants on, at, or from the Ludington Handy Things Facility.

XXI. COVENANT NOT TO SUE BY NGSC

21.1 NGSC hereby covenants not to sue or to take any civil, judicial, or administrative action against the State, its agencies, or their authorized representatives, for any claims or causes of action against the State that arise from this Decree, including, but not limited to, any direct or indirect claim for reimbursement from the Cleanup and Redevelopment Fund pursuant to Section 20119(5) of the NREPA or any other provision of law.

21.2 After the Effective Date of this Decree, if the MDAG initiates any administrative or judicial proceeding for injunctive relief, recovery of response activity costs, or other appropriate relief relating to the Ludington Handy Things Facility, NGSC agrees not to assert and shall not maintain any defenses or claims that are based upon the principles of waiver, *res judicata*, collateral estoppel, issue preclusion, or claim-splitting, or that are based upon a defense that contends any claims raised by the MDEQ or the MDAG in such a proceeding were or should have been brought in this case; provided, however, that nothing in this Paragraph affects the enforceability of the covenants not to sue set forth in Section XIX (Covenants Not to Sue by the State).

XXII. CONTRIBUTION PROTECTION

Pursuant to Section 20129(5) of the NREPA and Section 9613(f)(2) of the Comprehensive Environmental Response, Compensation, and Liability Act, 1980 PL 96-510, as amended (CERCLA or Superfund), 42 USC 9613; and to the extent provided in Section XIX (Covenants Not to Sue by the State), NGSC shall not be liable for claims for contribution for the matters set forth in Paragraph 19.1 of Section XIX (Covenants Not to Sue by the State) of this Decree, to the extent allowable by law. Entry of this Decree does not discharge the liability of any other person that may be liable under Section 20126 of the NREPA, or Sections 9607 and 9613 of the CERCLA. Pursuant to Section 20129(9) of the NREPA, any action by NGSC for contribution from any person that is not a Party to this Decree shall be subordinate to the rights of the State of Michigan if the State files an action pursuant to the NREPA or other applicable state or federal law.

XXIII. MODIFICATIONS

23.1 The Parties may only modify this Decree according to the terms of this Section. The modification of any Submission required by this Decree, excluding a RAP, may be made only upon written approval from the MDEQ Project Coordinator. Any modifications to an MDEQ-approved RAP must be approved in writing by the RRD Chief or his or her authorized representative.

23.2 Modification of any other provision of this Decree shall be made only by written agreement between NGSC's Project Coordinator, the RRD Chief, or his or her authorized representative, and the designated representative of the MDAG.

XXIV. SEPARATE DOCUMENTS

The parties may execute this Decree in duplicate original form for the primary purpose of obtaining multiple signatures, each of which shall be deemed an original, but all of which together shall constitute the same instrument.

XXV. SEVERABILITY

25.1 The provisions of this Decree shall be severable. If a court of competent jurisdiction declares that any provision of this Decree is inconsistent with state or federal law and therefore unenforceable, the remaining provisions of this Decree shall remain in full force and effect.

25.2 If the MDEQ's approval of the RAP becomes void or nullified, all other terms of this Decree remain in full force and effect.

IT IS SO AGREED BY:

MICHAEL A. COX
Attorney General
Attorney for Plaintiff

By: _____ Date: 12-09-09
Kathleen L. Cavanaugh (P38006)
Assistant Attorney General
Environment, Natural Resources,
and Agriculture Division
P.O. Box 30755
Lansing, MI 48909
(517) 373-7540

_____ Date: 12/09/09
Lynelle Marolf, Chief
Remediation and Redevelopment Division
Michigan Department of Environmental Quality

Northrop Grumman Systems Corporation

By:_____ Date: 12/8/09

Ian Ziskin
Corporate Vice President
Chief Human Resources
and Administrative Officer
Northrop Grumman Corporation
1840 Century Park East
Los Angeles, CA 90067
(310) 201-3116

Grant P. Gilezan Date: 12/9/09

Grant Gilezan
Attorney for Defendant
Dykema Gossett, PLLC
400 Renaissance Center
Detroit, MI 48243
(313) 568-6789

IT IS SO ADJUDGED AND DECREED THIS 10th day of December, 2009. This is a final order which closes the case.

for Honorable JOYCE DRAGANCHUK

LF:Industrial Plating-Handy Things/1993-200084/Consent Decree 12-01-09

ATTACHMENT A
LEGAL DESCRIPTION OF LUDINGTON HANDY THINGS PROPERTY

814 North Rowe Street (Former Handy Things):

Parcel 1: Property No. Liber 249, Page 388

All of Block Eleven (11) of Manufacturer's Addition to the City of Ludington, except Lots One (1), Seven (7) and Eight (8) and except the right of way of the Pere Marquette Railway Company's tracks over and across said lands, Mason County, Michigan.

Parcel 2: Property No. Liber 415, Page 93 and 94

All of Block Eleven (11) except Lot One (1) of Manufacturer's Addition to the City of Ludington, according to the recorded plat thereof recorded in Liber 1 of Plats at Page 38 of the Mason County Records, Mason County, Michigan.

ATTACHMENT B
LEGAL DESCRIPTION OF LPC PROPERTY

902 North Harrison Street (Former Industrial Plating/Ludington Plating):

Parcel 1: Property No. Liber 244, Page 181

The East Half (E 1/2) of Lots twenty-five (25) and twenty-six (26), Block Seventeen (17) Manufacturer's Addition to the City of Ludington, Mason County, Michigan.

Parcel 2: Property No. Liber 296, Page 806

Lots 1,2,3,4 and the West 1/2 of Lots 25, 26, 27, 28, and all of Block 17, Manufacturer's Addition to the City of Ludington, Mason County, Michigan.

ATTACHMENT C
COST SUMMARY REPORT

Site Name: Industrial Plating Area County: Mason
Site ID: 53000010
Packages: 451947-00 Industrial Plating : Original, Update 1, Update 1a, Update 2, Update 2 rev, Update 3, Update 4, Update 5

Total for Employee Salaries and Wages		
Period Covered: 07/01/1991 - 05/05/2007	$221,247.48	
Indirect Dollars	$40,461.52	
Sub-Total		$261,709.00
Total for Employee Travel Expenses		
Period Covered: 07/01/1991 - 07/10/2006		$17,737.27
Contractual Expenses		
WW OPERATION SERVICES (92-GA7209)		
Period Covered: 01/22/1992 - 01/31/1992	$1,751.00	
WW OPERATION SERVICES (92-GA8053)		
Period Covered: 01/23/1992 - 08/31/1992	$13,216.16	
WW OPERATION SERVICES (92-GA7200)		
Period Covered: 01/23/1992 - 01/31/1992	$141.00	
Weston Solutions Inc (GA7728)		
Period Covered: 02/24/1992 - 03/06/1995	$377,488.92	
WW OPERATION SERVICES (93-GA7010)		
Period Covered: 10/07/1992 - 02/26/1993	$11,297.00	
WW OPERATION SERVICES (94-GA7081)		
Period Covered: 10/26/1993 - 04/12/1994	$4,494.70	
Malcolm Pirnie, Inc. (LOE #9499) (P7000878)		
Period Covered: 02/22/1997 - 11/05/2001	$300,918.57	
DLZ/SEG (Y60300)		
Period Covered: 06/24/1997 - 09/30/1997	$23,778.50	
Malcolm Pirnie, Inc. (LOE #2005) (P1000449)		
Period Covered: 08/01/1997 - 12/13/2005	$356,890.11	
Trace Analytical Laboratories, Inc. (Y80243)		
Period Covered: 06/24/1998 - 12/03/2002	$35,131.00	
American Disposal/Northern A-1 (W9004834)		
Period Covered: 10/12/1998 - 10/13/1998	$23,270.10	
Natural Systems, Inc. (Y02320)		
Period Covered: 08/30/2002 - 05/22/2003	$405,142.31	
Trace Analytical Laboratories, Inc. (Y03088)		
Period Covered: 05/10/2004 - 05/21/2004	$1,303.00	
Contract Sub-Total		$1,554,822.37
Total for Miscellaneous Expenses		
Period Covered: 06/01/1995 - 07/28/2004		$10,767.20
MDNR/MDEQ Lab		
Period Covered: 10/01/1996 - 05/25/2004		$64,921.27
Total for MDPH/Community Health Expenses		
Alternate Water Supply		
Period Covered:	$0.00	

Bottled Water		
Period Covered:	$0.00	
MDPH/MDCH Lab		
Period Covered:	$0.00	
Sub-Total		$0.00
Attorney General Expenses		
Period Covered: 06/01/1993 - 06/30/2007		$30,975.00
Other Expenses		
Period Covered:		$0.00
Sub-Total		$1,940,932.11
Interest Calculated from through		$0.00
Total Combined Expenses for Site and Interest		**$1,940,932.11**

Run Date 06/30/2007

Cost Recovery Summary Report - Combined

Site Name: Former Handy Things Manufact. County: Mason

Site ID: 53000078

Packages: 451473-00 FORMER HANDY THINGS MANUFACTURING: Original, Update1, Update 2, Update 3, Update 4

Total for Employee Salaries and Wages		
Period Covered: 07/01/1991 - 04/21/2007	$50,213.28	
Indirect Dollars	$8,478.02	
Sub-Total		$58,691.30
Total for Employee Travel Expenses		
Period Covered: 07/01/1991 - 05/05/2007		$1,611.89
Contractual Expenses		
Not Specified ( )		
Period Covered: 07/01/1991 - 09/01/1994	$1,527.00	
Contract Sub-Total		$1,527.00
Total for Miscellaneous Expenses		
Period Covered: 07/01/1991 - 05/16/1997		$17,564.53
MDNR/MDEQ Lab		
Period Covered:		$0.00
Total for MDPH/Community Health Expenses		
Alternate Water Supply		
Period Covered:	$0.00	
Bottled Water		
Period Covered:	$0.00	
MDPH/MDCH Lab		
Period Covered:	$0.00	
Sub-Total		$0.00
Attorney General Expenses		
Period Covered: 07/01/1991 - 02/28/2007		$4,202.50
Other Expenses		
Period Covered:		$0.00
Sub-Total		$83,597.22
Interest Calculated from through		$0.00
Total Combined Expenses for Site and Interest		**$83,597.22**

Run Date 06/07/2007

ARCADIS
Infrastructure, environment, buildings

Imagine the result

Former Ludington Plating Company

Monitored Natural Attenuation Work Plan for Chlorinated Volatile Organic Compound Impacts Downgradient of the Former Ludington Plating Company

Ludington, Michigan

October 9, 2007

ARCADIS

Nicklaus R.H. Welty
Scientist II

John F. McInnis, PE
Senior Engineer

Brian J. O'Mara, PG
Principal Engineer

Monitored Natural Attenuation Work Plan for Chlorinated Volatile Organic Compound Impacts Downgradient of the Former Ludington Plating Company

Ludington, Michigan

Prepared for:
Michigan Department of Environmental Quality
Cadillac District Office
120 West Chapin Street
Cadillac, Michigan 49601-2158

Prepared by:
ARCADIS
28550 Cabot Drive
Suite 500
Novi
Michigan 48377
Tel 248.994.2240
Fax 248.994.2241

Our Ref.:
MI000951.0005

Date:
October 9, 2007

Executive Summary

This monitored natural attenuation (MNA) work plan describes the approach proposed by Northrop Grumman Space and Mission Systems Corporation (NGS&MSC), as part of a settlement with the State of Michigan, to evaluate MNA as a potential remedial alternative to address the chlorinated volatile organic compound (CVOC) plume associated with the former Ludington Plating Company (LPC) site in Ludington, Michigan (Site). This work plan was prepared in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operational Memorandum No. 4, *Site Characterization and Remediation Verification*, Attachment 8: *Monitored Natural Attenuation*. Analysis of historical concentration data from the LPC plume indicates that the plume is naturally attenuating, as evidenced by the presence of CVOC daughter products and decreasing CVOC concentration trends. Preliminary statistical analysis using current and historical data indicates that the LPC plume has reached a stable to decreasing condition. Analysis of the molar concentration sum of CVOCs suggests that the overall mass of CVOCs in the LPC plume is decreasing. To provide a comprehensive assessment of plume behavior, NGS&MSC will conduct 1 year of quarterly sampling at wells within and adjacent to the LPC plume. In addition to characterizing the distribution and magnitude of CVOCs, relevant biogeochemical parameters will be assayed to evaluate the subsurface geochemistry and determine potential biodegradation pathways.

