000039

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May 11, 1997

Via Hand Delivery

Nola Hicks, Esq.
U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

Re: Formal Dispute Resolution - Statement of Position
Motor Wheel Disposal Site

Dear Ms. Hicks:

Enclosed is the Statement of Position of the Settling Defendants to the Motor Wheel Disposal Site Consent Decree.

Very truly yours,

John W. Kampman

cc: Charles Graff (w/encls.)
Rob Franks (w/encls.)
Heather Nelson (w/encls.)
Richard Beal (w/encls.)

Settling Defendants - Statement of Position
Motor Wheel Disposal Site – May 11, 1999

The Goodyear Tire & Rubber Company, Textron, Inc., and WR Grace & Co. - Conn. (collectively "Settling Defendants"), hereby invoke the formal dispute resolution process provided by Section XX of the Consent Decree for the Motor Wheel Disposal Site ("MWDS"). Settling Defendants are invoking the formal dispute resolution process in response to Region V's October 1, 1998, demand for stipulated penalties ("Demand Letter"), and submits this document as the Statement of Position in accordance with paragraph 63(a) of the Consent Decree. The formal dispute resolution process should proceed under paragraph 65 of the Consent Decree.

The Settling Defendants invoked informal dispute resolution on November 2, 1998, and submitted an informal negotiation position paper on November 17, 1998 ("November Letter"). The November Letter is adopted by reference and is enclosed as Attachment I. Region V responded to the November Letter by correspondence dated February 16, 1999 ("February Letter"). Settling Defendants replied to the February 16th Letter by letter dated April 9, 1999 (the "April Letter"). The April Letter is adopted by reference and is enclosed as Attachment II. The informal negotiation period under Section XX of the Consent Decree concluded on April 27, 1999.

As an introductory matter, Setting Defendants request that the Agency reconsider its demand for stipulated penalties. The ostensible purpose of stipulated penalties is to assure that obligated parties will perform specifically listed obligations within specified time frames. In this case, the Consent Decree is unambiguous as to its inapplicability. Stipulated penalties can only be invoked for failure to meet a schedule required by the Consent Decree. No such schedule has been exceeded by the Settling Defendants. Further, the events which Region V has alleged are the basis for stipulated penalties occurred in large part, because the Settling Defendants completed installation of certain components of the remediation system almost a year earlier than required by the Consent Degree. Finally, the groundwater treatment and extraction system, including the reduced summer pumping, complies with the Consent Decree and all applicable laws. The Agency's demand is requiring both the Settling Defendants and Region V to expend considerable time and resources to resolve the matter, time and resources that the Settling Defendants believe would be better spent focused on the MWDS remediation. Therefore, we respectfully request that Region V review this statement of position, and rescind the Agency's demand for stipulated penalties.

I. The Agency's Demand for Stipulated Penalties Is Not Authorized By The Consent Decree

Section XXI of the Consent Decree allows Region V to demand stipulated penalties as "set forth in Paragraphs 68 and 69 . . . for failure to comply with the requirements of this Consent Decree specified below." Consent Decree at ¶67. Plainly the Consent Decree does not provide for stipulated penalties for all actions, or failures to act, that may be a violation of the Consent Decree. The Agency may assess stipulated penalties only for violations of certain "specified" requirements, and only in accordance with paragraphs 68 and 69.[1]

The Demand Letter states as the basis for stipulated penalties that "[p]aragraph 68 of the Consent decree provides [for] stipulated penalties for failure to complete ground water treatment." The Demand Letter does not accurately reflect the Consent Decree. Paragraph 68 provides for stipulated penalties only when a failure to complete certain components of the remedial action, including the ground water treatment component, results in "noncompliance with the schedules in the SOW and the . . . RA Work Plan." (emphasis added).[2] Thus, before stipulated penalties can be assessed for "failure to complete groundwater treatment," Region V must be able to show that the ground water treatment component of the remedial action was not completed in accordance with the schedule for that component set forth in the SOW or RA Work Plan.

The alleged "failure to complete ground water treatment" is the only violation for which the Demand Letter seeks stipulated penalties. The facts demonstrate that the Settling Defendants have met the schedule and there has been no failing in meeting the construction timetable set forth in the SOW or RA work plan. By letter dated July 25, 1997, Region V approved the Final Design Report the Settling Defendants submitted for the MWDS, including the design submitted for the groundwater treatment component of the remedial design. Thereafter, all facets of the groundwater treatment component of the remedial design were completed in full compliance with all applicable schedules in the SOW and the RA Work Plan.

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[1] This conclusion does not leave U.S. EPA without a remedy for violations of Consent Decree requirements that are not specified in Section XXI. For example, pursuant to Section XXII the Agency has reserved the right to assert claims "based on a failure by the Settling Defendants to meet a requirement of this Consent Decree." *See* Consent Decree at ¶79.

[2] The language Paragraph 68 limiting stipulated penalties to a violation of a schedule, is consistent with Agency guidance and other documents that indicate stipulated penalties are appropriate for "clearly definable events" such as schedules, interim and final milestones, and reporting requirements. *See Guidance on the Use of Stipulated Penalties in Hazardous Waste Consent Decrees*, U.S. EPA, Office of Enforcement and Compliance Monitoring 1987; Memorandum, *Use of Stipulated Penalties in EPA Settlement Agreements*, U.S. EPA, Office of Enforcement and Compliance Monitoring, January 1990, James Strock, Asst. Administrator.

Nothing in the administrative record supports a conclusion that the Settling Defendants did not complete the groundwater treatment component in accordance with a schedule in the SOW or RA Work Plan. Indeed, the ground water treatment component of the remedial action was completed and has been operating since November 1997. The language of the Consent Decree is clear and unambiguous: stipulated penalties are allowed only in certain specified circumstances that do not exist in this case. Thus, the Consent Decree does not provide Region V with authority to assess the stipulated penalties the Agency has demanded.

Further, Region V cannot claim that stipulated penalties may be assessed because the Settling Defendants have failed to meet a remediation objective or performance standard applicable to groundwater. There is nothing in the Consent Decree, SOW, or RA Work Plan that establishes a schedule for when the Settling Defendants must achieve groundwater remediation objectives or performance standard. In fact, paragraph 12 of the Consent Decree contains the only timing reference pertaining to achieving groundwater remediation objectives. That paragraph provides a mechanism whereby the Settling Defendants may, after ten years of groundwater extraction and treatment, submit evidence to the Agency that it is technologically impractical to meet groundwater standards. The submission may serve as the basis for a petition to "Region V to waive compliance with Ground Water Cleanup Standards." Thus, the only mention of time in the Consent Decree relates to the possibility that the groundwater standards may be not achievable. Therefore, stipulated penalties may not be assessed on the grounds that the Settling Defendants failed to meet a groundwater performance standard or remediation objective.

Even if the language of the Consent Decree was ambiguous, applicable law prohibits the assessment of stipulated penalties in this circumstance. In a similar case, where the parties disputed the meaning of stipulated penalty provisions of a consent decree, the Sixth Circuit held that any ambiguity in such provisions should be strictly construed against assessing the stipulated penalties. *See United States v. National Steel Corp.*, 767 F.2d 1176, 1184 (6th Cir. 1985). The Sixth Circuit reasoned in that case that the stipulated penalties were like forfeitures, and stated: "If there was any ambiguity about the matter, we would in all events be inclined to apply the general proposition that ***equity and the law abhor forfeitures, and that forfeitures are to be strictly construed.***" 767 F.2d at 1184 (emphasis added). The Sixth Circuit applied this principle to reject the position of the United States that a higher amount of stipulated penalties should be assessed against National Steel Corporation. *Id.* The Sixth Circuit ruled against the United States despite acknowledging that the United States' position "represents a rational explanation of what might have been its subjective intent in entering into the consent agreement." *Id.*

II. Region V's Demand for Stipulated Penalties is Inappropriate and Inconsistent with Settling Defendants' Cooperation and Remediation Efforts

The Demand Letter alleges that stipulated penalties have accrued, and summarizes certain events and communications as support. Settling Defendants contend that a more complete summary and description of those facts as well as other events and communications that have occurred over the last two years, as set forth below, will demonstrate that stipulated penalties are not appropriate.

- Under the terms of the Consent Decree, the Settling Defendants must implement the remedial action set forth in the Record of Decision ("ROD") for the MWDS . The primary remedial measures called for by the ROD included a groundwater extraction and treatment system ("Groundwater System"). Under a 1992 Administrative Order on Consent ("AOC") the Settling Defendants prepared the remedial design for the remedial action. Under the AOC the Settling Defendants were required to submit a Preliminary Design (30%), a pre-Final Design (95%), and a Final Design (100%). The Preliminary Design was submitted in July 1996, and the pre-Final Design was submitted in December 1996.

- The Settling Defendants received Region V Comments on the pre-Final Design (95% design) in February 1997. The Settling Defendants responded to the Agency's comments and submitted the Final Design in April 1997. Approximately one month later, in May 1997, the surface water quality division of the Michigan Department of Environmental Quality ("MDEQ") provided the limits for the permit that would be applicable to the surface water discharge from the Groundwater System. As a result of the limits set for the summer months, the discharge called for by the Final Design that Region V was reviewing would exceed permit requirements for three months of each year.

- Immediately after the problem caused by the summer discharge limits was identified, the Settling Defendants and Region V met to discuss alternative solutions. The Settling Defendants submitted a proposal dated May 23, 1997, that called for reduced pumping of the Groundwater System during the summer months as a way of complying with MDEQ discharge limits. The Settling Defendants also discussed with the individual who was then the Region V remedial project manager ("RPM") several other alternatives that included the rerouting of the discharge from the Groundwater System to a nearby "pit" during the summer months. While the Settling Defendants understood that Region V would fully consider all of the alternatives being discussed, the RPM indicated that the alternative involving discharge to the pit was an attractive and viable alternative.

- In May 1997 the Settling Defendants understood that the Final Design had not yet been approved, and the summer months discharge problem had not been resolved. However, the Settling Defendants and the Agency were cooperating fully, and the Settling Defendants, and we believe Region V, expected that remaining issues would be resolved quickly. To ensure that the Groundwater System could be completed during the 1997 construction season, the Settling Defendants elected, with Region V verbal concurrence, to begin construction in May of 1997. At the same time, Region V was still in the process of reviewing the Final Design, well aware of the fact that the Final Design did not address the summer months discharge problem.

- In July 1998 Region V approved the Final Design *knowing full well* that the Groundwater System was not capable of complying with the newly issued summer months permit discharge limits. The Settling Defendants received Region V's approval of the Final Design in July 1997.

- The Groundwater System was constructed and began operations in November 1997. In a letter dated March 9, 1998, Region V denied the proposal the Settling Defendants submitted in May 1997 that called for reduced pumping during the summer months. The letter stated that a design for another alternative was to be submitted to the Agency by April 30, 1998, for review and comment. The letter specifically mentioned the possibility that the design to be submitted might be a design for the alternative the Settling Defendants had been told was favored by a prior RPM,[3] *i.e.*, discharge to a nearby pit. On April 30, 1998, the Settling Defendants submitted a design for discharging to the pit.

- To ensure that the permit discharge limits would not be exceeded during the summer months, in June 1998 the Settling Defendants requested Region V approval to install the piping necessary to effectuate discharge to the nearby pit. The Agency verbally approved the piping installation as proposed, but cautioned that the design for discharge to the nearby pit had not been approved. In June 1998 the Settling Defendants submitted additional technical documents supporting the proposed discharge to the nearby pit. On July 1, 1998, the proposal to discharge to the nearby pit was still being considered by Region V. The Groundwater System had been constructed in accordance with the Final Design, and did not address the summer discharge problem. Therefore, Settling Defendants were faced with a difficult dilemma: reduce pumping from July 1, 1998, until September 30, 1998, or exceed limitations imposed by the Settling Defendants discharge permit.

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[3] Because of people leaving the Agency, during the time period leading to the events that are the subject of the Demand Letter, three different individuals were named as the remedial project manager for the MWDS. Settling Defendants believe that the lack of continuity resulting from the RPM changes contributed to misunderstandings that arose between the Settling Defendants and the Agency with regard to likelihood that the discharge alternatives proposed by the Settling Defendants would be approved.

- By letter dated July 17, 1998, the Agency notified the Settling Defendants that Region V would not approve the proposed discharge to the pit. A July 21, 1998, letter requested that the Settling Defendants submit by July 31, 1998, "a final determination for the resolution of the current pumping scenario" at the MWDS.

Settling Defendants contend that the above chronology demonstrates that Agency's demand for stipulated penalties is inappropriate for the following reasons.

A. The Settling Defendants' expedited work facilitated remediation effectiveness, and will reduce the time that might otherwise have been required to reach the cleanup criteria.

The above chronology demonstrates clearly that the Settling Defendants' remediation efforts advanced the schedule required by the Consent Decree by at least 12 months. For example, the Final Design Region V approved on July 25, 1997, did not require the Settling Defendants to submit a work plan for the remedial action until September 25, 1997. This was far too late in the season for construction of the Groundwater System to have begun in 1997. Thus, under the Consent Decree the Settling Defendants would not have had to start construction of the Groundwater System until the spring of 1998; operation would not have begun until the fall of 1998, well after the summer months' discharge limitations would have been in effect. The Project Timeline contained in Exhibit C to the November Letter, Attachment I, shows the schedule required by the Consent Decree along with the schedule achieved by the Settling Defendants.