Please note that nothing in this work plan is an admission of any fact or liability concerning the Site, nor is it a waiver of any defenses, rights or privileges, all of which are expressly reserved. Moreover, this work plan is a settlement communication regarding disputed claims between NGS&MSC and the MDEQ, and as such, nothing presented in this work plan shall be admissible into evidence under any applicable rules of evidence.

ARCADIS

Monitored Natural Attenuation Work Plan for Chlorinated Volatile Organic Compound Impacts Downgradient of the Former Ludington Plating Company

Ludington, Michigan

1. Introduction

ARCADIS was retained by Northrop Grumman Space and Mission Systems Corporation (NGS&MSC) to prepare this work plan for evaluating monitored natural attenuation (MNA) as a remedial option for groundwater impacts associated with the Site (see Figure 1). Historical data from the Ludington Plating Company (LPC) plume are indicative of natural attenuation, and recent discussions among NGS&MSC, ARCADIS and the Michigan Department of Environmental Quality (MDEQ) concluded that MNA appears to be a viable option for the remediation of chlorinated volatile organic compound (CVOC) impacts to groundwater emanating from the Site.

This work plan incorporates comments from the MDEQ contained in the June 26, 2007 letter and the October 3, 2007 e-mail from Kathleen L. Cavanaugh, Assistant Attorney General, State of Michigan. Based on telephone conversations and e-mail correspondence between Mr. Jim Skipper of the MDEQ Cadillac District Office and Mr. John McInnis of ARCADIS to discuss these comments, additional monitoring wells were added to the MNA groundwater sampling program and clarification was made in this work plan to include tabulated empirical data in the MNA analysis reports. Based on the October 3, 2007 e-mail from Ms. Cavanaugh and on subsequent follow-up telephone conversations and e-mail correspondence between Mr. Skipper and Mr. McInnis between October 3 and October 8, 2007, the list of monitoring wells to be sampled and analyzed for biogeochemical parameters was revised.

This work plan describes the current Site conditions, which indicate a favorable environment for natural attenuation, and future LPC site monitoring activities and data analyses that will allow a further evaluation of MNA at the Site.

This MNA work plan will include the following activities:

- Quarterly groundwater sampling at up to 17 monitoring wells for CVOCs for 1 year
- Quarterly sampling of biogeochemical parameters at up to 14 wells for 1 year
- Nonparametric statistical tests to evaluate CVOC temporal trends
- Quantitative attenuation rate estimates consistent with United States Environmental Protection Agency (USEPA) guidance
- Preparation of reports presenting results of the MNA analysis

2. Background

2.1 Site History

Groundwater impacts in the area are associated with three separate properties: the Site, another property owned by Straits Steel and Wire Company (SSW) and the former Handy Things Manufacturing Company (HT) site. This work plan addresses only the CVOC contamination associated with the LPC plume, as the impacts from the SSW and HT sites are being actively remediated with multiple pump-and-treat systems by SSW and NGS&MSC, respectively.

2.1.1 Former Ludington Plating Company

The original metal plating plant operating at the Site was known as Ludington Plating until the company went bankrupt and was acquired and operated by Industrial Plating in 1975. SSW purchased the LPC property on November 5, 1982 from Henry Marek. Chromium, zinc, cyanide and other metal plating materials were used at the Site. The first documented environmental problem at the Site occurred on May 13, 1968, when a nearby sanitary sewer collapsed, and plating wastes were allegedly discharged to earthen pits. In 1974, 2,000 gallons of cyanide solution were reportedly spilled at the LPC property, and MDEQ documents indicate that plating sludge was dumped into a pit on the north side of the main building in 1976. In 1997, the MDEQ discovered impacted soils at the Site that allegedly exceeded Part 201 direct contact criteria. Impacted soils were excavated by the MDEQ in 1998, and the area was covered with clean soil. Compromised tanks were discovered in the excavation area.

Review of the MDEQ file for the Site revealed that a soil sample collected by Malcolm Pirnie in 2000 on the LPC property contained 870 micrograms per kilogram (µg/kg) of trichloroethene (TCE) and 5,100 µg/kg tetrachloroethene (PCE) (Malcolm Pirnie Engineers 2000). Neither the primary source area nor the extent of these impacts in soil was delineated.

The MDEQ has conducted area-wide investigations between 1993 and 2002 to aid in the determination of the nature and extent of groundwater contamination. The MDEQ also designed, installed, and tested a groundwater extraction well (PW 200) in 1998. The extraction well was installed near the downgradient end of the contamination plume that was determined to be emanating from the Site. This extraction well was never put into operation by the MDEQ.

The MDEQ demolished the LPC building in 2002 and removed additional impacted soils, other plating waste and related debris from under the building.

In June 2006, NGS&MSC conducted a groundwater investigation. The investigation included measurement of groundwater elevations and collection of groundwater samples from select wells downgradient of the Site. The investigation was performed to aid the MDEQ's understanding of the groundwater conditions downgradient of and within the LPC plume. Results of the laboratory analysis showed detectable concentrations of CVOCs in groundwater within the central portion of the LPC plume. TCE was also reported in monitoring well MW-213 at a concentration of 460 micrograms per liter (µg/L), which is above the MDEQ Part 201 groundwater surface water interface (GSI) criterion. The presence of CVOCs in soil at the Site, the shallow water table and highly permeable subsurface soils, and the groundwater impacts detected hydraulically downgradient of the Site support the conclusion that the source of LPC plume is the Site itself. The LPC plume trends generally west-northwest, and there are no known receptors or completed exposure pathways at risk from the groundwater plume emanating from the Site.

2.2 Local Geology

The Ludington area is underlain by 75 to 120 feet of sand and silt (Malcolm Pirnie Engineers 1999). The sand ranges from very fine to medium-grained and is often interbedded with silt. According to Farrand and Bell (1982), this upper unit is a dune sand deposit. Beneath the upper sand unit is a clay unit with thin stringers of silt and fine sand.

2.3 Local Hydrogeology

The water table is located in the upper sand unit at depths ranging from 6 to 30 feet below ground surface (bgs) (Malcolm Pirnie Engineers 1999). Groundwater flow is to the northwest (see Figure 2), presumably discharging to Lincoln Lake (not shown), which is approximately 4,500 feet northwest of the LPC site.

3. Monitored Natural Attenuation Evaluation

3.1 Conceptual Overview of Monitored Natural Attenuation

A significant factor responsible for the attenuation and mass reduction of organic chemicals in groundwater is degradation by indigenous microorganisms present in the

aquifer. Microbial degradation of compounds can result in the complete breakdown or mineralization of the constituents to innocuous by-products compared to conventional techniques that only transfer chemicals from one environmental medium to another (*e.g.*, transfer from dissolved phase to gas phase). Several species of bacteria can be responsible for the degradation of chlorinated compounds. Energy and nutritional requirements are important factors in microbial degradation. Microorganisms require three basic things: an electron donor, an electron acceptor and a carbon source. Microorganisms use electron donors and electron acceptors to obtain energy to build proteins and other molecules. A carbon source is also used to build proteins and other molecules and, in many cases, the electron donor and carbon source are the same. However, certain bacterial species can gain energy from inorganic compounds and consequently require a separate carbon source to build biomass.

Individual biological metabolic pathways are defined by the electron acceptors and electron donors utilized in the process. An organic chemical is said to be an electron acceptor and become reduced if it undergoes a net gain of electrons as the result of a chemical reaction; it is said to be an electron donor and become oxidized if it undergoes a net loss of electrons. In an uncontaminated aquifer, native organic carbon is used as an energy source, and oxygen is the electron acceptor. After oxygen is consumed, anaerobic microorganisms use alternative electron acceptors in the following order of preference: nitrate, ferric iron, sulfate and carbon dioxide. An evaluation of the distribution of these electron acceptors can provide evidence of conditions conducive to reductive dechlorination.

During the reductive dechlorination process, a chlorine atom is removed and replaced with a hydrogen atom on the chlorinated hydrocarbon. The reductive dechlorination pathway of PCE occurs by sequential dechlorination of PCE to TCE to 1,2-dichloroethene (1,2-DCE) to vinyl chloride and ethene as shown below.

PCE → TCE → 1,2-DCE → Vinyl Chloride → Ethene → Ethane

The reductive dechlorination of chlorinated solvents can be quantified with the accumulation of daughter products and an increase in the concentration of chloride ions. Reductive dechlorination has been demonstrated under nitrate and Fe^{3+} reducing conditions, but the most rapid degradation rates occur under sulfate reducing and methanogenic conditions.

The complete reduction of PCE and TCE to ethene and ethane has been observed at many sites, although partial transformation products (*i.e.*, compounds containing fewer

chloride atoms such as *cis*-DCE, *trans*-DCE and vinyl chloride) may also be observed. Evidence of intrinsic biodegradation of chlorinated aliphatic hydrocarbons can be represented by the presence of degradation products as well as additional chemical parameters supporting conditions conducive to reductive dechlorination. These additional parameters include dissolved oxygen (DO), nitrates, total and soluble iron, sulfates and the production of methane. In addition to reductive dechlorination, vinyl chloride has been shown to serve as an electron donor and become oxidized under anaerobic conditions. Vinyl chloride can be directly oxidized to carbon dioxide and water through oxidation (mineralization) under anaerobic conditions with Fe^{+3} as the electron acceptor. During this degradation pathway, Fe^{+3} will be consumed, and carbon dioxide and Fe^{+2} will be produced. As defined below, several lines of evidence have been identified at the Site suggesting that MNA is a potential and applicable remediation strategy for addressing the LPC plume.

3.2 Requirements for Demonstration of Monitored Natural Attenuation

The MDEQ requires that a number of conditions be met for a site to use MNA as a remedy (MDEQ 2005). The LPC plume's state (shrinking, stable, etc.) can be more clearly assessed after 1 year of quarterly data collection. However, several of the requisite conditions outlined by the MDEQ are currently satisfied. The following sections describe the relevant MDEQ requirements for demonstration of MNA and indicate if the requirement is currently met.

3.2.1 Plume Delineation

In June 2006, CVOCs were not detected in side-gradient and downgradient monitoring wells MW-28, MW-300, MW-301, MW-302, MW-303, MW-307, MW-306, MW-44, MW-305, MW-304, MW-311, MW-310, MW-48 and MW-35. However, low concentrations of *cis*-DCE and *trans*-DCE were detected in monitoring well MW-309 during the June 2006 sampling event at concentrations significantly below the Drinking Water Protection criteria. Figure 3 presents the results of the June 2006 groundwater sampling event. Analysis of historical analytical results also indicate low to non-detect concentrations of CVOCs in downgradient monitoring wells. Based on the low to non-detect levels of CVOCs on the downgradient perimeter of the LPC plume, and the stable to decreasing historical concentration trends, it appears that the plume has achieved a stable to decreasing condition. Therefore, further delineation is not required.

3.2.2 Identification and Analysis of Receptors

MDEQ guidance requires that all receptors be identified and not immediately threatened for MNA to be protective of the public health, safety, and welfare and the environment (MDEQ 2005). Potential receptors of impacted groundwater associated with the LPC plume include surface water bodies (Lake Michigan and Lincoln Lake) and residential drinking water wells. As stated in a 2006 Technical Memorandum from NGS&MSC to the MDEQ, the absence of detectable levels of CVOCs in monitoring wells around the LPC plume indicates that the LPC plume poses little risk to potential receptors located west of Beechwood Drive and northwest of the Bryant Street-Beechwood Drive intersection (ARCADIS 2006). In addition, a groundwater use ordinance is proposed that would restrict the use of groundwater in this area. The proposed ordinance would extend from Whittier Street north to Lincoln Lake and from Delia Street west to Lakeshore Drive, covering the area of identified groundwater impacts.

3.2.3 Stable or Shrinking Plume

The *Monitored Natural Attenuation Analysis*, included as Appendix D of the *Plume Analysis, Former Handy Things, Ludington Michigan* submitted by NGS&MSC suggests that CVOC concentrations (PCE, TCE, *cis*-DCE, *trans*-DCE and vinyl chloride) in the LPC plume are decreasing (ARCADIS 2006). The MNA analysis applied a nonparametric statistical test to the historical concentration data from six wells. The six wells selected were MW-1, MW-27, MW-213, MW-20, MW-215 and SMW47. These wells were chosen because they are located within the path of the plume and had three or more historical CVOC detections over a period of 5 years. The statistical test calculates whether the concentration is increasing, decreasing or stable through time. At the 90 percent confidence level, no individual CVOC or sum of CVOCs were calculated as increasing (see Table 1). Additional nonparametric tests will be performed, and attenuation rates will be calculated using the proposed additional quarterly data.

3.2.4 Degradable Contaminants

The MDEQ MNA guidance requires that all target compounds of MNA are capable of undergoing biodegradation or transformation to less mobile or toxic forms. At the Site, MNA is being proposed as a remedy for the CVOC plume, which is composed of readily degradable compounds (PCE, TCE, *cis*-DCE, *trans*-DCE and vinyl chloride).

3.2.5 Source Control

If non-aqueous phase liquid (NAPL) or soil with contaminants above the saturation concentration (C_{sat}) are present, MNA cannot be considered as a remedy. The MDEQ excavated soils from the Site in 1998 and 2002, and the results of analysis of these soils indicate that there is no known soil contamination that exceeds C_{sat}. In addition, the dissolved-phase concentrations of CVOCs within the plume are less than 0.001 percent of their respective solubilities, which indicates that NAPL is not likely to be present. Similarly, no NAPL has been detected in any of the LPC plume monitoring wells.

3.2.6 Favorable Geochemistry

Biogeochemical indicators must document that naturally occurring biodegradation is sustainable prior to initiating MNA (MDEQ 2005). Analysis of the historical data indicates stable to decreasing concentration trends, and the presence of CVOC daughter products are indicative of reductive dechlorination. NGS&MSC proposes analyzing biogeochemical parameters (DO, carbon dioxide, oxidation reduction potential [ORP], ethene, ethane, methane, iron, sulfate, sulfide, nitrate, nitrite, chloride, alkalinity and dissolved organic carbon [DOC]) during the quarterly sampling events to further characterize the subsurface geochemistry and identify potential biodegradation pathways.

4. Proposed Activities

4.1 Quarterly Sampling Events

Upon approval of this MNA work plan, four quarterly groundwater sampling events will be performed on the following monitoring wells except for Monitoring Wells MW-2R, MW-3R, and MW-4R2. Monitoring Wells MW-2R, MW-3R, and MW-4R2 will be sampled during the first quarterly event. One or two of these wells will be sampled during the remaining quarterly events based on results of CVOC analysis in Monitoring Wells MW-1, MW-2R, MW-3R, and MW-4R2. Of the two Monitoring Wells MW-2R and MW-3R (screened at approximately 9 to 14 feet bgs), the monitoring well with the highest concentration of CVOCs detected during the first quarterly event will be sampled during the remaining three quarterly events. Of the two Monitoring Wells MW-1 and MW-4R2 (screened at approximately 40 to 45 feet bgs), the monitoring well with the highest concentration of CVOCs detected during the first quarterly event will be sampled during the remaining three quarterly events. Because Monitoring Well MW-1

is already in the sampling program, both Monitoring Wells MW-1 and MW-4R2 will be sampled if Monitoring Well MW-4R2 yields the highest CVOC concentrations.

MW-1	MW-18	MW-27	MW-216
MW-2R	MW-19	MW-28	MW-309
MW-3R	MW-20	MW-213	
MW-4R2	MW-21	MW-214	
MW-15	MW-23	MW-215	

All of the samples will be assayed for CVOCs, and a subset of 10 samples will be assayed for the following biogeochemical parameters:

Ethene	Ferric iron	Sulfate	Alkalinity
Ethane	Nitrate	Sulfide	Dissolved organic carbon
Methane	Nitrite	Chloride	

Additional biogeochemical parameters, including pH, oxidation reduction potential (ORP), DO, temperature and specific conductance, will be measured and recorded for up to 17 monitoring wells using field instrumentation.

Table 2 summarizes the proposed sampling and analytical program to be employed. The June 2006 groundwater elevation contour map (see Figure 2) and the historical groundwater analytical results were used to identify monitoring wells that are along the longitudinal flow axis of the plume and downgradient and side-gradient of the plume. This technique ensures that monitoring wells used in this work plan are consistent with the guidelines issued by the MDEQ (2005). Figure 4 presents the approximate lateral extent of CVOCs in groundwater associated with this plume and the 17 monitoring wells proposed for groundwater monitoring.

5. Monitoring Program

5.1 Sampling Techniques

Groundwater samples will be collected using low-flow sampling techniques in accordance with the standard operating procedure provided in Appendix A. This technique minimizes shifts in the geochemistry of samples that can result from the exposure of groundwater samples to atmospheric conditions. For example, when groundwater is brought to the surface, it can undergo rapid changes in ORP, and the concentrations of ORP-sensitive constituents such as DO, iron, manganese, sulfate/sulfide and nitrate/nitrite may be affected. Similarly, the purging of groundwater

at relatively higher flow rates can volatilize or strip out dissolved gases and other volatile constituents and introduce oxygen into the samples.

Studies by Barcelona et al. (1994) suggest that low-flow purging and sampling methods utilizing peristaltic pumps or low-flow submersible pumps result in more representative samples than traditional high-flow centrifugal pump purge or bailer sampling techniques. Additionally, the use of a flow-through cell has been documented as the most representative ex-situ method for measuring water quality parameters, is consistent with the USEPA (Wiedemeier et al. 1998), and is consistent with approved sampling methods defined by the MDEQ (2004).

5.2 Decontamination and Waste Disposal Procedures

Down-hole and reusable groundwater sampling equipment (*e.g.,* water level meter) will be decontaminated with a laboratory-grade soap, rinsed with distilled water and allowed to air-dry prior to each sampling event and between each sample location. Dedicated polyethylene or silicone tubing will be used for sampling and properly disposed of following groundwater sampling. Purge water will be managed in accordance with MDEQ-approved procedures.

5.3 Analytical Methods

Samples will be submitted to a certified laboratory for analysis of CVOCs using USEPA SW-846 Method 8021B. A complete list of the targeted analytes is provided in Appendix B. The relevant biogeochemical parameters (Fe^{3+}, sulfate, sulfite, nitrate, nitrite, ethene, ethane, methane, DOC, chloride and alkalinity) will be analyzed using methods defined by the USEPA (Wiedemeier et al. 1998).

5.4 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) samples will be collected during each sampling event. Equipment blank and field blank samples will be analyzed to ensure that contamination in the field has not occurred. In addition, duplicate and trip blank samples will be analyzed to assess the quality of the data resulting from the field sampling program. Table 2 summarizes the QA/QC sampling frequency and analysis. A brief discussion of the purpose, frequency and mode of collection for the QA/QC samples follows.

- **Equipment Blanks**: Equipment blanks will be collected by running deionized water through sampling equipment and collecting the water in pre-cleaned, laboratory-supplied bottles. Equipment blanks will be collected once per sampling event and analyzed for CVOCs to check for potential cross-contamination from field equipment.

- **Field Blanks**: Field blanks will be collected by filling pre-cleaned, laboratory-supplied bottles with deionized water at a sample location in the field. Field blanks will be collected once per sampling event and analyzed for CVOCs to check for contamination resulting from ambient conditions in the field.

- **Duplicates**: Duplicate samples will be analyzed for CVOCs to check for sampling and analytical reproducibility. The general frequency will be one field duplicate for each sampling event. All duplicates will be submitted to the laboratory as "blind" samples (*i.e.*, the sampling location and times will be recorded in the field logbook but not on the chain-of-custody form).

- **Matrix Spike/Matrix Spike Duplicates (MS/MSD)**: MS/MSD results from the spiked sample(s) will be used as a measure of the potential bias and precision of the results from the unspiked field samples, and therefore as a measure of the applicability of the methods employed to the sample matrix. Site-specific MS/MSD samples will be collected once per sampling event.