For this reason, -- the Groundwater System, and therefore groundwater treatment is a year ahead of schedule. Stipulated penalties for failure to meet an obligation that was not due for an additional year is both unauthorized and inappropriate.

Moreover, as the result of the Settling Defendants' expedited and substantial efforts, the Groundwater System was in operation in November 1997, and the system was operated for most of the almost eight months before July 1, 1998. The system was controlling the groundwater plume and removing contaminants almost a year earlier than the required schedule in the Consent Decree. Further, the eight months of operation also allowed the Settling Defendants to develop considerable information about the aquifers being remediated, as well as operational and effectiveness information about the remediation systems. Thus, the Settling Defendants' expedited efforts had a highly beneficial effect on remediation effectiveness, and will reduce significantly the time that might otherwise have been required to reach the cleanup criteria required by the Consent Decree.

B. Actions by the Settling Defendants following the initial receipt of the summer permit discharge limits were the result of Settling Defendants and Region V expectations regarding the alternatives the Settling Defendants had proposed.

The problem created by the new permit limitations had not been resolved when the Settling Defendants began construction of the Groundwater System. However, based on discussions with the Agency, the Settling Defendants expected that one of the alternatives the Settling Defendants had proposed to Region V would be approved and resolve the problem. Further, we believe the record is indisputable that Region V shared those expectations because the Agency approved the Final Design after Region V became aware of the permit limitation problem. In fact, the Final Design was completed and submitted before the permit discharge problem had been identified. Thus, Region V approved the Final Design *knowing full well* that the system called for by that design was not capable of complying with the newly issued summer months discharge limits.

Region V could not have considered the design that the Agency approved to be viable unless Region V had shared the Settling Defendants' expectations that one of the alternatives the Settling Defendants had proposed would be approved, i.e., the summer discharge problem would be resolved by reduced pumping during the summer months, or discharge to a nearby pit during the summer months. Region V provided no indication to the contrary until it sent the July 17, 1998, letter. Therefore, both Settling Defendants *and* Region V expected that one of the alternatives the Settling Defendants had proposed to Region V would be approved and resolve the problem. The actions taken by Settling Defendants following receipt of Region V's July 17, 1997, approval of the Final Design were the result of those expectations.

C. The Agency's July 17, 1998, letter came too late for the Settling Defendants to install treatment systems, or to arrange for discharge to the local sewer system.

The Agency's letter rejecting discharge to the pit was not sent until July 17, 1998. Importantly, this was the first notice to any Settling Defendant that Region V would reject the proposal to discharge to the pit. Many discussions on this issue occurred during the preceding nine months between Region V and the Settling Defendants and not once did the Agency inform the Settling Defendants that a denial was probable. In its letter of denial, Region V demanded that the Settling Defendants immediately install an ammonia treatment system. Such a system would have involved costs exceeding two million dollars and could not possibly have been engineered, installed, tested, and made operational by September 30, 1998. The July 17, 1998, letter also came too late to allow the Settling Defendants to arrange for discharge to the local sewer system, which is a new alternative that Region V, MDEQ, and the Settling Defendants have agreed to as an interim solution to the discharge problem for the summer of 1999.

IX. The Allegations in the Demand Letter Are Incorrect, Settling Defendants Have Met All Applicable Performance Objectives

Although not relevant to the issue of stipulated penalties, we also respond to Region V's incorrect assertion set forth in the Demand Letter alleges the Settling Defendants have not met other requirements of the Consent Degree, including the requirements of Michigan NREPA Part 201. As stated below, Settling Defendants have not violated the Consent Decree, and have met all applicable remediation objectives. Thus, the Agency has no basis for concluding that the Consent Decree has been violated.

1 The Actions of Setting Defendants did not violate the Consent Decree.

There is no provision in the Consent Decree, or any document incorporated by reference in the Consent Decree that prohibits Settling Defendants from reducing pumping of groundwater in the Glacial Aquifer during the summer. The Final Design provides that the "purpose of the extraction wells is to control and intercept the groundwater contaminant plume, down-gradient of the MWDS." Operations and Maintenance ("O&M") Manual ("O&M" Manual), Appendix A to Final Remedial Design, § 2.1.1, at A-4. The Glacial Aquifer Groundwater Remediation System approved by Region V employs performance-based standards. It is designed to meet the requirements of the ROD. Id., § 1.3, at A-3. The Demand Letter states that the ROD provides that "ground water remèdiation will continue until the cleanup standards . . . are met." ROD, pp. 39-40. Similarly, the Consent Decree provides that the Settling Defendants have an obligation "to achieve the Performance Standards." Consent Decree, ¶12.a.

The groundwater treatment system has been in operation since November 1997. Neither the ROD nor the Consent Decree specify the operational parameters or the systems to be utilized to achieve the groundwater cleanup standards. The Final Design sets forth the general process but it contains neither specific pumping rates at which groundwater must be pumped, nor a requirement of continuous pumping of all extraction wells 365 days/year. Instead, the system was designed and operates to achieve the overall objective of capture of the plume.

The term capture, which is used interchangeably with the term hydraulic capture of the plume, refers to the ability of the groundwater extraction system to contain and ultimately remove unacceptable levels of contaminants in the Glacial Aquifer to prevent the spread of such contaminants from passing from the Glacial Aquifer to the deeper Saginaw Aquifer.

The meaning of the term capture and the requirements under the Consent Decree to achieve capture are clarified in Section 5.0 of the O&M Manual which is entitled: "SYSTEM PERFORMANCE EVALUATION." It provides that there "are two categories of performance: treatment of contaminated water by the Shallow Tray Air

Stripper and hydraulic capture." O&M Manual, §5.0, at A-15. Section 5.1 then details how hydraulic capture will be evaluated. It contemplates, among other things, adjustments in pumping rates. Id., §5.1, at A-15-A-16:

> Since the interceptor well network is a dynamic system, individual well pumping rates are subject to change over time based on changes in the saturated thickness of the aquifer, degradation of well efficiencies, and system improvements. Therefore, changes in design pumping rates will also be evaluated annually based on ground water table maps and capture zone analysis. The results will be reported as part of the monthly reports.

Id., § 5.1, at A-16. (emphasis added) The pumping rates that appear in the Final Design were not intended to be static. See, e.g., Final Design Report, § 3.1.2, at p. 16 (estimated yields from extraction wells); O&M Manual, § 2.1.1, at A-4-A-5 (estimated pumping rates of extraction wells). They were estimates that were used as a basis for the system design that would be adjusted to meet the needs of the system and to ensure hydraulic capture of the plume. The Settling Defendants have, therefore, adjusted the pumping rates to achieve hydraulic capture of the plume and to ensure compliance with another Consent Decree requirement, i.e., the National Pollutant Discharge Elimination System ("NPDES") Permit. The system design, installation and operation, therefore, expressly contemplate that the system will be refined and reconfigured as necessary, based upon performance monitoring, so as to ultimately achieve and verify the performance requirements, i.e., hydraulic capture, utilizing actual field data for such redesign, reconfiguration and verification.

B. The Groundwater System achieved and maintained capture during the entire period that Region V has questioned the performance of the Groundwater System.

The Settling Defendants have conducted five rounds of quarterly monitoring well sampling and analysis since the start of groundwater purging and treating in November 1997. These sample rounds were conducted in February 1998, May 1998, August 1998, November 1998 and February 1999. This monitoring well testing was performed in accordance with the requirements of the Consent Decree for the purpose of assessing the performance of the groundwater treatment system and determining the effectiveness of the site remedial action.

Figures 1 through 5, attached to this document, show the concentrations of ammonia in the groundwater in the glacial aquifer. Figures 6 through 10 show the concentrations of vinyl chloride. The direction of groundwater flow is to the south, i.e. toward the bottom of the Figures. The areas in the glacial aquifer which have concentrations of ammonia in groundwater above the cleanup standard are shown inside the isoconcentration line for 34 parts per million ("ppm").

The Groundwater System has only been operated for approximately 18 months. Ammonia concentrations were plotted to demonstrate capture because the cleanup standard level of ammonia, the lowest concentration of ammonia being monitored, is elevated sufficiently to discern the effectiveness of the Groundwater System. The effectiveness of the system at much lower concentrations will not become evident for several more years. Vinyl chloride, with a much lower cleanup standard of 2 ppb, is monitored at concentration levels that are almost three orders of magnitude lower than the lowest concentrations being monitored for ammonia. Therefore, it will take a number of years of pumping to reduce vinyl chloride to the level of the cleanup standard. However, the transport and flow characteristics of ammonia through groundwater are essentially identical to other inorganic and organic contaminants, including vinyl chloride, in the plume. Thus, the effect of the Groundwater System on the ammonia plume demonstrates that the system must also be effective for other contaminants.

It can be seen in Figure 2 that the area shown by the 34 ppm isoconcentration line that is to the north of the Zone 1 purge wells has separated from the area that is within the 34 ppm isoconcentration that is to the south of the Zone 1 purge wells. This separation shows that the groundwater containing the contaminant plume, i.e., the area in which ammonia exceeds the cleanup standard, has been captured by the purge wells. The purge wells are holding, i.e. capturing, the groundwater containing the contamination and preventing it from flowing downgradient to the south. This separation continues in Figure 3 showing the August 1998 test results for ammonia. Likewise, Figures 4 and 5 showing the November, 1998 and February, 1999 test results for ammonia also show that the groundwater containing the contamination, i.e. the plume, has separated. Figure 1 does not show separation and capture because the system had not yet achieved this since it had only been operating for three months.

The above graphical depiction of the actual site test results proves that the groundwater contamination plume has been captured and that the capture was maintained during and following the period of time when the pumping rates for wells in Zones 1 and 2 of the Glacial aquifer were reduced during the Summer of 1998 in order to comply with the NPDES Permit limits. The Groundwater System, therefore, achieved capture of the contaminant plume despite the fact that during the summer months of 1998, the Settling Defendants were forced to operate the system at reduced pumping rates so as not to violate NPDES Permit requirements.

C. The Settling Defendants have complied with Michigan NREPA Part 201.

All activities taken pursuant to the Consent Decree must be performed in accordance with applicable federal and state laws, including applicable or relevant and appropriate requirements ("ARARs"). <u>See</u> Consent Decree, ¶7. The Agency asserts that

> The limited pumping scenario does not comply with Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 P.A. 451, as amended which states, "The horizontal and vertical extent of hazardous substance concentrations in an aquifer above the higher of either the concentration allowed by Rule 299.5707 (background) or the

concentration allowed by Rule 299.5709 (human health risk based) shall not increase after initiation of remedial actions to address an aquifer." It has not been demonstrated through groundwater sampling analyses that these cleanup criteria have been met by the system, nor that the groundwater plume will not expand and the contaminant levels will not rise.

Letter from Heather Nelson, U.S. EPA, to Mark Whitmore, Goodyear, dated March 9, 1998, at p. 2 ("March 9, 1998 U.S. EPA Letter").