- **Trip Blanks**: Trip blanks will be used to assess whether crossover of constituents among samples occurs during sample shipment and storage. One laboratory-supplied trip blank consisting of high-grade deionized water (*i.e.*, laboratory "purge" water) will be included along with each shipment of samples and analyzed for CVOCs.

6. Data Analysis and Reporting

6.1 Data Analysis

NGS&MSC plans to conduct a comprehensive analysis of data collected in the quarterly sampling events. In addition to presenting the tabulated empirical data, plume behavior will be qualitatively assessed using nonparametric statistical routines and quantitatively assessed using attenuation rate calculations. The combination of these types of data analysis techniques will provide further characterization of the LPC plume to demonstrate natural attenuation.

6.1.1 Nonparametric Statistics

A primary requirement for the demonstration of natural attenuation is the presence of stable to decreasing concentration trends in monitoring wells within the plume. Two approaches can be used to meet this requirement. First, when concentration trends are obvious, plotting concentrations through time can clearly demonstrate stable or decreasing trends. However, this method can be highly subjective, as natural data variability often obscures concentration trends. A supportive approach for demonstrating stable or decreasing concentrations is to employ nonparametric statistics. Nonparametric statistical tests reveal qualitative plume trends that may not be immediately obvious. These tests filter out data variability by using ordinal rather than cardinal descriptions of concentration data through time. Cardinal numbers refer to actual values (*e.g.*, 10 µg/L, 30 days), whereas ordinal numbers refer to rank (*e.g.*, the second highest concentration, the fourth measurement). Using ordinal numbers also removes data structure restrictions required by parametric statistics (*e.g.*, normal distribution). These limitations are often not met by the small populations encountered in MNA studies. Because they are ordinal by nature, nonparametric statistical results cannot be used to estimate cleanup times or decay rates. As such, neither test will be used to estimate plume duration. Both will be used only to test for trends.

Nonparametric tests are most valuable when used in concert with other approaches that demonstrate MNA. Two common nonparametric techniques are recommended by the MDEQ (2005): the Mann-Kendall test and Mann-Whitney test. For statistical diligence, both tests will be used in the MNA evaluation. The tests will be performed on monitoring wells within the LPC plume, using the complete data set including new data obtained during the proposed quarterly sampling events. The results will be tabulated in order to better assess CVOC concentration trends in the LPC plume and presented in the reports described in section 6.2 of this work plan.

6.1.1.1 Mann-Kendall Test

The Mann-Kendall test (Kendall 1938) is a common nonparametric test for comparing two populations. In this test, concentration measurements for a specific well are placed in temporal order, and each measurement is compared with all other measurements (USEPA 2006). If a measurement is lower than a previous measurement, a value of -1 is recorded. Conversely, if a measurement is higher than a previous measurement, a value of 1 is recorded. Equal values result in a value of 0. After all measurements have been compared, the computed values are summed to determine the Mann-Kendall S statistic. This value is compared to a table of characteristic values at different

significance levels. If S is greater than or equal to the characteristic value for a given significance level, then the trend is increasing; if S is less than or equal to the characteristic value, then the trend is decreasing. If S equals the characteristic value, then there is neither a decreasing nor increasing trend. If this occurs, the S value can be subjected to a stability test:

$$CV = \frac{\sigma}{\frac{1}{n}\sum_{i=1}^{n} c_i}$$

Where

σ = standard deviation of concentration data

n = population size

c_i = concentration and

CV = coefficient of variation

If CV is less than 1, the standard deviation is low relative to the mean value, and so there are stable conditions as the relative "spread" of the dataset is small. Conversely, a CV greater than 1 indicates a larger "spread" and is thus a non-stable condition.

6.1.1.2 Mann-Whitney Test

The Mann-Whitney test (Mann and Whitney 1947) is another nonparametric statistical approach for evaluation of trend data. In this technique, temporal concentration data are first ranked according to the magnitude of the concentration. Then, the data are placed in temporal order and split into two populations of equal size. Next, the number of times a value in the second population exceeds a value in the first population is summed to yield the Mann-Whitney U statistic. This value can range from 0 to 1-n, where 0 represents a strong decreasing trend (the second population never exceeds the first population), and 1-n represents a strong increasing trend (the second population always exceeds the first population).

6.1.2 Attenuation Rate Estimates

Nonparametric statistics provide a qualitative analysis of plume behavior, but a quantitative analysis will be made through attenuation rate estimates. The USEPA (Newell et al. 2002) defines the following types of natural attenuation rates:

(1) Point attenuation rates (k_{point})

(2) Bulk attenuation rates (k)

The first type of rate will be used to estimate plume persistence at a single point. Concentrations at a monitoring well are plotted through time, and k_{point} is the slope of this curve. Although useful for demonstrating reduction in contaminant concentration through time at a point, point attenuation rates cannot be used to determine if concentrations are reducing with distance from the source.

To evaluate spatial trends, the second type of rate is required. Bulk attenuation rates (k) are calculated as the slope of the concentration versus distance curve. In contrast to point attenuation rates, bulk attenuation rates cannot be used to demonstrate reduction in concentrations over time; however, the spatial trends are related to temporal trends when the data are evaluated along the centerline of the plume axis. A key assumption in the bulk attenuation rate calculation is that the concentrations are located on the plume centerline. Both point and bulk attenuation rates represent the combined effects of biodegradation, advective transport, dispersion, dilution and sorption.

Attenuation rates at the Site will be calculated using historical data and new data from the proposed quarterly sampling events. The typical convention for analysis of contaminant levels is to normalize mass to volume and express the quantity as concentration (mass/volume). This technique is adequate for comparing contaminant levels against state and federal criteria. On the other hand, a more sophisticated analysis is required when sequential decay is linking parent and daughter products. For example, if 100 µg/L of TCE degrade, 100 µg/L of *cis*-DCE is not produced because the two compounds have different molecular structures and thus different molecular weights. However, the molar sum of the two compounds remains constant. Expressing compound mass as a molar concentration thus allows comparison of different CVOC species. A molar concentration is simply the contaminant concentration normalized to the molecular weight of the compound. The molecular weight of a compound is the sum of the atomic weights of the atoms that make up the compound.

TCE, *cis*-DCE and vinyl chloride have molecular weights of 131.39 grams (g), 96.94 g and 62.5 g, respectively. If one mole of TCE (131.39 g) degrades, one mole of *cis*-DCE (96.94 g) is produced. Therefore, if 100 µg/L of TCE degrade, the result is approximately 74 µg/L of *cis*-DCE.

Expressed as a molar concentration, if 0.76 micromoles per liter (µmol/L) (100 µg/L) of TCE degrade, an equal amount of *cis*-DCE is produced, 0.76 µmol/L (74 µg/L). Therefore, representing contaminant levels using molar concentration facilitates detection of degradation. Examining the sum of the molar concentrations of TCE, *cis*-DCE and vinyl chloride through time is one method of determining if the overall mass of hydrocarbons is decreasing. Preliminary analysis indicates that the molar concentration sum of these compounds is decreasing, indicating that the overall mass of CVOCs in the LPC plume is declining (ARCADIS 2006). This analysis will be repeated using the groundwater analytical results generated during the proposed quarterly sampling events in order to further demonstrate mass reduction within the LPC plume.

6.2 Reporting

The results of the proposed quarterly sampling events conducted under this work plan will be documented in three Quarterly Reports and one comprehensive Technical Memorandum. Each of the Quarterly Reports will be completed within 30 days of receipt of the final laboratory data package, and will include the following:

- Groundwater gauging data table including the monitoring well screened intervals, top of casing survey data, depth to water, elevation of groundwater and total depth of the monitoring well
- Groundwater analytical data table including the date of sampling, analytical parameters, current analytical data and method detection limits
- Biogeochemical data table providing the results, date and method of collection
- Scaled figures presenting groundwater elevation contours and approximate contaminant plume extent

The fourth report will be a comprehensive Technical Memorandum detailing the entire four quarters of sampling and analysis to be completed within 60 days of receipt of the final fourth quarter laboratory data package. The Technical Memorandum will provide updated figures and tables as described above, in addition to the following:

- Results of nonparametric statistical analyses
- Estimates of attenuation rates
- Evaluation of new data with respect to the conceptual model for natural attenuation

7. Summary

As discussed with the MDEQ, evaluation of the current and historical LPC plume data indicates that MNA is a viable and applicable remedial option for addressing the LPC CVOC plume. An analysis of historical concentration data indicates that the plume is naturally attenuating, as evidenced by the creation of CVOC daughter products and decreasing concentration trends. Preliminary statistical analysis using current and historical data indicates that the LPC plume has reached a stable to decreasing condition. Further, analysis of the molar concentration sum of CVOCs in the LPC plume suggest that the overall mass of CVOCs is decreasing. This MNA work plan describes the approach NGS&MSC is proposing, as part of a settlement with the MDEQ, to further demonstrate natural attenuation of the LPC plume. To provide a comprehensive assessment of the plume's behavior, NGS&MSC proposes to conduct 1 year of quarterly sampling at wells in and surrounding the LPC plume. In addition to characterizing the distribution and magnitude of CVOCs, relevant biogeochemical parameters will be assayed to better evaluate the subsurface biogeochemistry and determine potential biodegradation pathways.

8. References

ARCADIS. 2006. Technical Memorandum: Plume Analysis, Former Handy Things, Ludington, Michigan. 5 p.

Barcelona, M. J., H. A. Wehrmann and M. D. Varljen. 1994. Reproducible well purging procedures and VOC stabilization criteria for ground-water sampling. *Ground Water*, vol. 32, no. 1, 12-22 pp.

Farrand, W. R. and D. L. Bell. 1982. Quaternary Geology of Southern Michigan. University of Michigan, Lansing, Michigan.

Kendall, M. G. 1938. A new measure of rank correlation. *Biometrika*, vol. 30, no. 1-2, 81-93 pp.

Malcolm Pirnie Engineers, LP. 1999. Phase II Remedial Investigation Technical Memorandum. 22 p.

Malcolm Pirnie Engineers, LP. 2000. Industrial Plating Area Site, Draft Technical Memorandum.

Mann, H. B. and D. R. Whitney. 1947. On a test of whether one of 2 random variables is stochastically larger than the other. Annals of Mathematical Statistics, vol. 18, 50-60 pp.

Michigan Department of Environmental Quality (MDEQ). 2004. RRD Operational Memorandum No. 2, Sampling and Analysis-Attachment 5, Collection of Samples for Comparison to Generic Criteria.

MDEQ. 2005. RRD Operational Memorandum No. 4, Site Characterization and Remediation Verification-Attachment 8, Monitored Natural Attenuation, Interim Final Draft.

Newell, C. J., H. S. Rifai, J. T. Wilson, J. A. Connor, J. A. Aziz and M. P. Suarez. 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies*. Report Number: EPA/540/S-02/500, United States Environmental Protection Agency National Risk Management Research Laboratory Cincinnati, OH, 28 p.

United States Environmental Protection Agency. 2006. Data Quality Assessment: Statistical Methods for Practitioners. Report Number: EPA/240/B-06/003, USEPA Office of Environmental Information, Washington, DC, 198 p.

Wiedemeier, T. H., M. A. Swanson, D. E. Moutoux, E. K. Gordon, J. T. Wilson, B. H. Wilson, D. H. Kampbell, P. E. Haas, R. N. Miller, J. E. Hansen and F. H. Chapelle. 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. Report Number: EPA/600/R-98/128, United States Environmental Protection Agency Office of Research and Development, Washington DC, 248 p.

ARCADIS

Table 1. Results of Mann-Kendall Analysis, Ludington Plating Company, Ludington, Michigan

Monitoring Well	S	n	Mean	σ	CV	Trend ≥ 80% Confidence Level	Trend ≥ 90% Confidence Level
Tetrachloroethene:							
MW-1	-2	4	0.01	0.00	0.37	No Trend	No Trend
MW-27	0	6	0.00	0.00	0.00	No Trend	No Trend
MW-213	0	4	0.00	0.00	0.00	No Trend	No Trend
MW-20	0	5	0.00	0.00	0.00	No Trend	No Trend
SMW47	0	5	0.00	0.00	0.00	No Trend	No Trend
MW-215	0	4	0.00	0.00	0.00	No Trend	No Trend
Trichloroethene:							
MW-1	-6	4	1.59	1.94	1.21	Decreasing	Decreasing
MW-27	6	7	0.52	0.24	0.46	No Trend	No Trend
MW-213	-4	4	3.60	2.81	0.78	Decreasing	No Trend
MW-20	2	5	3.95	1.97	0.50	No Trend	No Trend
SMW47	-8	5	5.89	1.55	0.26	Decreasing	Decreasing
MW-215	-1	4	0.08	0.13	1.55	No Trend	No Trend
***cis*-1,2-Dichloroethene:**							
MW-1	-3	4	0.01	0.00	0.31	No Trend	No Trend
MW-27	-10	7	0.04	0.05	1.46	Decreasing	Decreasing
MW-213	0	4	1.04	1.10	1.06	No Trend	No Trend
MW-20	-2	5	0.01	0.01	0.75	No Trend	No Trend
SMW47	-4	5	0.02	0.03	1.61	No Trend	No Trend
MW-215	4	4	0.85	0.61	0.71	Increasing	No Trend

See notes on page 3

Table 1. Results of Mann-Kendall Analysis, Ludington Plating Company, Ludington, Michigan

Monitoring Well	S	n	Mean	σ	CV	Trend ≥ 80% Confidence Level	Trend ≥ 90% Confidence Level
***trans*-1,2-Dichloroethene:**							
MW-1	0	4	0.01	0.00	0.00	No Trend	No Trend
MW-27	-6	7	0.01	0.01	1.13	No Trend	No Trend
MW-213	-3	4	0.07	0.13	1.85	No Trend	No Trend
MW-20	0	5	0.01	0.00	0.00	No Trend	No Trend
SMW47	0	5	0.01	0.00	0.00	No Trend	No Trend
MW-215	2	4	0.16	0.12	0.73	No Trend	No Trend
Vinyl Chloride:							
MW-1	0	4	0.01	0.00	0.00	No Trend	No Trend
MW-27	0	6	0.01	0.00	0.00	No Trend	No Trend
MW-213	0	4	0.01	0.00	0.00	No Trend	No Trend
MW-20	0	4	0.01	0.00	0.00	No Trend	No Trend
SMW47	0	5	0.01	0.00	0.00	No Trend	No Trend
MW-215	0	4	0.008	0.00	0.00	No Trend	No Trend
Molar Sum:							
MW-1	-6	4	1.61	1.94	1.21	Decreasing	Decreasing
MW-27	4	7	0.56	0.20	0.36	No Trend	No Trend
MW-213	0	4	5.94	2.16	0.36	No Trend	No Trend
MW-20	2	5	3.96	1.98	0.50	No Trend	No Trend
SMW47	-8	5	5.90	1.56	0.26	Decreasing	Decreasing
MW-215	2	4	1.09	0.80	0.73	No Trend	No Trend

See notes on page 3

ARCADIS

Table 1. Results of Mann-Kendall Analysis, Ludington Plating Company, Ludington, Michigan

Notes:

σ	Standard deviation of sample size "n".
CV	Coefficient of variation.
Mean	Mean concentration in micromoles per liter detected at well for sample size "n".
n	Sample size.
S	Statistic (Mann-Kendall).

ARCADIS

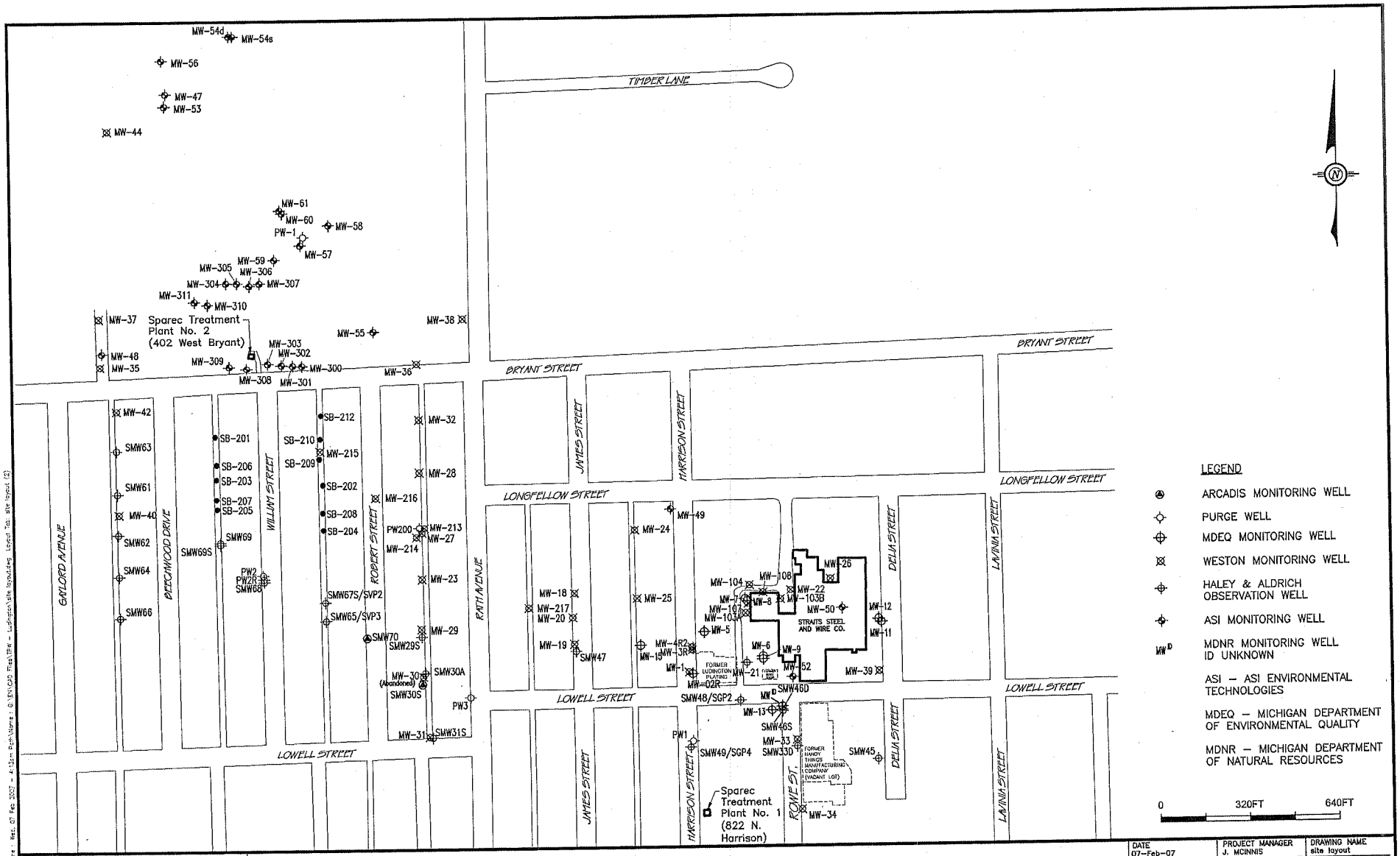
Table 2. Proposed MNA Sampling Program, Ludington Plating Company, Ludington Michigan

Wells	Approximate Well Screen (ft bgs)	Location	Quarterly Monitoring Events (each)	Biogeochemical Analytical Parameters Quarterly Sampling																
				Dissolved Gases			Terminal Electron Acceptors and Redox Pairs									Field Parameters				
			CVOCs	Ethene[1]	Ethane[1]	Methane[1]	Ferrous Iron[2]	Nitrate[2]	Nitrite[2]	Sulfate[2]	Sulfide[2]	DOC[3]	Chloride[4]	Alkalinity[5]	pH	ORP	DO[2]	Temperature	Specific Conductance
MW-21	43 - 48	Upgradient	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-1	40 - 45	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-2R[6]	9 - 14	Within plume	L												F	F	F	F	F
MW-3R[6]	9 - 14	Within plume	L												F	F	F	F	F
MW-4R2[6]	40 - 45	Within plume	L												F	F	F	F	F
MW-15	40 - 45	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-18	35 - 40	Within plume	L	--	--	--	--	--	--	--	--	--	--	--	F	F	F	F	F
MW-19	69 - 74	Within plume	L	--	--	--	--	--	--	--	--	--	--	--	F	F	F	F	F
MW-20	52 - 57	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-23	68 - 75	Side-gradient	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-27	80 - 85	Within plume	L	--	--	--	--	--	--	--	--	--	--	--	F	F	F	F	F
MW-28	97-102	Side-gradient	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-213	80 - 85	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-214	80 - 85	Within plume	L	--	--	--	--	--	--	--	--	--	--	--	F	F	F	F	F
MW-216	100 - 105	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-215	100 - 105	Within plume	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
MW-309	83 - 93	Downgradient	L	L	L	L	H	L	L	L	L	L	L	L	F	F	F	F	F
QA/QC Samples																			
Duplicate	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trip Blank	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Equipment Blank	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Field Blank	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MS	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MSD	--	--	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Number of samples:	23	10	10	10	10	10	10	10	10	10	10	10	17	17	17	17	17

Notes:

DO	Dissolved oxygen.
F	Field measurement using a water-quality meter.
ft bgs	Feet below ground surface.
H	Field analysis using a Hach Spectrophotometer.
L	Laboratory analysis.
ORP	Oxidation reduction potential.
CVOCs	Chlorinated Volatile organic compounds.