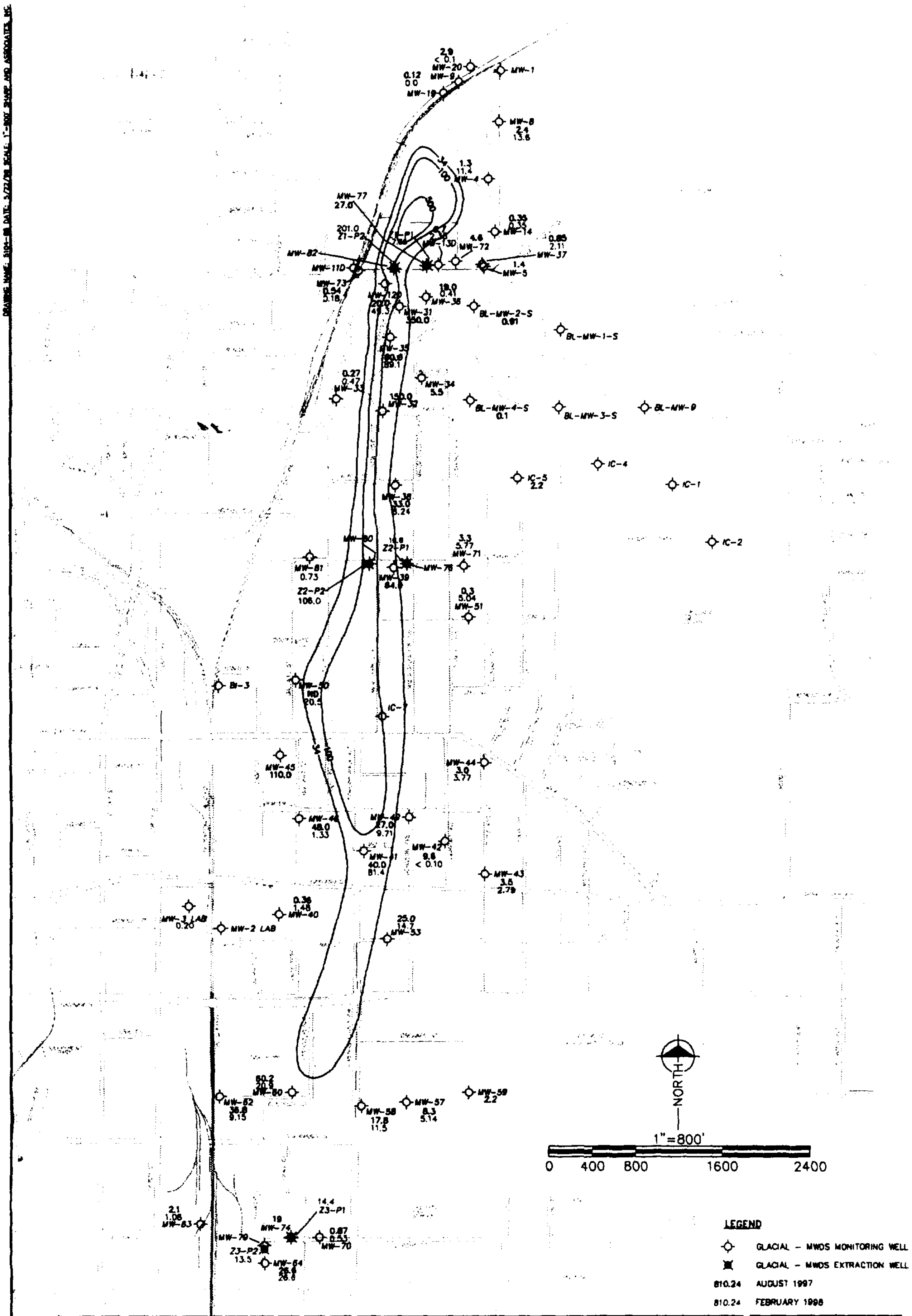
Figures 1 through 10 graphically demonstrate using actual test results that the plume separation was maintained during the period of May 1998 through February 1999 and that the plume did not grow in size. This proves conclusively that the Settling Defendants complied with Part 201. This satisfies the requirements of the Consent Decree.

In summary, the Agency's stipulated penalty demand is unauthorized by the Consent Decree and is inconsistent with the purpose for which the stipulated penalties provision was included in the Consent Decree. Further, Settling Defendants have met their obligations regarding capture, as well as Michigan Part 201 standards.

Settling Defendants would be pleased to meet with you to discuss the Demand Letter, this statement of position, and other issues related to the MWDS, including options to ensure future cooperation and adequate communication.

Respectfully submitted:

Settling Defendants to the Motor Wheel Disposal Site Consent Decree



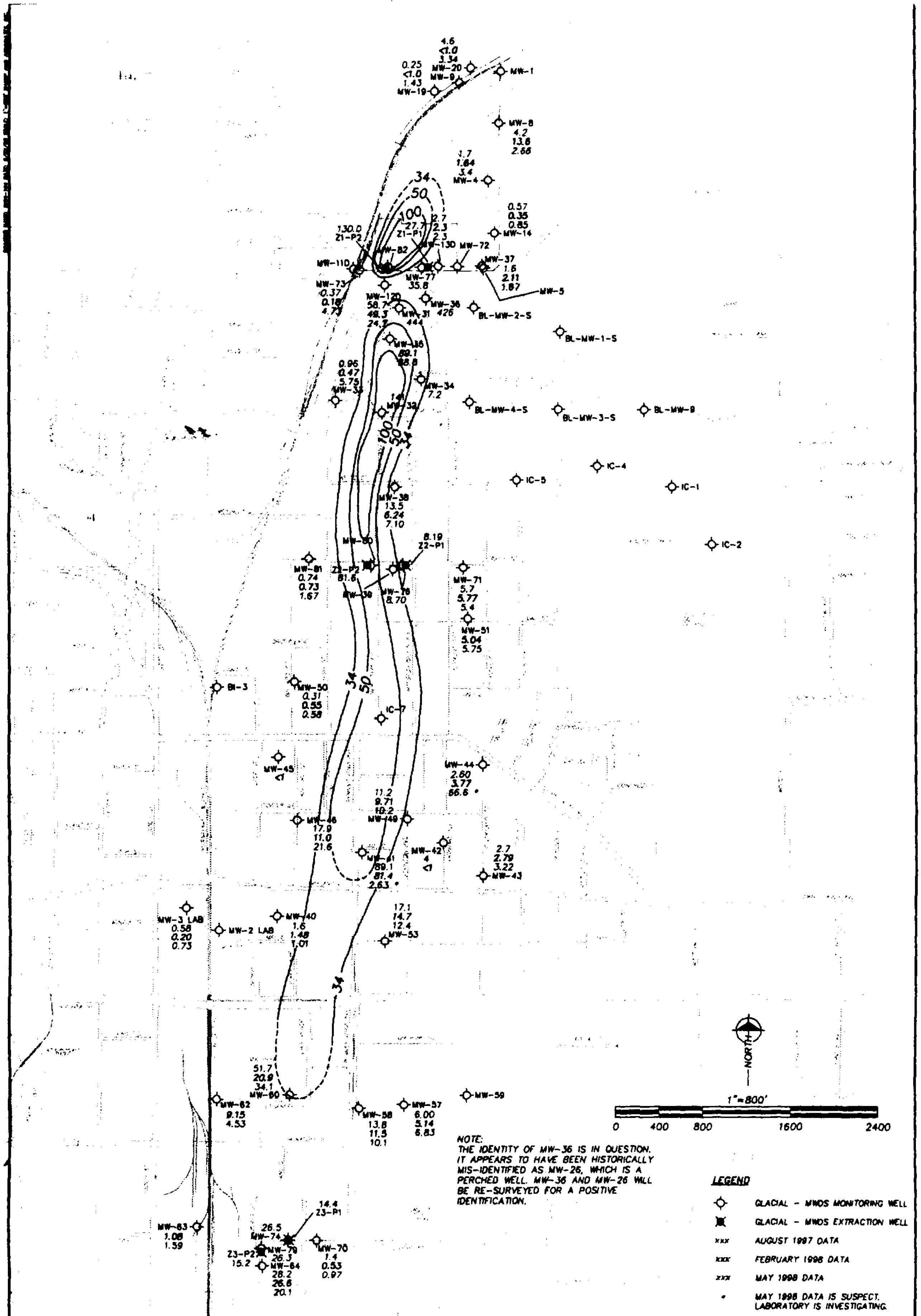
Project Reference: #5104
MOTOR WHEEL SITE DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

1

GLACIAL AQUIFER
AMMONIA ISOCONCENTRATION MAP
FEBRUARY 1998 DATA
vs. 1997 BASELINE COMPILATION

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
982 Crupper Avenue
Columbus, Ohio 43229



Project Reference: #5104

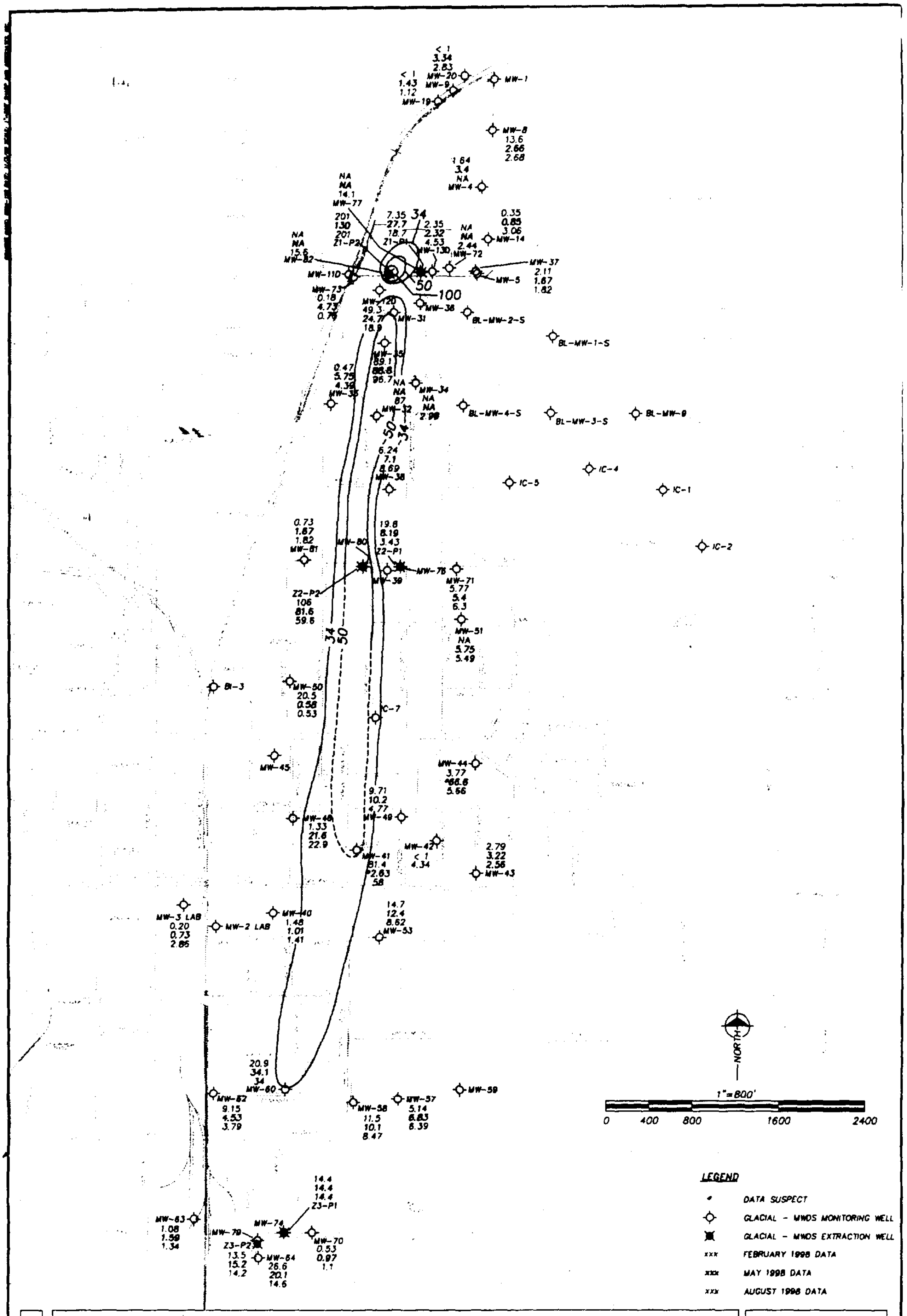
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

2

GLACIAL AQUIFER AMMONIA ISOCONCENTRATION MAP BASELINE MAY 1998

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4696 / FAX (614) 841-4660



Project Reference: #5104

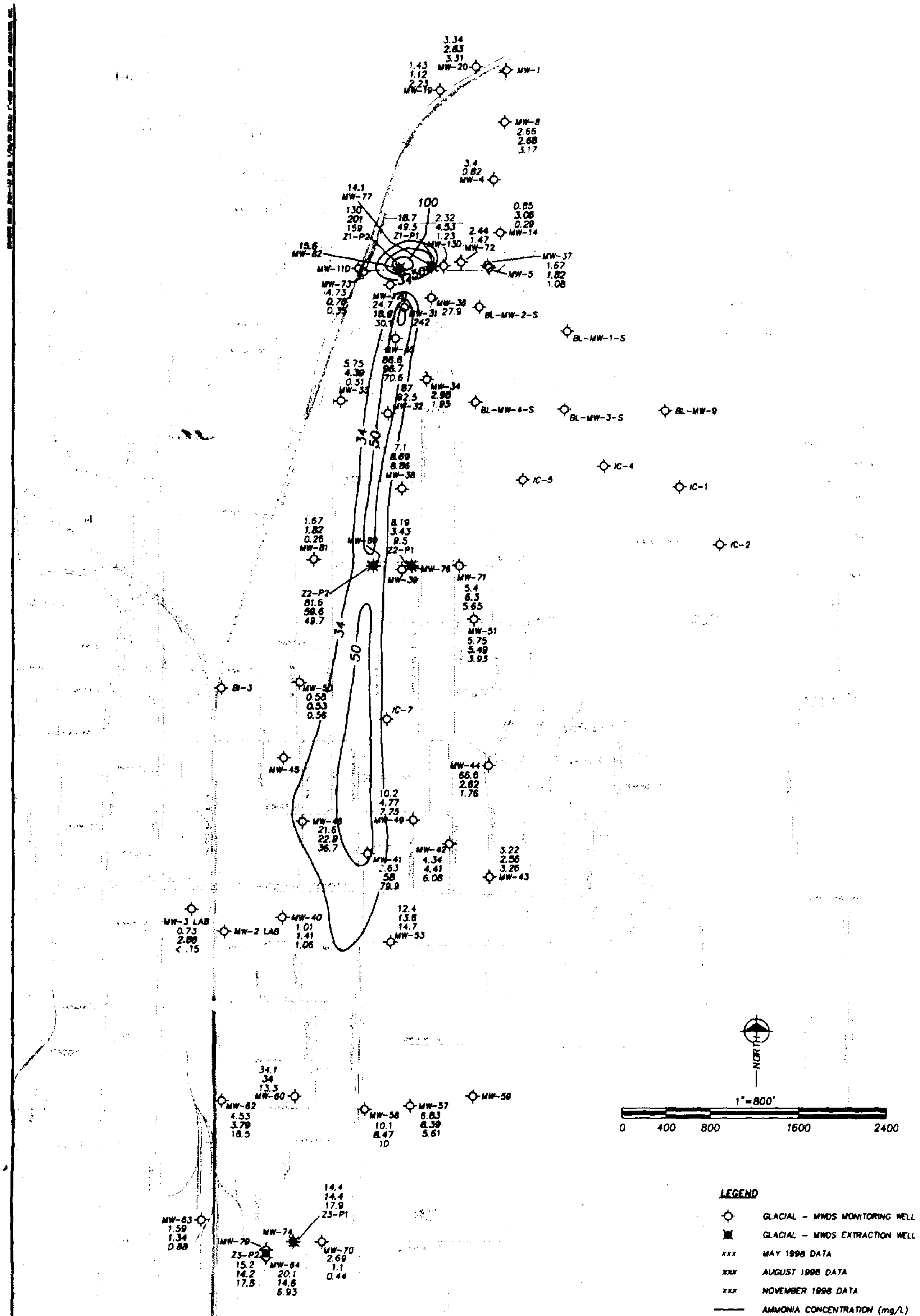
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

3

GLACIAL AQUIFER
AMMONIA
ISOCONCENTRATION MAP
BASELINE AUGUST 1998

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
902 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4650 / FAX (614) 841-4660

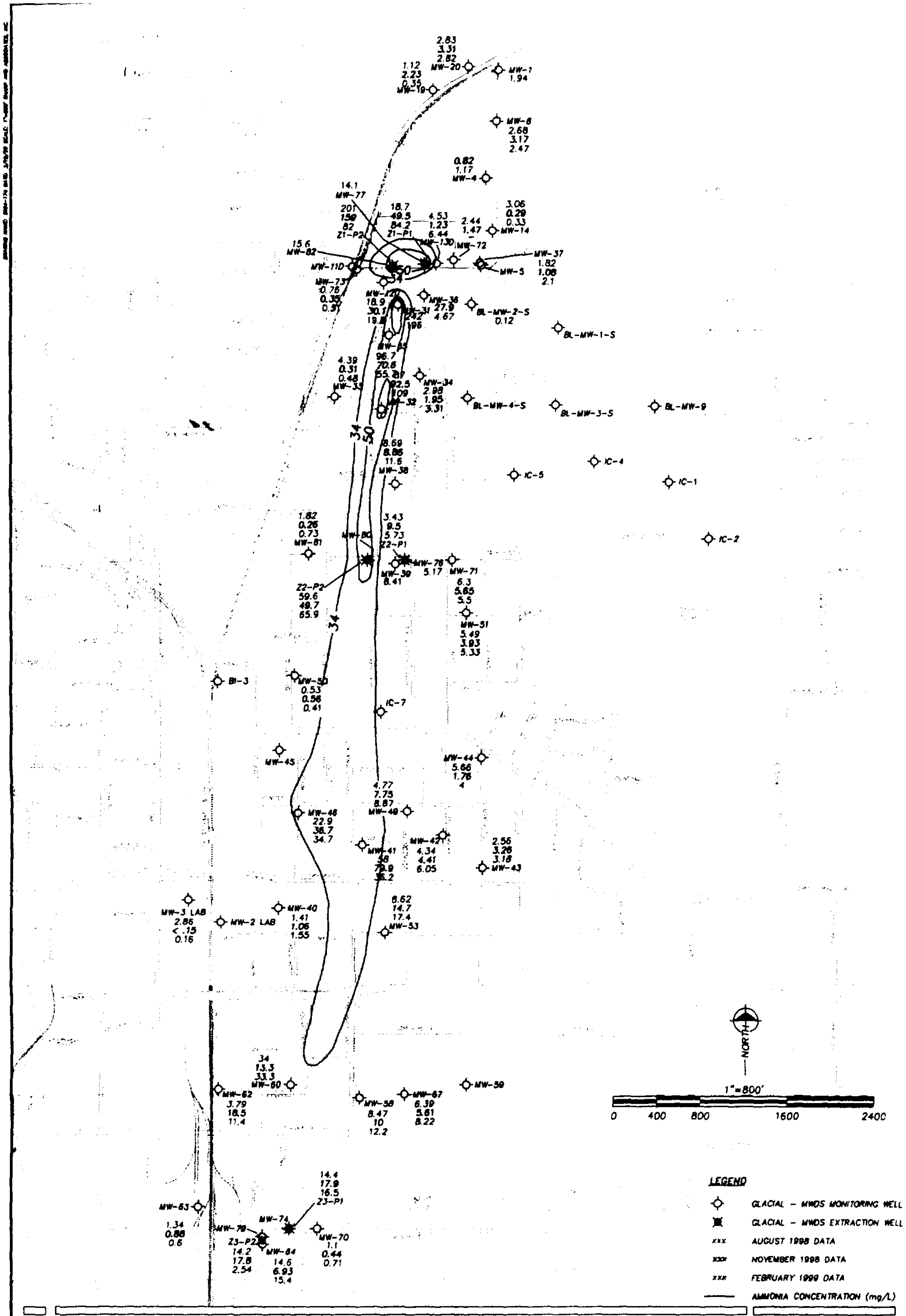


4 GLACIAL AQUIFER AMMONIA ISOCONCENTRATION MAP CONTOURED ON NOVEMBER 1998 DATA

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4659 / FAX (614) 841-4660



5

GLACIAL AQUIFER AMMONIA ISOCONCENTRATION MAP FEBRUARY 1999 DATA

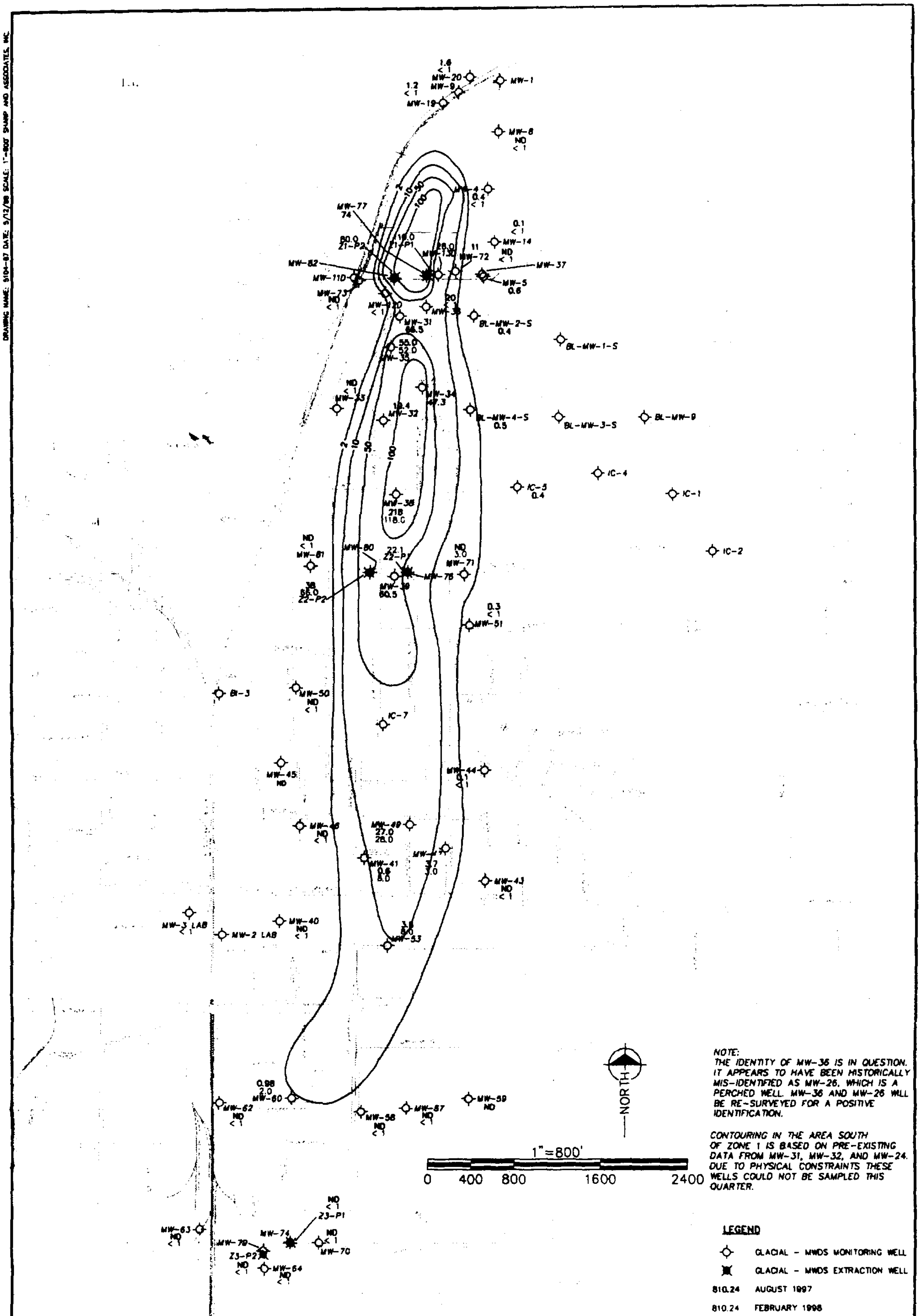
Project Reference: #5104

MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4680 / FAX (614) 841-4660

DRAWING NAME: 5104-87 DATE: 5/12/98 SCALE: 1"=800' SHARP AND ASSOCIATES, INC.



Project Reference: #5104

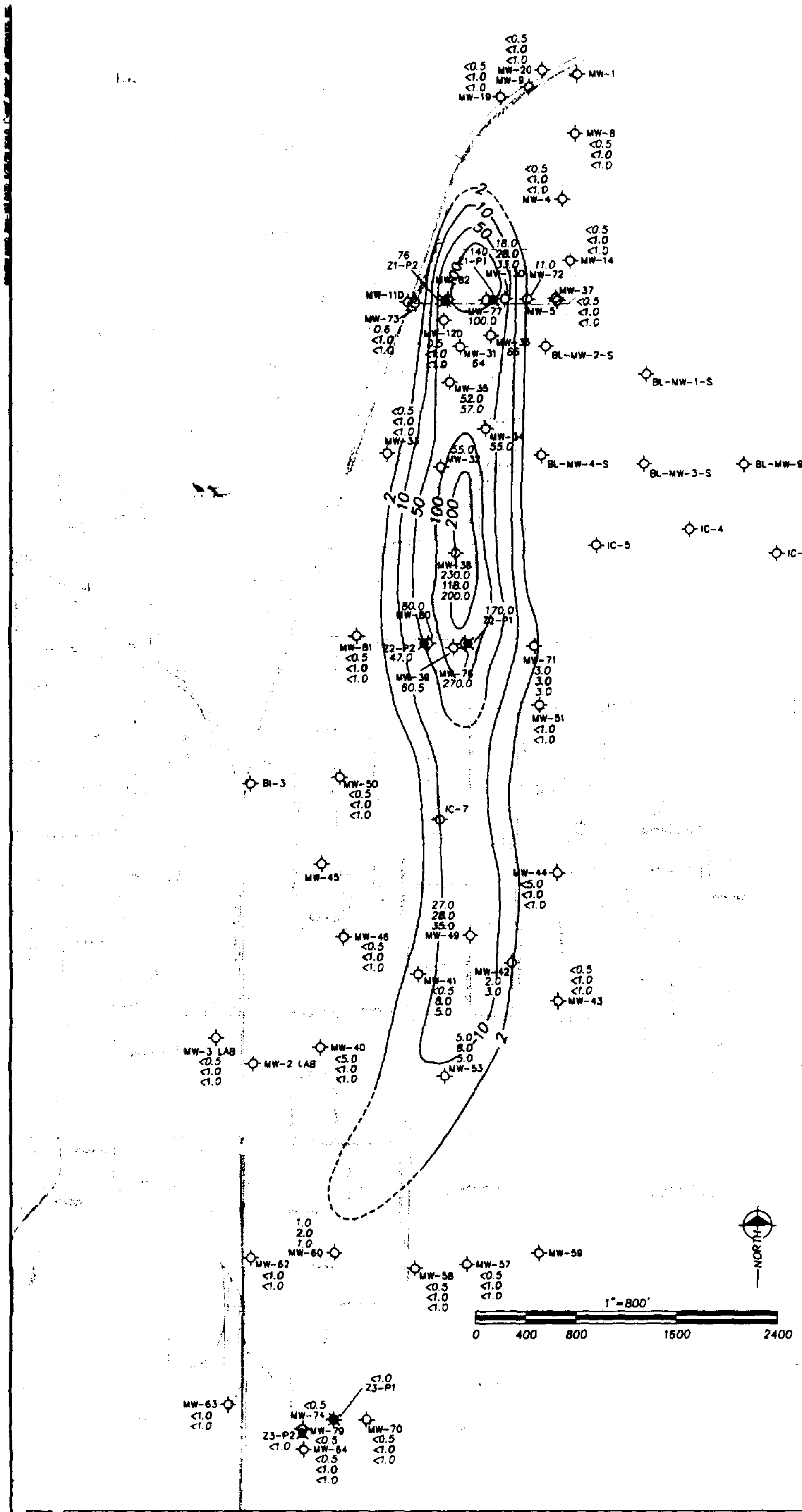
MOTOR WHEEL SITE DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

6

GLACIAL AQUIFER
VINYL CHLORIDE ISOCONCENTRATION MAP
FEBRUARY 1998 DATA
vs. 1997 BASELINE COMPILATION

Client: MOTOR WHEEL PRP GROUP

SHARP
AND ASSOCIATES, INC.
982 Crupper Avenue
Columbus, Ohio 43229



NOTE:
THE IDENTITY OF MW-36 IS IN QUESTION. IT APPEARS TO HAVE BEEN HISTORICALLY MIS-IDENTIFIED AS MW-26, WHICH IS A PERCHED WELL. MW-36 AND MW-26 WILL BE RE-SURVEYED FOR A POSITIVE IDENTIFICATION.