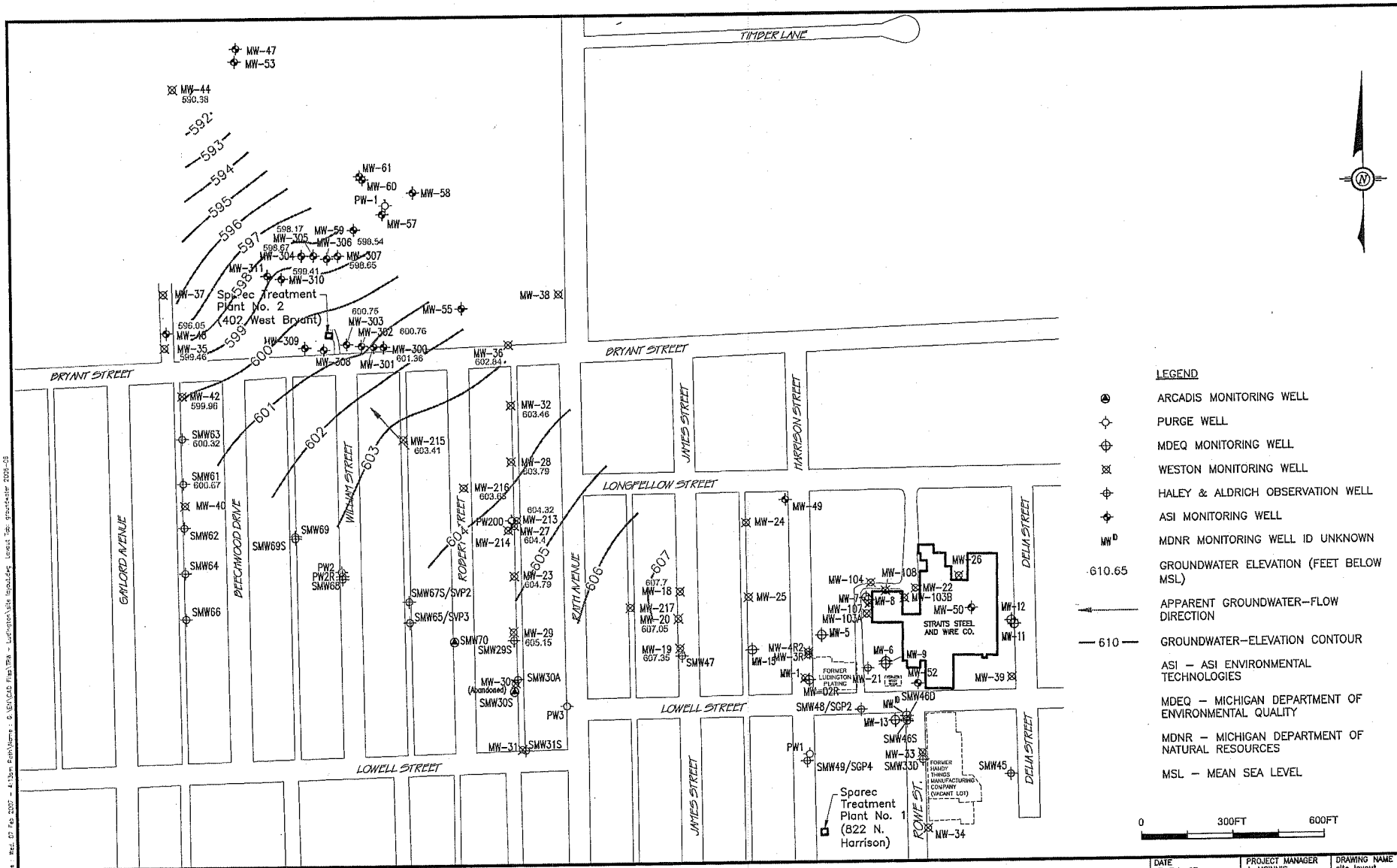
1	Indicator of degradation products present in the aquifer. To also determine if methanogenesis is occurring.
2	Evaluation of the distribution of these electron acceptors can provide evidence of conditions conducive to reductive dechlorination.
3	Dissolved organic carbon - Indicator of available carbon present in the aquifer.
4	Indicator of degradation products present in the aquifer.
5	Indicator of buffering capacity of the aquifer.
6	These monitoring wells to be sampled during the first quarterly event. One or two of these wells will be sampled during the remaining quarterly events based on the results of CVOCs in these monitoring wells and Monitoring Well MW-1.
NA	Not applicable



ARCADIS
28550 Cabot Drive, Suite 500
Novi, Michigan 48377
Ph: 248.994.2240 Fx: 248.994.2241

SITE LAYOUT MAP
FORMER LUDINGTON PLATING COMPANY
LUDINGTON, MICHIGAN

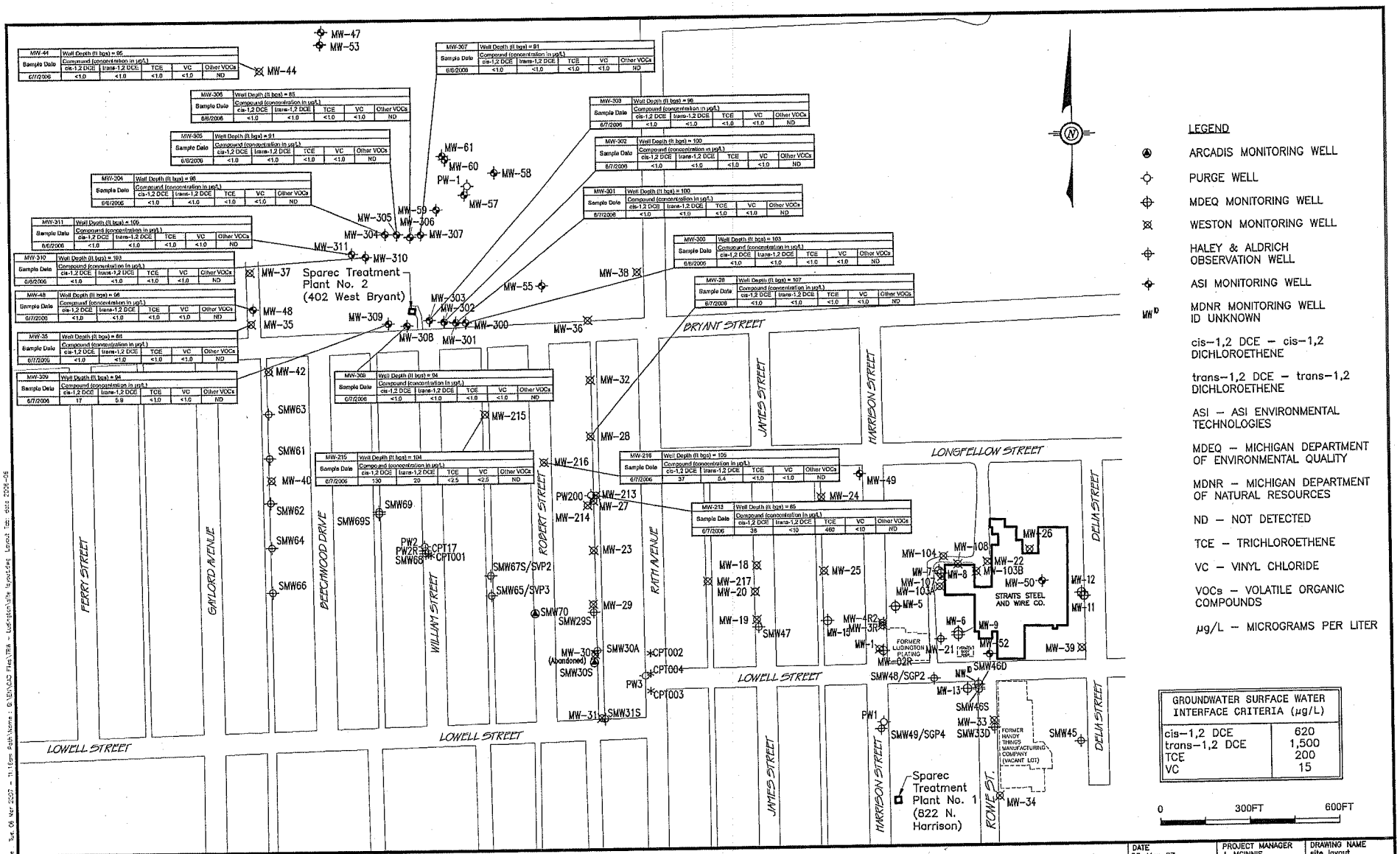
DATE 07-Feb-07	PROJECT MANAGER J. MCINNIS	DRAWING NAME site layout	
DRAWN A. SMITH	LEAD DESIGN PROF.	CHECKED L. EENIGENBURG	
PROJECT NUMBER MI000951.0005		FIGURE NUMBER 1	



ARCADIS
28550 Cabot Drive, Suite 500
Novi, Michigan 48377
Ph: 248.994.2240 Fx: 248.994.2241

GROUNDWATER ELEVATION CONTOUR MAP - JUNE 2006
FORMER LUDINGTON PLATING COMPANY
LUDINGTON, MICHIGAN

DATE 07-Feb-07	PROJECT MANAGER J. MCINNIS	DRAWING NAME site layout	
DRAWN TRY	LEAD DESIGN PROF.	CHECKED L. EENIGENBURG	
PROJECT NUMBER MI000951.0005		FIGURE NUMBER 2	



LEGEND

- ARCADIS MONITORING WELL
- PURGE WELL
- MDEQ MONITORING WELL
- WESTON MONITORING WELL
- HALEY & ALDRICH OBSERVATION WELL
- ASI MONITORING WELL
- MW^{ID} MDNR MONITORING WELL ID UNKNOWN