CONTOURING IN THE AREA SOUTH OF ZONE 1 IS BASED ON PRE-EXISTING DATA FROM MW-31, MW-32, AND MW-24 DUE TO PHYSICAL CONSTRAINTS THESE WELL COULD NOT BE SAMPLED THIS QUARTER.

LEGEND

- ⌖ GLACIAL – MWDS MONITORING WELL
- ✱ GLACIAL – MWDS EXTRACTION WELL
- xxx AUGUST 1997 DATA
- xxx FEBRUARY 1998 DATA
- xxx MAY 1998 DATA

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

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GLACIAL AQUIFER VINYL CHLORIDE ISOCONCENTRATION MAP BASELINE MAY 1998

Client: MOTOR WHEEL PRP GROUP

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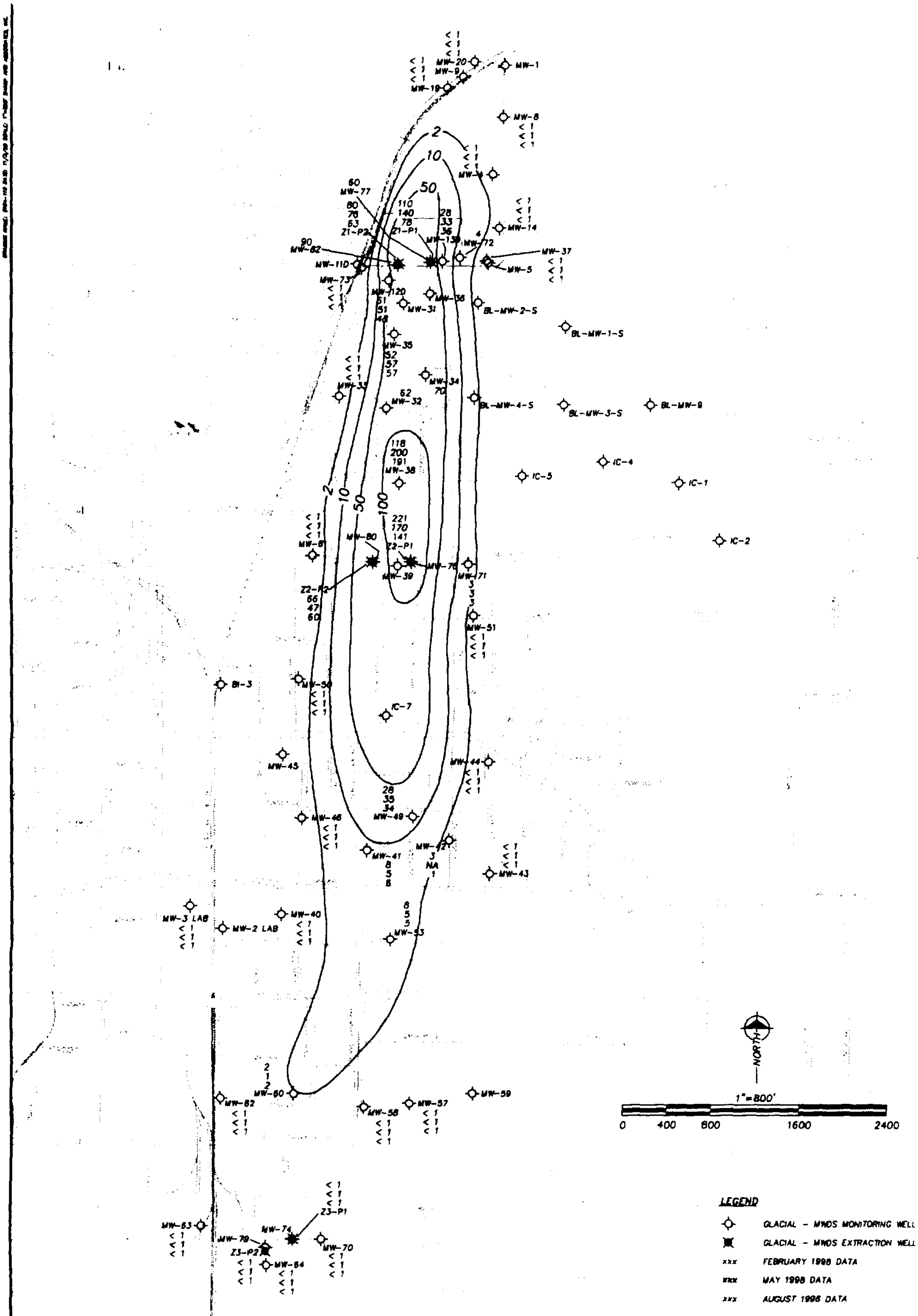

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GLACIAL AQUIFER
VINYL CHLORIDE
ISOCONCENTRATION MAP
BASELINE AUGUST 1998

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

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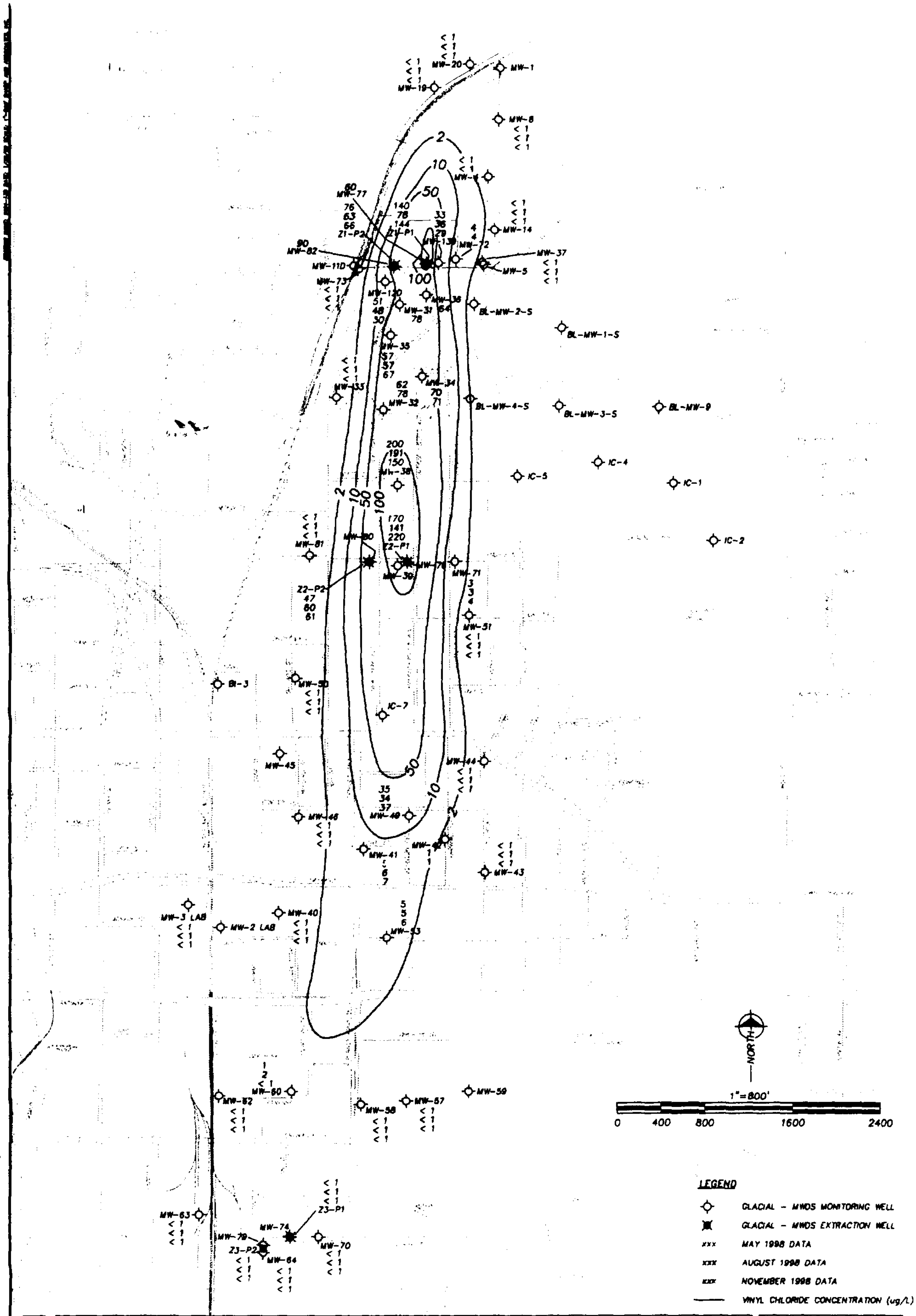

9 GLACIAL AQUIFER VINYL CHLORIDE ISOCONCENTRATION MAP CONTOURED ON NOVEMBER 1998 DATA

Project Reference: #5104

MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

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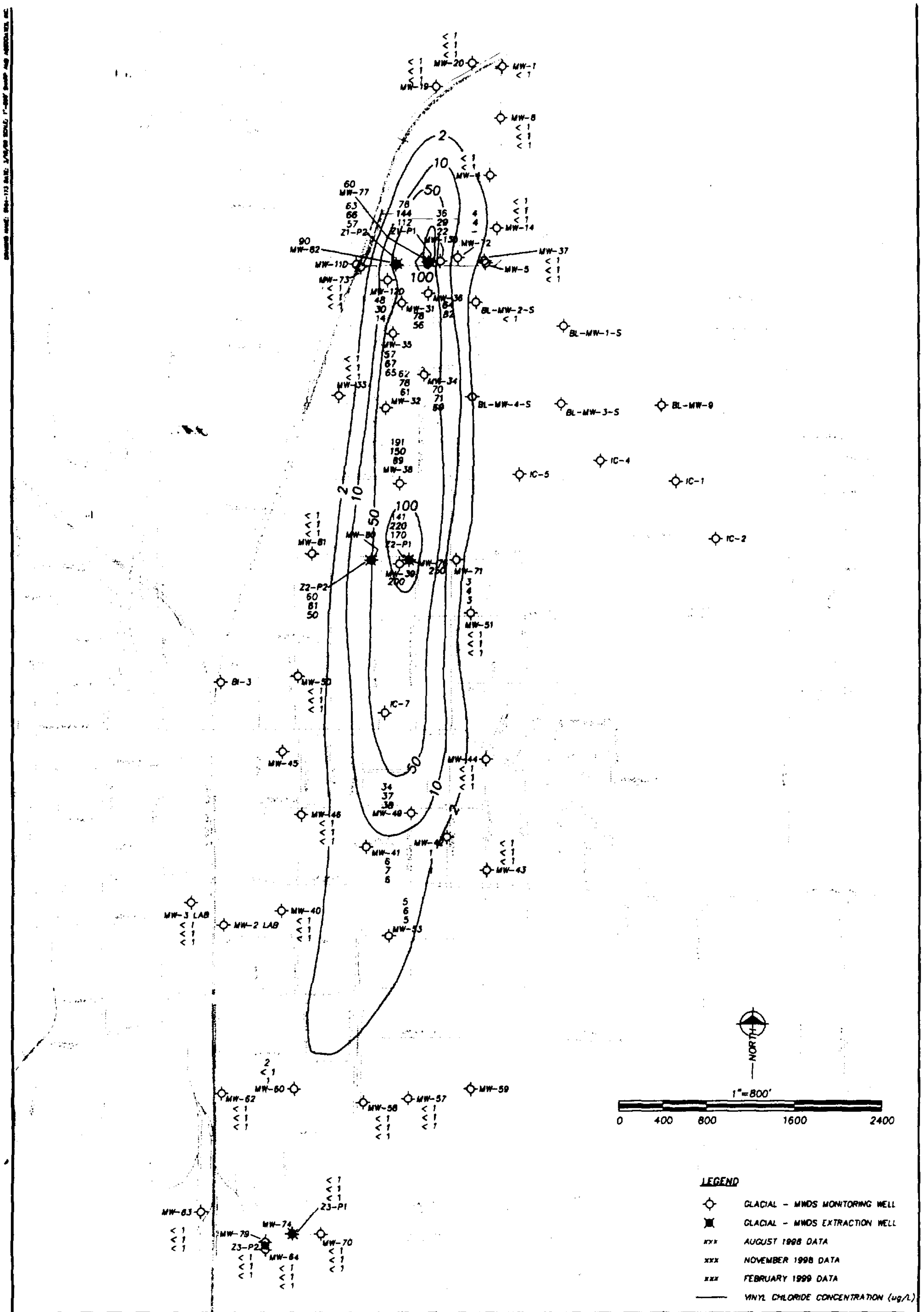

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GLACIAL AQUIFER
VINYL CHLORIDE
ISOCONCENTRATION MAP
FEBRUARY 1999 DATA

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

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ATTACHMENT I

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November 17, 1998

Nola M. Hicks, Esq.
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Chicago, Illinois 60604-3590

Re: <u>Motor Wheel Disposal Site</u>

Dear Ms. Hicks:

I am writing in response to your letter to me dated October 1, 1998 in which the United States Environmental Protection Agency ("EPA") demands payment of stipulated penalties by the Motor Wheel Disposal Site ("MWDS") PRP Group (the "Group") pursuant to paragraphs 68, 71, and 72 of the Consent Decree for alleged violations of the Consent Decree. Your demand letter alleges that reduced pumping of the groundwater extraction and treatment system during the summer months violates the Consent Decree and fails to comply with the Record of Decision ("ROD"); the Remedial Design; and State applicable or relevant and appropriate requirements ("ARARs").

Specifically, your letter alleges that (1) the groundwater extraction and treatment system has not been shown to be capable of maintaining capture of the plume of contaminated groundwater in the Glacial Aquifer and (2) that the groundwater extraction and treatment system is in violation of the Michigan NREPA Part 201 requirement that "the horizontal and vertical extent of hazardous substance concentrations in an aquifer above the higher of either the concentration allowed by Rule 299.5707 (background) or the concentration allowed by Rule 299.5709 (human health risk based) shall not increase after initiation of remedial actions to address an aquifer."

I received your letter on October 5, 1998. The Group notified EPA through its letter dated November 2, 1998 that it was invoking dispute resolution with respect to EPA's claims. This correspondence is submitted as the Group's informal negotiation position paper.

As stated in my correspondence dated July 30, 1998 (copy attached as Exhibit A) and in our meeting on August 25, 1998, the MWDS PRP Group asserts unequivocally that its operation of the groundwater extraction and treatment system, including the reduced summer pumping, complies with the Consent Decree and all applicable laws. This correspondence shows that:

1. The MWDS Group has complied with and will continue to comply with the groundwater extraction and treatment requirements of the Consent Decree and the ROD.

2. The MWDS Group has complied with and will continue to comply with Michigan NREPA Part 201, including Rule 705(5) relating to the control of groundwater contamination.

3. The U.S. EPA's sudden and unexpected demand on July 15, 1998 requiring immediate additional treatment of treated groundwater for the removal of ammonia unilaterally imposed an impossible requirement. This arbitrary and capricious demand exceeded the Agency's authority under the Consent Decree.

4. The MWDS Group is considerably ahead of its required schedule for performing work under the Consent Decree and the Group was not even required under the Consent Decree to perform groundwater extraction and treatment during the July 1 to September 30, 1998 time period. Therefore, it cannot be claimed that the Group failed to comply with any obligation to operate the extraction and treatment system during this time frame.

5. The MWDS Group cannot be held responsible for the payment of stipulated penalties because the Consent Decree expressly provides that stipulated penalties may be assessed for "(f)ailure to complete ... (g)round water treatment (emphasis added)." Groundwater treatment activities are not to be "completed" under the Consent Decree for many years and it cannot be asserted that the MWDS Group is obligated to pay stipulated penalties under this provision.

Applicable Provisions of the Consent Decree.

There is no provision in the Consent Decree, or any document incorporated by reference in the Consent Decree that prohibits the Group from reducing pumping of groundwater in the Glacial Aquifer during the summer. The Final Remedial Design ("FRD") provides that the "purpose of the extraction wells is to control and intercept the groundwater contaminant plume, down-gradient of the MWDS." Operations and Maintenance ("O&M") Manual ("O&M" Manual), Appendix A to Final Remedial Design, § 2.1.1, at A-4. The Glacial Aquifer

Groundwater Remediation System approved by EPA employs performance-based standards. It is designed to meet the requirements of the ROD. Id., § 1.3, at A-3. As you cite in your letter, the ROD provides that "ground water remediation will continue until the cleanup standards . . . are met." ROD, pp. 39-40. Similarly, the Consent Decree itself provides that the Group has an obligation "to achieve the Performance Standards." Consent Decree, ¶12.a. The groundwater treatment system has been in operation since November 1997. Neither the ROD nor the Consent Decree specify the operational parameters or the systems to be utilized to achieve the groundwater cleanup standards. The FRD sets forth the general process but it contains neither specific pumping rates at which groundwater must be pumped, nor a requirement of continuous pumping of all extraction wells 365 days/year. Instead, the system was designed and operates to achieve the overall objective of capture of the plume. The term capture, which is used interchangeably with the term hydraulic capture of the plume, refers to the ability of the groundwater extraction system to contain and ultimately remove unacceptable levels of contaminants in the Glacial Aquifer to prevent the spread of such contaminants from passing from the Glacial Aquifer to the deeper Saginaw Aquifer.

The meaning of the term capture and the requirements under the Consent Decree to achieve capture are clarified in Section 5.0 of the O&M Manual which is entitled: "SYSTEM PERFORMANCE EVALUATION." It provides that there "are two categories of performance: treatment of contaminated water by the Shallow Tray Air Stripper and hydraulic capture." O&M Manual, §5.0, at A-15. Section 5.1 then details how hydraulic capture will be evaluated. It contemplates, among other things, adjustments in pumping rates. Id., §5.1, at A-15-A-16:

> Since the interceptor well network is a dynamic system, individual well pumping rates are subject to change over time based on changes in the saturated thickness of the aquifer, degradation of well efficiencies, and system improvements. Therefore changes in design pumping rates will also be evaluated annually based on ground water table maps and capture zone analysis. The results will be reported as part of the monthly reports.

Id., § 5.1, at A-16 (emphasis added). The pumping rates that appear in the FRD were not intended to be static. See, e.g., Final Design Report, § 3.1.2, at p. 16 (estimated yields from extraction wells); O&M Manual, § 2.1.1, at A-4-A-5 (estimated pumping rates of extraction wells). They were estimates that were used as a basis for the system design that would be adjusted to meet the needs of the system and to ensure hydraulic capture of the plume. The PRPs have, therefore, adjusted the pumping rates to achieve hydraulic capture of the plume and to ensure compliance with another Consent Decree requirement, i.e. the National Pollutant Discharge Elimination System ("NPDES") permit.

The system design, installation and operation, therefore, expressly contemplate that the system will be refined and reconfigured as necessary, based upon performance monitoring, so as to ultimately achieve and verify the performance requirements, i.e., hydraulic capture, utilizing actual field data for such redesign, reconfiguration and verification. The ultimate objective of the MWDS Group is to optimize the system design and operation through this process so that each segment of the system, i.e. Zones 1, 2 and 3, will individually clean up its own zone and prevent migration of contamination to the next zone to speed up the cleanup.

In accordance with this approach, the MWDS Group, based upon the data obtained since the start up of the system, has optimized the pumping rate from Zone 1 during the non-summer months to maintain hydraulic capture of the plume throughout the entire year. The performance of the system and verification of the hydraulic capture of the plume is shown in the enclosed Report titled "Supplemental Modeling Report For The Motor Wheel Disposal Site," dated November 17, 1998, Exhibit B.

The MWDS Group Has Complied with Michigan NREPA Part 201

All activities taken pursuant to the Consent Decree must be performed in accordance with applicable federal and state laws, including ARARs. See Consent Decree, ¶7. The Agency asserts that

> The limited pumping scenario does not comply with Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 P.A. 451, as amended which states, "The horizontal and vertical extent of hazardous substance concentrations in an aquifer above the higher of either the concentration allowed by Rule 299.5707 (background) or the concentration allowed by Rule 299.5709 (human health risk based) shall not increase after initiation of remedial actions to address an aquifer." It has not been demonstrated through groundwater sampling analyses that these cleanup criteria have been met by the system, nor that the groundwater plume will not expand and the contaminant levels will not rise.

Letter from Heather Nelson, EPA, to Mark Whitmore, Goodyear, dated March 9, 1998, at p. 2 ("March 9, 1998 EPA Letter").

As we have explained before and as the attached report further demonstrates, there has been no increase in the "horizontal" or "vertical extent of hazardous substance concentrations above the higher of either the . . . (background) . . . or . . . (human health risk based)" limits during the summer. See Report, Exhibit B. Thus, during the summer when pumping rates were reduced, the PRPs complied with the Part 201 provision cited above. This satisfies the requirements of the Consent Decree.

In summary, EPA has misconstrued the requirements of the Consent Decree by asserting that continuous pumping at specific pumping rates is required. The reduced summer pumping did not violate the Consent Decree because (1) the MWDS Group has satisfied its obligations with respect to capture as explained and demonstrated above, and (2) the size of the zone of groundwater exceeding the Michigan Part 201 standards did not increase. The MWDS Group has therefore complied with the Consent Decree.

<u>The Installation of An Ammonia Treatment System During The Summer of 1998 Was Impossible And The PRPs Had No Choice But To Reduce Summer Pumping To Ensure Compliance With The NPDES Permit.</u>

Your letter of October 1, 1998 omits important events from the chronology that begins with submission of the FRD and ends with the PRPs' decision to reduce summer pumping. In the Spring of 1997, the parties learned that the NPDES permit would severely restrict summer discharges to the Grand River. The PRPs met with EPA and the Michigan Department of Environmental Quality ("MDEQ") on several occasions during the Summer of 1997 to discuss alternatives for meeting the NPDES requirements, which included reduced summer pumping and discharging groundwater to the on-site pit (known as the MSV pit). EPA's Remedial Project Manager ("RPM") at the time, Bob Whippo, was in favor of discharging to the MSV pit. Mr. Whippo was replaced by Alison Kovalcik in January 1998, who in turn was replaced by Heather Nelson in March 1998.

In the Spring of 1997, the Group submitted a reduced summer pumping proposal to EPA to address the issue of NPDES compliance. It took EPA 9 months to act on the PRPs' proposal. In a letter dated March 9, 1998, EPA rejected the reduced summer pumping proposal. March 9, 1998 EPA Letter, at p. 1-2. In the same letter, EPA invited the PRPs to decide between discharging to the MSV pit or treating the groundwater discharge to address the excess ammonia issue and to present a proposal to EPA by April 30, 1998. Id. at p. 2.

The Group submitted the requested design, which proposed summer discharge to the MSV pit on April 30, 1998. The PRPs met with EPA and MDEQ on June 3, 1998. At the meeting, it was EPA's and MDEQ's position that while certain technical details remained to be worked out, there were no objections to the proposal to discharge to the pit in the summer. Towards that end, the PRPs requested authorization to install the piping required to carry out the summer discharge proposal. EPA and MDEQ concurred with the installation with the caveat that summer discharge to the MSV pit was still subject to submission of a performance plan and generic groundwater discharge permit exemption. In June 1998, the PRPs installed the pipeline to the MSV pit.

At a meeting on July 15, 1998, and in a follow-up letter to that meeting dated July 17, 1998, EPA abruptly and unexpectedly changed course by incorrectly refusing to grant final approval to the proposal to discharge to the pit during the summer based upon its claim that such a discharge would not be allowed by Michigan law. The Group responded to EPA's July 17th letter with its correspondence dated July 30, 1998. This correspondence, which is attached to this letter as Exhibit B and is incorporated by reference, sets forth the basis for the Groups's assertion that the proposed discharge to the pit fully complies with all applicable laws.

At the same time that EPA took the position that the Group could not discharge to the pit, it unreasonably, arbitrarily and capriciously demanded that the PRPs immediately install an ammonia treatment system. Such a system would involve extensive equipment, chemical additive handling and storage systems, operating personnel, a building to house all of this and would cost in excess of $2.0 million. The MWDS Group expected the final approval of the summer discharge to the pit. Due to representations made by EPA relating to the viability of the summer discharge proposal, the Group's reliance on such representations, and the timing of EPA's change in position, it was impossible for the PRPs to design, construct and commence operations of an ammonia treatment plant before September 30, 1998.

The EPA's arbitrary and capricious behavior with respect to its demand for the immediate installation of an ammonia treatment system is demonstrated by Ms. Heather Nelson's remarks to Mark Whitmore in a telephone conversation held shortly after the July 15th meeting. In response to Mr. Whitmore's statements regarding the impossibility of the Group's compliance with EPA's demands, Ms. Nelson stated that an ammonia treatment system satisfying EPA's requirements was available "off the shelf." Such is plainly not the case as demonstrated by

EPA's own experience at the Bofors-Nobel Site where EPA reportedly spent one year and $9 million redesigning and modifying the treatment system to provide ammonia treatment.