cis–1,2 DCE – cis–1,2 DICHLOROETHENE

trans–1,2 DCE – trans–1,2 DICHLOROETHENE

ASI – ASI ENVIRONMENTAL TECHNOLOGIES

MDEQ – MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MDNR – MICHIGAN DEPARTMENT OF NATURAL RESOURCES

ND – NOT DETECTED

TCE – TRICHLOROETHENE

VC – VINYL CHLORIDE

VOCs – VOLATILE ORGANIC COMPOUNDS

µg/L – MICROGRAMS PER LITER

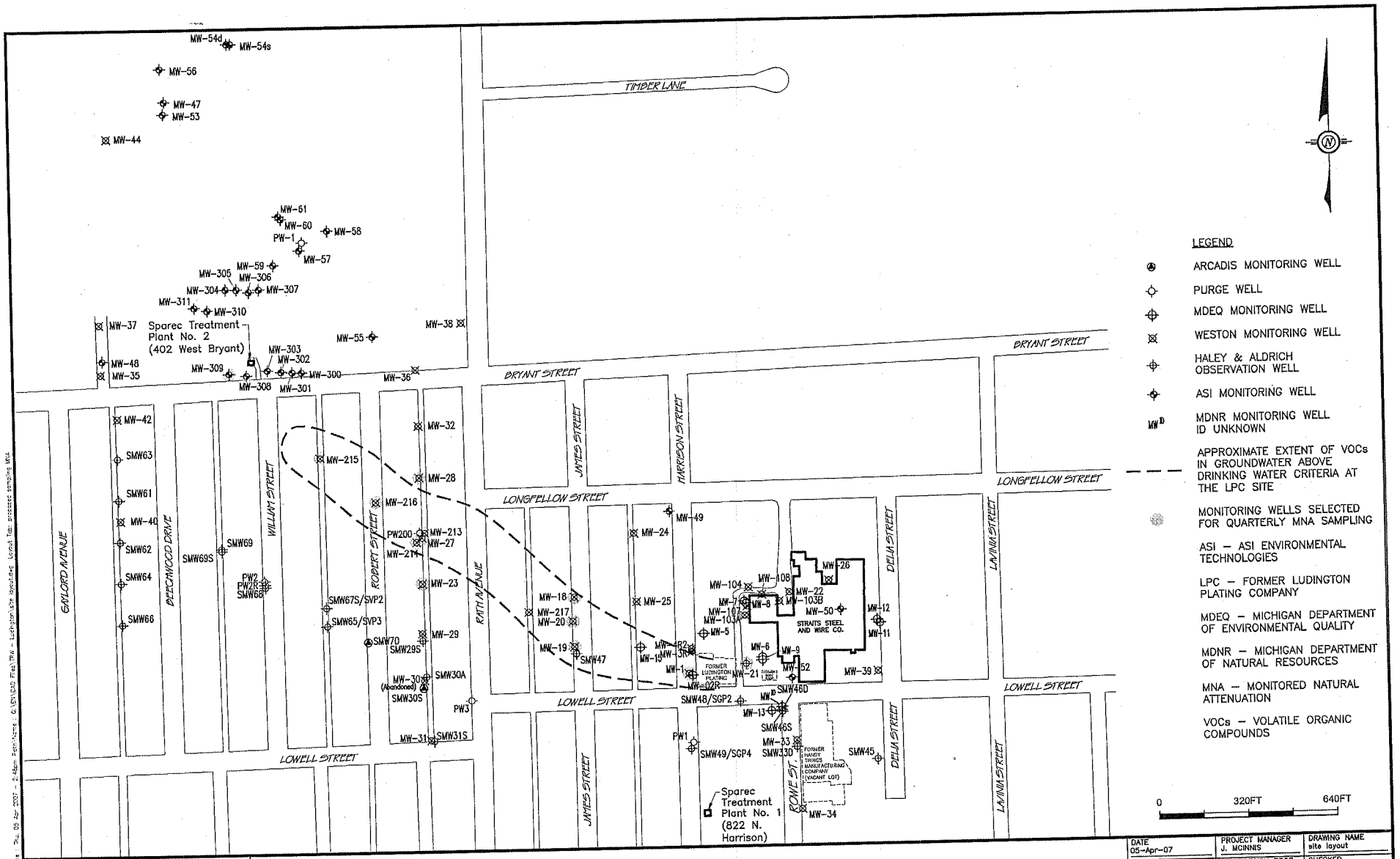
GROUNDWATER SURFACE WATER INTERFACE CRITERIA (µg/L)	
cis–1,2 DCE	620
trans–1,2 DCE	1,500
TCE	200
VC	15

0 300FT 600FT

ARCADIS
28550 Cabot Drive, Suite 500
Novi, Michigan 48377
Ph: 248.994.2240 Fx: 248.994.2241

GROUNDWATER ANALYTICAL RESULTS MAP - JUNE 2006
FORMER LUDINGTON PLATING COMPANY
LUDINGTON, MICHIGAN

DATE 06–Mar–07	PROJECT MANAGER J. MCINNIS	DRAWING NAME site layout
DRAWN TRY	LEAD DESIGN PROF.	CHECKED L. EENIGENBURG
PROJECT NUMBER MI000951.0005		FIGURE NUMBER 3



ARCADIS
28550 Cabot Drive, Suite 500
Novi, Michigan 48377
Ph: 248.994.2240 Fx: 248.994.2241

PROPOSED SAMPLING PROGRAM FOR MNA EVALUATION MAP
FORMER LUDINGTON PLATING COMPANY
LUDINGTON, MICHIGAN

DATE 05-Apr-07	PROJECT MANAGER J. MCINNIS	DRAWING NAME site layout
DRAWN A. SMITH	LEAD DESIGN PROF.	CHECKED L. EENIGENBURG
PROJECT NUMBER MI000951.0005		FIGURE NUMBER 4

ARCADIS

Appendix A

Low-Flow Groundwater Sampling
Standard Operating Procedure

ARCADIS

Infrastructure, buildings, environment, communications - Chicago

LOW FLOW GROUNDWATER SAMPLING STANDARD OPERATING PROCEDURE

No. T101
By: M. Hamper
Approved by: G. Vanderlaan
Date: 1/14/97
Revision Number: 3
Revision Date: 3/6/02

1. Applicability

1.1 This ARCADIS Standard Operating Procedure (SOP) covers the collection of groundwater samples from monitoring wells using a low flow technique to minimize the disturbance of particulate matter in the well. This method may be used to collect samples for total metals analysis, organic analysis including volatile organic compounds, and general water chemistry parameters. This method may also be used for the collection of samples for dissolved metals analysis by the addition of a field filtration step.

1.2 The presence of the disturbed particulate matter in a groundwater sample will have an affect on the analytical results for total metals. Kearl et al. (1994) recommends using a low flow procedure to obtain representative samples of the total mobile metal load in the groundwater, which includes the dissolved and colloidal portions. The disturbance of the particulate matter in the well is minimized by using a pump to purge and sample the well, inserting (or installing) the pump in the well at least one day prior to sampling (if possible), low flow purging the well prior to sampling, and then sampling the well at a low flow rate (approximately 100mL/min)(Kearl et al., 1994).

1.3 This SOP does not address health and safety, water level measurements, decontamination, field filtration, sample preservation, sample bottle filling, chain-of-custody, field parameter analysis, pump operation and maintenance, or laboratory analysis. Refer to other ARCADIS SOPs, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan, as appropriate. Refer to pump manufacturer's operation and maintenance manual for pump operating procedures.

2. Pump Selection

The type of pump used to low flow purge and sample the well will have an impact on the chemistry of the groundwater sample. A dedicated, submersible bladder pump is recommended for use with this SOP. A portable, submersible bladder pump may be used if time allows. A peristaltic pump may also be used to collect samples for non-volatile analyses. The potential impact of a peristaltic pump on volatile fractions of samples must be considered on a project specific basis. Other pumps may be found to be suitable on a

project specific basis. The pump and transfer tubing selected for use must be composed of materials that will not affect the sample quality (i.e., stainless steel, tygon, teflon, or other equivalent material) and that will utilize a pumping action that also will not significantly impact sample quality (i.e., positive displacement without aeration). See Parker (1994) for a recent summary of the potential impacts of sampling devices on sample quality.

3. Definitions

3.1 Dedicated Pump-A permanently installed pump.

3.2 Dissolved Metals-The water sample is filtered in the field prior to the preservation step, and then analyzed in the laboratory.

3.3 Low Flow Purging-The purging of "volumes" of water through the sample pump, and transfer tubing only at a low rate with no appreciable drawdown in the well. Puls and Barcelona (1996) recommend that water quality parameters such as pH, temperature and specific conductance stabilize prior to the collection of the water sample. A "volume" is the amount of water contained in the sample pump and the transfer tubing when completely full. Low flow purging is performed with the pump intake located at the midpoint of the well screen.

In a typical well, stagnant water, when present, is located in the solid portion of the well pipe above the screen. Under conditions where low flow sampling is applicable, fresh groundwater is continuously moving through the screened interval of the well according to the existing gradients in the hydrostratigaphic unit. Purging of stagnant groundwater from the entire well is not performed because when the well is pumped at a low rate, the stagnant water from the solid portion of the well pipe above the screened interval does not mix with the fresh groundwater present in the screened interval, resulting in a sample representative of the groundwater in the vicinity of the well.

3.4 Total Metals-The water sample is not filtered in the field prior to the preservation step, and then analyzed in the laboratory.

3.5 Total Mobile Metals Load-This is similar to 3.4, except that special techniques (i.e., low flow sampling) have been employed to minimize the potential for the presence of particulates in the water sample due to disturbance of the well by the sampling technique (i.e., creating sediment suspended by agitating the well). The water sample is expected to contain the dissolved and colloidal metals being transported in the groundwater (i.e., the mobile constituents).

4. Equipment

4.1 Electronic water level indicator (SOP T103) or water level measuring tape with popper.

4.2 Sampling pump and transfer tubing (with centralizer). Use SOP T124 for peristaltic pump.
4.3 Well construction logs for each well.
4.4 Previous round of water levels and measurements of total well depth (if any).
4.5 Watch with ability to accurately measure one minute.
4.6 Graduated cylinder or other device to accurately measure 100 mL
4.7 Well lock keys
4.8 Field Log Book (SOP T102)
4.9 Table of pump and transfer tubing volumes
4.10 Field Chain-of -Custody SOP T107
4.11 Field Filtration SOP T114 (as needed)
4.12 Plastic bucket
4.13 Plastic sheeting
4.14 pH paper
4.15 Ice
4.16 Coolers
4.17 Sample bottles (pre-preserved) (minimum one extra set)
4.18 Water sampling log forms
4.19 Flow-through cell and pH, conductivity, and turbidity meter (if required)

5. Procedure

5.1 Unlock well and remove cap. Let the well stand open to allow the water level to equilibrate, if necessary. Measure the water level in the well and the total depth of the well (skip total depth measurement for dedicated pump situation, or if total depth is known and the time available to let the well stand undisturbed is limited). Record measurements in field book. Skip to 5.6 if a dedicated pump is in use. *Note: It may be appropriate to obtain a complete round of water levels from each of the monitoring wells at the site prior to sampling any of the wells.*

5.2 Review the well construction log and determine the depth of the well screen midpoint below the top of casing and the total depth of the well. Record in field book.

5.3. Compare the measurement of total depth of the well with the well construction log and previous measurements, if any, to determine available length of well screen. Confer with project manager or field supervisor if a significant accumulation of sediment is present in the well, or other discrepancies are identified. Record in field book.

5.4 Insert the pre-cleaned tubing, or pump and tubing into the well to the midpoint of the well screen. Record installation time in field book.

5.5 Let well stand undisturbed overnight after installation of downhole equipment, if possible.

5.6 Start pump at the lowest possible flow rate and adjust the pumping rate to approximately 100 mL/min. (Refer to pump SOP or manufacturers instructions for pump setup and operation). Record pump start time in field book. Verify the flow rate with a graduated cylinder (or equivalent) by collecting the water from the discharge line for one minute. Record results in field book. Manage the collected water according to project work plans.

5.7 Monitor water level to verify that little or no drawdown is occurring in the well. If desired, the flow rate may be increased to up to 300 mL/min in more permeable formations as long as no drawdown is occurring in the well. Record measurements and flow rates in field book. If required, monitor the turbidity using a flow-through cell. If turbidity increases with increasing flow rate, reduce flow rate to minimize turbidity.