The EPA's sudden, unilateral demand for the immediate installation of an ammonia treatment system is inconsistent with the procedures required under CERCLA to evaluate the effectiveness, environmental protectiveness and costs of an alternative system.

As a final but not insignificant point to illustrate the lack of consistency, Ms. Nelson's July 21, 1998 letter confuses and contradicts the instructions contained in her July 17, 1998 letter. This July 21st letter states that EPA "...is requesting a final determination for resolution of the current limited pumping scenario....(emphasis added)." This language and the remainder of the July 21st letter backtracks from and contradicts the more specific demands for treatment system installation contained in the July 17th letter leaving the Group with confused and unclear demands.

The MWDS Group Is Ahead of the Schedule Required by the Consent Decree and Can Not Be Assessed Penalties for the Alleged Failure to Perform Work That It Was Not Lawfully Obligated to Perform.

The PRPs object to the unfairness and unreasonableness of EPA's decision to attempt to penalize the Group for reducing summer pumping. From the outset, it should be noted that the Group has been extremely proactive and has enjoyed a very cooperative relationship with EPA and the local community. Based upon this very proactive and cooperative approach, the Group worked tirelessly and at increased expense to implement the remedy a year ahead of schedule. The Project Timeline contained in Exhibit C shows the schedule required by the Consent Decree along with the schedule achieved by the Group. The Group's achievement can be better appreciated by recognizing that the work that it performed in the accelerated time frame involved the capping of the landfill, the construction of the water treatment plant, the installation of eleven monitoring wells, nine extraction wells and three miles of piping through Lansing streets. This work includes the installation of extraction wells and piping for the Saginaw Aquifer which are not even required by the Consent Decree. Furthermore, as will be discussed below, the Group commenced construction of the groundwater extraction and treatment system in May 1997 to accelerate the performance of the work. This cut eleven months off the schedule taking into account the fact that the construction season is limited to the period of April through October. Had the Group not been proactive and ahead of schedule, the groundwater extraction and treatment would not have been required by the Consent Decree until October 1998.

Had the Group waited for final approval and complete resolution of the summer discharge issue (which was pending resolution for ten months) before beginning construction of the groundwater treatment system, construction would not have commenced until the summer of 1998. The PRPs could have waited until the issue was resolved. Instead, the Group pressed ahead in reliance upon EPA's representations and the Group's proactive and cooperative relationship to commence construction and operation of the groundwater treatment system a year ahead of schedule. To penalize the Group because the summer discharge issue was not resolved as anticipated by the parties is patently unreasonable, unfair, arbitrary and capricious.

It is manifestly obvious that the MWDS Group cannot be found to be in violation of a requirement under the Consent Decree that it is not lawfully obligated to comply with until a date after the alleged date of noncompliance.

The Stipulated Penalties Provision at Paragraph 68 of the Consent Decree Is Inapplicable.

The Consent Decree specifies that the Group "shall be liable for stipulated penalties in the amounts set forth in Paragraphs 68 and 69 to the United States for failure to comply with the requirements of this Consent Decree specified below." Consent Decree, ¶67 (emphasis added). Compliance is defined to include "completion of the activities under this Consent Decree or any work plan or other plan approved under this Consent Decree identified below in accordance with all applicable requirements of law, this Consent Decree, the SOW, and any plans or other documents approved by EPA pursuant to this Consent Decree and within the specified time schedules established by and approved under this Consent Decree. Id. (emphasis added). Thus, the United States is not entitled to stipulated penalties for all violations of the Consent Decree; instead it is entitled to stipulated penalties only for certain enumerated violations, namely failure to complete certain response activities on schedule.

Indeed, paragraph 68 is very specific and provides that the Group shall incur stipulated penalties "for any identified noncompliance with the schedules in the SOW and the approved RA Work Plan" relating to completion of "the following components of remedial action: Ground water treatment." Id., ¶68a. As you are aware, the schedule for completion of groundwater treatment in the SOW requires Settling Defendants to continue groundwater treatment "until groundwater cleanup standards are achieved and maintained throughout the plume of contamination." SOW, p. 6.

EPA is not entitled to assess stipulated penalties for such alleged violation. There is no stipulated penalty for reduced groundwater pumping. By its terms, paragraph 68a of the Consent

Decree authorizes EPA to assess stipulated penalties only for the failure to complete groundwater treatment. Given that groundwater treatment is scheduled to occur until groundwater cleanup standards are met, or for a minimum of ten years, whichever occurs later, and given that the PRPs have been operating the groundwater treatment system for approximately one year, the stipulated penalties provision of paragraph 68 is simply inapplicable to the current dispute.

Pursuant to the Dispute Resolution procedures of the Consent Decree, and for the reasons stated herein, the MWDS PRP Group requests that EPA withdraw its demand for payment of stipulated penalties. We look forward to meeting with you on November 23, 1998 per our request.

Very truly yours,

DYKEMA GOSSETT PLLC

David L. Tripp

DLT/md

Enclosures

cc: Heather Nelson (w/Encls.)
Rob Franks (w/Encls.)
Charles Graff (w/Encls.)

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EXHIBIT A

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DAVID L. TRIPP

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July 31, 1998

Via Telecopy and U.S. Mail

Heather Nelson
Assistant Remedial Project Manager
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Protection Agency, Region V
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Chicago, Illinois 60604-3590

Re: Motor Wheel Disposal Site

Dear Ms. Nelson:

This letter responds to your correspondence to Mark Whitmore dated July 17, 1998 and July 21, 1998 and to correspondence to you from Rob Franks dated July 17, 1998 which was forwarded to us by your July 17th letter.

As an initial point, the Motor Wheel Disposal Site Group ("MWDSG") has acted in a responsible and proactive manner to aggressively move the remedial design and remedial action for this site forward and fully cooperate with the U.S. EPA, the MDEQ and the local community. We are surprised and dismayed by the U.S. EPA's recent sudden and radical changes of position which were presented as unequivocal regulatory determinations coupled with demands for responses and commitments by the MWDSG that are totally unrealistic and unreasonable. This approach does not foster cooperation or wise decision making.

This letter is intended to explain our position on the issues you have identified and establish a basis for going forward together in full compliance with the Consent Decree.

Your letter of July 21st requests that the MWDSG provide you by July 31, 1998 with a "final determination for resolution of the current limited pumping scenario at the Motor Wheel Site." Your letter indicates that the U.S. EPA is concerned that the MWDSG may not be in compliance with the Consent Decree because the rate of groundwater extraction and treatment will be reduced during the July 1st to September 30th time period to assure compliance with surface water quality discharge requirements.

The MWDSG emphatically states that it is in full compliance with its Consent Decree obligations because the reduction in groundwater extraction and treatment rates during the summer months has no material impact on the effectiveness or the rate of cleanup of the affected groundwater. This was demonstrated in our submission to Robert Whippo dated May 23, 1997 which was supplemented by later submissions. This was discussed with the U.S. EPA RPM, Robert Whippo, and with MDEQ representatives during meetings on September 11, 1997 and on several other occasions. Furthermore, as will be explained in this letter, the MWDSG's previous proposal to discharge treated groundwater to the pit is consistent with Michigan NREPA Parts 201 and 31.

Mr. Whippo, in response to the information provided by the MWDSG regarding the effectiveness and sufficiency of the proposed groundwater extraction system stated that the U.S. EPA and the MDEQ preferred that the system not operate at a reduced pumping rate in the summer months. He further stated that this should not be an important issue to the MWDSG since maximum rate pumping was apparently feasible and practical through the utilization of the on-site pit as a discharge point during the summer months.

In an effort to resolve this issue in a practical and pragmatic fashion, the MWDSG proceeded with the analysis, engineering and partial installation of the system to convey and discharge treated groundwater to the pit despite the fact that it disagreed with the U.S. EPA and MDEQ position that the reduction in the pumping rate during the summer months was inappropriate.

We were very surprised to learn at our July 15th meeting and through your July 17, 1998 correspondence that the U.S. EPA and the MDEQ have concerns regarding discharges to the pit. Specifically, the U.S. EPA and MDEQ are concerned that the proposed discharge to the pit will not comply with Michigan Part 201 requirements. Your letter references Act 307 Rule 299.5709(1) "Compliance with Type B criteria shall be attained when the conditions specified in subrule (2) are met ... ", and Act 307 Rule 299.5705(5) "the horizontal and vertical extent of hazardous substance concentrations in an aquifer above the higher of either the concentrations allowed by R299.5707 or the concentration allowed by R299.5709 shall not increase after the initiation of remedial actions to address an aquifer, except as approved by the Director."

In the correspondence accompanying your letter, the MDEQ also raised the issue of the compliance of the proposed discharge to the pit with the Michigan Part 22 Groundwater Quality Rules which are administered by the MDEQ under Michigan NREPA Part 31.

The MWDSG believes that its proposed remedial action is in compliance with both the Act 307 Rules you have referenced as well as the requirements under the Part 22 Rules.

With respect to the Rule R299.5709(1), this Rule requires that when the remediation is completed it shall attain Type A or B criteria. The remedial action will attain these criteria and, therefore, the MWDSG is in compliance with this Rule and with the Consent Decree.

With respect to Rule R225.5705(5), the Director of the MDEQ approved and issued on September 19, 1996 a determination titled "Michigan Department of Environmental Quality Exemption For Groundwater Remediation Activities Discharge Within the Plume of Contamination" (the "Exemption Determination"). Condition A.2. of the Exemption Determination states as follows:

> The discharges of pump test water, treated water or groundwater shall be into the contaminated portion of the aquifer being remediated, or directly hydraulically upgradient of the contaminated portion of that aquifer, not to exceed 50 feet upgradient. The discharge shall not change the physical dimension of the plume in the contaminated aquifer, unless such a change will be, or has already been accounted for in the Remedial or Corrective Action Plans. (Emphasis added.)

Condition A.3. of the Exception Determination states in relevant part:

> The discharge for remediation activities shall consist only of treated water or groundwater, or surfactants nutrients and/or microorganisms added to mobilize contaminants in the soil or enhance biodegradation of contaminants. The level of contaminants, surfactants, or nutrients in the discharge may be above the Generic Residential Cleanup Criteria for Groundwater from Part 201 of Act 451, as long as the discharge is part of a treatment system capable of meeting Condition A.9 of this exemption, and not merely the recirculation of contaminated groundwater. (Emphasis added.)

Condition A.9. of the Exemption Determination states in relevant part:

Part 201 of Act 451 - Upon completion of the remediation according to the approved Remedial Action Plan, and concurrence by the MDEQ Division responsible for compliance oversight pursuant to Rule 5607(4) of the Administrative Rules of Part 201, all contaminants present in the groundwater and/or soil shall be less than the Generic Residential Cleanup Criteria for Groundwater from Part 201, according to the approved Remedial Action Plan. Additives and nutrients discharged back to the contaminated portion of the aquifer being remediated shall not exceed nondegradation "Target Effluent Limits" established under Part 31 of Act 451. "Target Effluent Limits" may be obtained from the Groundwater Program Section, WMD.

The Exemption Determination as approved by the Director of the MDEQ, therefore, clearly allows the size of the contaminant plume to increase beyond its original dimensions as a result of the discharge of treated groundwater and also allows the discharge of contaminants above residential drinking water standards provided that the remediation is conducted in accordance with an approved corrective action plan.

We contacted Jim Janiczek and Scott Ross in the Groundwater Program Section of the Waste Management Division and discussed the application of the Exemption Determination. They confirmed the potential applicability of the Exemption Determination to the Motor Wheel Disposal Site and clarified the following points:

1. The "Target Effluent Limits" cited in Conditions A.3. and A.9. apply only to additives and nutrients that are intentionally added to the groundwater discharge as part of a treatment process, e.g., bioremediation additives.

2. If a discharger cannot meet the requirement that the point of discharge be no more than 50 feet upgradient of the plume, the discharger may apply for a site specific exemption rather than the generic exemption. A major consideration in approving a site specific exemption is whether a pristine aquifer will be affected upgradient of the plume. As you know, the aquifer that is upgradient of the Motor Wheel Disposal Site is far from pristine. This aquifer has been contaminated by the Granger Landfill and the City Landfill on Paulson Street. Both of these sites are directly upgradient and the aquifer that flows onto our site is contaminated with trichloroethene ("TCE") at 28 ppb. This TCE contamination is actually captured and remediated by our treatment system. The circumstance of the upgradient aquifer favors the issuance of a site specific exemption.

For all of the above reasons, the MWDSG believes it is in compliance with the Consent Decree and further believes that the proposed discharge to the pit is consistent with the requirements of Michigan NREPA Part 201 and Part 31. As we have stated earlier in this letter, the MWDSG's original proposal to reduce the pumping rate during the summer months fully complies with the Consent Decree and all applicable laws. Additional information on groundwater extraction rates and plume capture modeling has further confirmed the completely equivalent performance of this approach. While the pit discharge approach is also consistent with the requirements of the Consent Decree and applicable laws, this approach adds complexity and costs which are avoidable by utilizing the approach of reduction of the summer pumping rate. For this reason, the MWDSG proposes that this effective and compliant alternative be utilized.

The MWDSG requests a meeting with you and MDEQ representatives to discuss this approach including our responses to questions you raised in your letter dated March 9, 1998. We suggest that this meeting be held at U.S. EPA in Chicago on August 19, 1998.