5.8 Low flow purge two pump and transfer tubing volumes of water at a flow rate of approximately 100 mL/min. A volume is composed of the tubing and equipment volumes, not the volume of the well. Determine pH, temperature and specific conductance values, which should reach stable values prior the collection of the sample. Record purge volume target and actual values in field book. Manage purge water according to project work plans.

5.9 Obtain field parameter measurements and record as required by project work plans.

5.10 Remove flow-through cell from discharge tubing prior to sample collection, if being used. Collect sample at low flow rate (100 mL/min) for laboratory analysis directly into the appropriate sample container from pump discharge tubing. Fill the sample bottles in the following order, as applicable:

1. Volatile organic compounds (VOCs).
2. Semivolatile organic compounds (SVOCs).
3. Pesticides/PCBs.
4. Total petroleum hydrocarbons.
5. Total metals.
6. Dissolved metals.
7. Alkalinity, BOD, total suspended solids, total dissolved solids, sulfate, chloride.
8. Sulfide.
9. Cyanide.
10. Phenols.
11. Nitrate + nitrite, ammonia, TOC, COD, phosphorus.

5.11 Fill the VOC vials completely (i.e., no headspace). Fill the vial until a meniscus forms at the bottle opening. Place the cap on the vial and screw it on. Invert the vial and check for air bubbles. If air bubbles are present, remove the cap and add more sample.

Replace the cap and re-inspect the vial for bubbles. Repeat if necessary. Label the vial with the appropriate information. If the vial sample label was filled out before the bottle was filled, verify that the information is correct and sign the label.

5.12 Fill the remaining bottles to the shoulder. Cap and label the bottles appropriately (including signature).

5.13 Filter the sample to be collected for dissolved metals prior to acid preservation.

5.14 Duplicate samples are prepared by alternately filling the container for the "investigative sample" for a particular parameter and then filling the container for the "duplicate sample" for that same parameter. Duplicate samples need to be included on the chain-of-custody form. Check the work plan or ask the project manager what the duplicate sample requirements are for each project.

5.15 Trip blanks (VOCs only) are prepared in the laboratory and are shipped from the laboratory with the VOC sample collection vials for each project. The trip blank vials should be inspected for air bubbles upon receipt from the laboratory. The trip blanks are not opened in the field. A trip blank should be present in each shipping cooler containing VOC samples going to the lab. Trip blanks need to be included on the chain-of-custody form.

5.16 Matrix spike/matrix spike duplicates (MS/MSDs), when required for the project, are collected in the same manner as a duplicate sample. Check with the laboratory for the volume requirements for each parameter. MS/MSDs need to be included on the chain-of-custody form. Check the work plan or ask the project manager what the duplicate sample requirements are for each project.

5.17 Equipment blanks are prepared by running distilled water through the each piece of the sampling equipment that comes into contact with a groundwater sample. To avoid confusion, do not use the term field blank. Equipment blanks needed to be included on the chain-of-custody form. Check the work plan or ask the project manager what the duplicate sample requirements are for each project.

5.18 For samples that require acid or base preservation, verify that the required pH is achieved by placing a small amount of sample from the sample container in a clean dish (or equivalent) and test the sample with pH paper. Do not place the pH paper in the sample container or cap. Conduct the pH measurement on the VOC vials on approximately 10% of the samples. Fill an extra VOC vial for pH testing, test the contents of the VOC vial, then discard the VOC vial appropriately.

5.19 Samples should be placed into a cooler containing ice immediately after collection.

5.20 Turn off pump. Remove non-dedicated downhole equipment from well and decontaminate or dispose of properly.

5.21 Replace cap on well and protective casing, and lock.

5.22 Ship the samples to the laboratory per project requirements following the Chain-of-Custody SOP (T107).

6. References

6.1 Kearl, P. M, Korte, N. E., Stites, M., and J. Baker, 1994, Field Comparison of Micropurging vs. Traditional Ground Water Sampling, Groundwater Monitoring Review, Fall 1994, pp. 183-190.

6.2 Parker, L.V., 1994, The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review, Groundwater Monitoring Review, Spring 1994, pp. 130-141.

6.3 Puls, Robert, W. and Michael J. Barcelona, 1996, Ground Water Issue, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, EPA/540/S-95/504, April 1996.

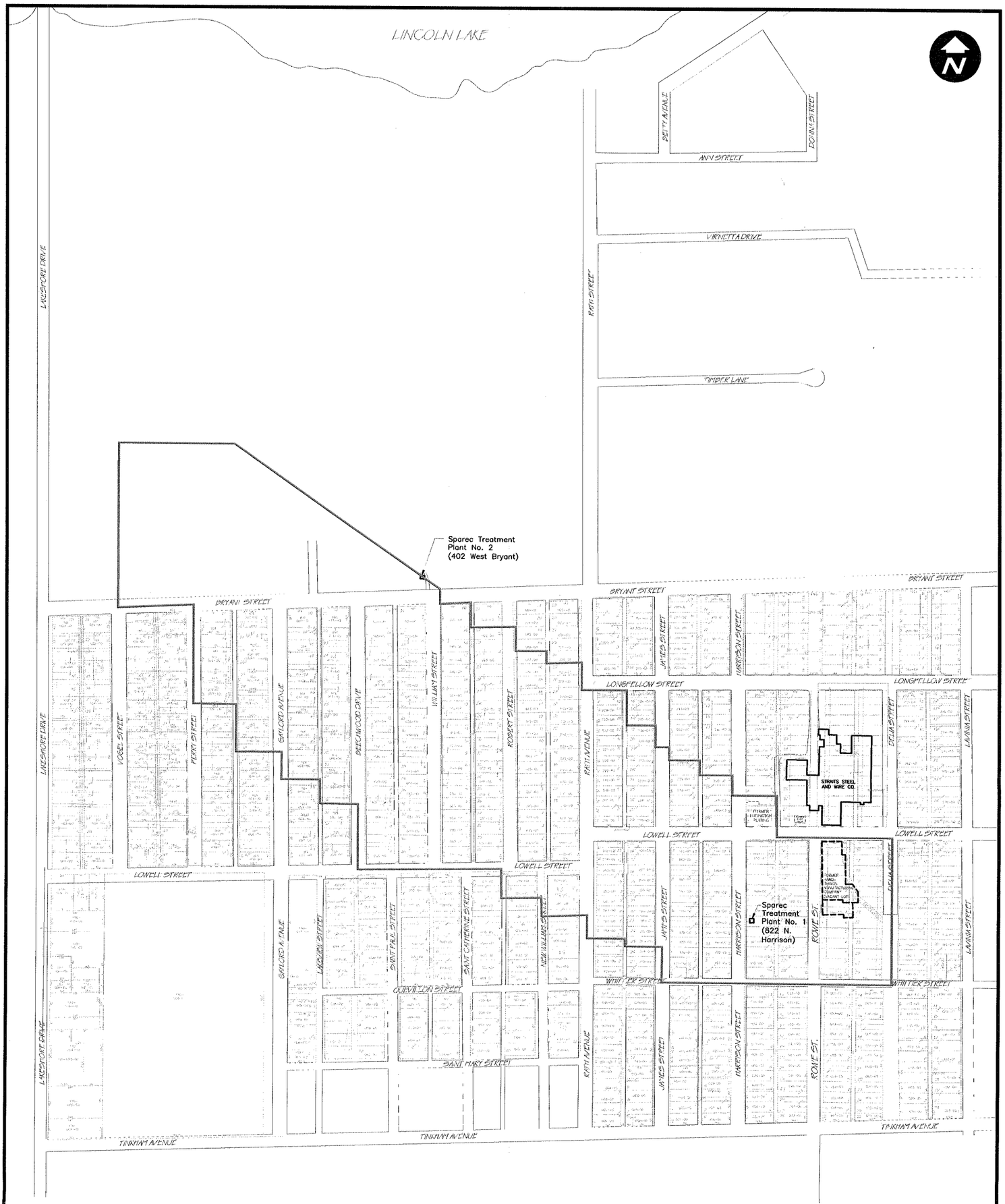
ARCADIS

Appendix B

Summary of CVOCs to be Analyzed
by USEPA Method 8021B

Summary of VOCs To Be Analyzed Per EPA Method 8021B
Ludington Plating Company
Ludington, Michigan

Analyte	CAS Number	Method
trans-1,3-Dichloropropene	10061-02-6	SW846 8021B
Trichlorofluoromethane	75-69-4	SW846 8021B
Methylene chloride	75-09-2	SW846 8021B
1,1,2,2-Tetrachloroethane	79-34-5	SW846 8021B
Tetrachloroethene	127-18-4	SW846 8021B
1,1,1-Trichloroethane	71-55-6	SW846 8021B
1,1,2-Trichloroethane	79-00-5	SW846 8021B
Trichloroethene	79-01-6	SW846 8021B
Vinyl chloride	75-01-4	SW846 8021B
1,4-Dichlorobutane	110-56-5	SW846 8021B
Bromodichloromethane	75-27-4	SW846 8021B
Bromoform	75-25-2	SW846 8021B
Bromomethane	74-83-9	SW846 8021B
Carbon tetrachloride	56-23-5	SW846 8021B
Chlorobenzene	108-90-7	SW846 8021B
Dibromochloromethane	124-48-1	SW846 8021B
Chloroethane	75-00-3	SW846 8021B
2-Chloroethyl vinyl ether	110-75-8	SW846 8021B
Chloroform	67-66-3	SW846 8021B
Chloromethane	74-87-3	SW846 8021B
1,2-Dichlorobenzene	95-50-1	SW846 8021B
1,3-Dichlorobenzene	541-73-1	SW846 8021B
1,4-Dichlorobenzene	106-46-7	SW846 8021B
Dichlorodifluoromethane	75-71-8	SW846 8021B
1,1-Dichloroethane	75-34-3	SW846 8021B
1,2-Dichloroethane	107-06-2	SW846 8021B
1,1-Dichloroethene	75-35-4	SW846 8021B
cis-1,2-Dichloroethene	156-59-2	SW846 8021B
trans-1,2-Dichloroethene	156-60-5	SW846 8021B
1,2-Dichloropropane	78-87-5	SW846 8021B
cis-1,3-Dichloropropene	10061-01-5	SW846 8021B



0 220FT 440FT

LEGEND

RESTRICTED AREA

Area Manager	
Project Director	P. DIRECTOR
Task Manager	T. MANAGER
Technical Review	T. REVIEW

ARCADIS
28550 Cabot Drive, Suite 500
Novi, Michigan 48377
Ph: 248.994.2240 Fx: 248.994.2241
www.arcadis-us.com

INDUSTRIAL PLATING AREA

ATTACHMENT E

LUDINGTON, MICHIGAN

Project Number	MI000951.05.01
Date	13-NOV-09
Figure Number	1