Very truly yours,

DYKEMA GOSSETT PLLC

David L. Tripp

DLT/md

cc: Robert Franks
Nola Hicks
Mark Whitmore
William Porter
Phil Brown
Takashi Ito
Jamieson Schiff
David Cleary
Todd Struttmann

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ID\DLTR

EXHIBIT B

Supplemental Ground Water Modeling Report for the Motor Wheel Disposal Site in Lansing, Michigan

Prepared for

The Motor Wheel Disposal Site PRP Group

Prepared by:

Sharp and Associates, Inc.
982 Crupper Avenue
Columbus, Ohio 43229

and

Waterloo Hydrogeologic, Inc
180 Columbia Street West - Unit 1104
Waterloo, Ontario, Canada N2L3L3

November 1998

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SUPPLEMENTAL MODELING REPORT FOR THE MOTOR WHEEL DISPOSAL SITE

1.0 INTRODUCTION

SHARP and Associates, Inc. (SHARP) was asked to model and evaluate projected groundwater flow and transport, in response to two issues raised by EPA and MDEQ during the evaluation phase of the system that was installed in 1997. Although final construction of the system was approved in July of 1998, evaluation has continued to determine system effectiveness and overall optimization to the goals agreed upon by the MWDS Group regarding hydraulic capture and cleanup of the Motor Wheel disposal Site. This report summarizes the requested ground water modeling.

Two specific items were at issue. The first relates to questions of capture due to cessation of pumping in Zones 1 and 2 from July through September of each year (henceforth referred to as the "MWDS Summer Pumping Plan"), and, secondly, whether the plume expands laterally or vertically due to the MWDS Summer Pumping Plan, in violation of Part 201 of NREPA. The independently confirmed technical evidence should allay any concerns of the regulators that the Summer Pumping Plan will have a negative impact on the cleanup objectives or the regulatory requirements of the MWDS Group to meet ARARs.

SHARP performed groundwater flow and contaminant transport modeling of the Glacial and Saginaw Aquifers for the purposes of comparing contaminant migration and cleanup times, and comparing transient pumping conditions (reduced pumping in the summer) with steady state pumping conditions (constant pumping from all extraction wells) throughout the year. This modeling confirmed that, despite EPA's reservations, capture of the contaminant plume is maintained when the MWDS Summer Pumping Plan is implemented. Similarly, SHARP's simulations confirm compliance with Part 201 as well.

The MWDS Group also employed Waterloo Hydrogeologic, Inc. (WHI) to evaluate SHARP's results. WHI is a nationally recognized groundwater modeling firm that not only prepares and reviews groundwater models, but also teaches modeling courses and has developed pre and post processing modeling programs for Modflow. Using an independent model, WHI not only confirmed SHARP's conclusions, but they also revealed (due to greater detail inherent in their smaller scale model) a more effective cleanup than SHARP's modeling did. Waterloo confirmed that capture would be maintained with a combined pumping rate of 90 gpm in Zone 1 if the MWDS Summer Pumping Plan was in effect for up to 110 days, well beyond the 90 days envisioned by the MWDS Group.

1.1 Basis of Extraction System Design

The overall design objective of the Glacial Aquifer remediation system (Zones 1, 2, and 3) is that it will remediate the contaminant plume of the MWDS to less than the Consent Decree limits. The primary focus of the treatment system design is to maintain plume capture within the 3-zone system as a whole, recognizing that downgradient migration would occur between Zone 1 and Zone 2, and between Zone 2 and Zone 3 until the contaminants were removed from the aquifer by the extraction wells.

Section 5.1 of the Operations and Maintenance Manual (Revised May 1, 1997) allows for the annual evaluation of pumping rates with subsequent refinements to the system to ensure that the system meets the Part 201 requirements of capture. The results of the modeling as well as the sampling results of the previous three quarters are currently being evaluated within that framework to refine and optimize system performance. The PRP Group recognizes that this process may include balancing the pumpage from the

existing extraction wells or the installation of additional extraction wells, in order to meet the requirements of the Consent Decree.
Plume capture refers to the ability of the groundwater extraction system to contain and ultimately remove contaminants at unacceptable levels in the Glacial Aquifer, and to prevent contamination at unacceptable levels from spreading to the deeper Saginaw Aquifer. Existing concentrations downgradient of the zone of capture can require long time periods to separate from the up gradient portion of the plume due to the minimal hydraulic gradients near the stagnation point. This phenomenon is illustrated in Figure 1: Near zero gradients in the vicinity of the stagnation point, adapted from the Guidelines For Delineation of Wellhead Protection Areas (EPA, 1987). In this figure, the minimal slope in the water table (hydraulic gradient) downgradient of the stagnation point (downgradient edge of the zone of capture) is evident.

Zone 1 Extraction wells were placed at the southern edge of the MWDS property to enable the removal of contaminants, so that the plume could be controlled and restricted from further migration to the south.

Zone 2 Extraction wells were positioned along North Street to control and restrict contaminant migration further south, where it had been identified that leakage was occurring from the Glacial Aquifer into the Saginaw Aquifer.

Zone 3 was positioned by MDEQ and USEPA to be approximately ½ mile downgradient of the leading edge of the ammonia plume as defined by the 34 mg/l regulatory limit. Zone 3 was originally proposed by the MWDS Group to be further upgradient, at the leading edge of the vinyl chloride contaminant plume. The location of the Zone 3 extraction wells (as accepted by MDEQ and USEPA) was therefore intended to allow the ammonia and vinyl chloride contaminant plumes to migrate downgradient prior to capture by the extraction wells.

1.2 History and Progression of the MWDS Model

The groundwater flow simulation was performed using MODFLOW, and is identical with the model submitted January 23, 1998 that is currently under review by the USGS, except for those modifications discussed below. Transport modeling was performed using MT3D (Zheng, 1996).

1.2.1 January 1998 Modification to the Model

The model described in the Final Additional Studies/Preliminary Design Report was modified in two stages. First, it was modified to include the Saginaw Aquifer as an active model layer. A model simulation was performed by the USGS to provide steady-state hydraulic heads in the Saginaw Aquifer for the area covered by the MWDS model. These heads were used to set the constant head boundaries around the perimeter of the Saginaw Aquifer model layer. The simulated heads for the Glacial Aquifer were retained from the MWDS model.

The second stage of modifications was a refinement using site specific geology and aquifer data collected in 1997. These refined data included additional hydraulic conductivity zones in the Glacial Aquifer that were defined by the aquifer tests conducted during the installation of the glacial extraction wells; additional zones to further define the leakance between the Glacial Aquifer and the Saginaw Aquifer, based upon additional data from the boring and monitoring well installation projects; and the addition of the MWDS Glacial Aquifer and Saginaw Aquifer extraction wells.

No changes were made to the size of the modeled area, the model grid spacing, or numbers of rows and columns in the MWDS model. Those BW&L wells with reported pumpage for 1993 and located within the boundaries of the MWDS model are included in the simulations of this investigation. Note that the withdrawal amounts for the BW&L wells from the years 1994, 1995, 1996, and 1997 are similar to the 1993 withdrawals on a gross scale.

1.2.2 September 1998 Modification to the Model with Respect to the Glacial Aquifer

The model was modified from the version submitted January 28, 1998, in two ways. The first was a reduction in leakance by a factor of 0.8 in the area south of Zone 3. This brought the calibration of the Glacial Aquifer water levels within the model into closer agreement with observed Zone 3 data. No other changes were made to the hydraulic parameters of the model. The model was also set to run in transient mode, with no summer pumping in Zones 1 and 2. Pumping continued year round in Zone 3 with no abatement during the summer months.

1.2.3 Attached Current work

This current model is being utilized to analyze the effects of the MWDS Summer Pumping Plan on contaminant transport and capture. Pumping continued year round in Zone 3 with no abatement during the summer months in all simulations. The approach for these simulations consisted of:

- using the steady state simulations previously run in the groundwater flow model of the Glacial and Saginaw Aquifers for comparison to the current simulations run in transient mode;
- using the program module MT3D to help in determining the transport and fate of ammonia and vinyl chloride in transient mode; and
- WHI reviewed the model and developed an independent, local-scale model to analyze the sensitivity of the capture prediction under the MWDS Summer Pumping Plan. Additionally there were some technical questions raised by USEPA and MDEQ, so an outside review of the model was conducted to review SHARP's work to date.

2.0 OBJECTIVE OF MODELING

The objective of the modeling is to assist the MWDS Group in fulfilling the Consent Decree requirements and to determine whether the MWDS Summer Pumping Plan will maintain capture in the Glacial Aquifer. Modeling is being used in conjunction with field observations to predict future conditions. The model is being continuously improved as additional information is attained from sampling and field operations. The results of the modeling as well as the sampling results of the previous three quarters are currently being evaluated within that framework to refine and optimize system performance.

2.1 SHARP Scope: Model of Glacial and Saginaw Aquifers

The model is an effective approach to determine the optimum configuration of the system so that it cost effectively fulfills the system design objective. The simulations that are currently being presented are part of the MWDS Group's effort to ensure that the MWDS Summer Pumping Plan does not adversely impact the overall remediation of the Glacial Aquifer. The pumping rates used in the model are the rates determined to be appropriate and feasible, based upon testing results and refinements to the system in the final design. The Saginaw Aquifer is included within the current model scenario for further calibration.

2.2 Waterloo Scope: Sensitivity Analysis on Zone 1 Performance

WHI was retained to perform a sensitivity analysis of Zone 1 performance with a focus on intermittent pumping. To achieve this, WHI developed a local scale model of Zone 1 with hydraulic properties identical to the SHARP model. Parameters in this model were then varied to evaluate the range of parameters under which plume capture could be maintained with intermittent pumping. To demonstrate the effectiveness of intermittent pumping, visualization tools were used to portray the transient nature of the flow and transport system.

3.0 MODEL RESULTS

3.1 SHARP Model Evaluation

Figures 2 through 7 show the change in the outline of the vinyl chloride plume over time for the three pumping zones. The extent of the contaminant plume for each of the years represented are coded by color and pattern, and represents the area within the 2 µg/l concentration boundary of the plume. Table 1 shows the Figure number, the years displayed on each map, and the pumping scenario.

Table 1. Key to figures

Figure Number	Years Shown	Pumping Scenario
2	0,1,2,3	Continuous
3	0,1,2,3	MWDS Summer Pumping Plan
4	3,4,5,6	Continuous
5	3,4,5,6	MWDS Summer Pumping Plan
6	6,7,8,9,10	Continuous
7	6,7,8,9,10	MWDS Summer Pumping Plan

This series of figures show that capture is maintained and that there is no increase in the width of the contaminant plume over time, with either steady state pumping or the MWDS Summer Pumping Plan. Within both scenarios, the only movement of the contaminant plume is the expected downgradient migration toward the Zone 3 extraction wells. As discussed in Section 1.1 above, the Zone 3 extraction wells were positioned by MDEQ and USEPA to be in a downgradient position of detected ammonia at a level lower than the 34 mg/l regulatory limit, and accepted as part of the Final Design to accomplish the design objectives. There is no change in the migration path of the vinyl chloride plume with the MWDS Summer Pumping Plan when compared to the migration path of the plume under constant pumping conditions.

Figure 8 shows the change in plume area over time for the MWDS Summer Pumping Plan. This graph indicates that there is no increase in the plume size.

3.2 Waterloo Model

To conduct a large number of simulations for sensitivity analysis, WHI developed an independent local-scale numerical model in Zone 1 to evaluate system performance with respect to ammonia. This modeling approach provided a close examination of the Zone 1 extraction wells. Recognizing the nature of the MWDS Summer Pumping Plan, all groundwater flow and contaminant transport simulations were conducted under transient conditions.

Using this local scale model, the sensitivity analysis was performed to test the range of effectiveness for intermittent pumping given the hydrogeologic uncertainties. The focus of the local scale analysis was on ammonia since this is the constituent with the discharge constraint. This model is calibrated to field conditions within the limitations of current knowledge of these conditions. The sensitivity analysis provides insight into the ability to maintain plume capture under MWDS Summer Pumping Plan.

3.2.1 Methodology for Analyzing Sensitivity of Zone 1 Plume Capture

The three steps in the WHI approach to analyze the sensitivity of Zone 1 plume capture consisted of:

1. Identification of the key physical parameters;
2. Establishment of the probable range of uncertainty associated with each of these parameters; and
3. Model prediction of plume capture within this range of uncertainty.

To establish the capture reliability of the intermittent pump and treat system the physical parameters that could potentially affect plume capture were considered. Table 2 is a list of physical parameters considered important to plume capture predictions and their potential affect under intermittent pumping conditions.

Table 2: Physical Parameters that Affect Plume Capture

PARAMETER	EFFECT
Hydraulic Conductivity	Hydraulic conductivity affects an extraction wells capture area and cone of depression. Larger hydraulic conductivity results in a smaller capture area, a smaller cone of depression and is more conservative than a larger conductivity while evaluation plume capture.
Porosity	Contaminant velocities are inversely proportional to the porosity value. A small porosity will result in higher velocities, which is conservative for making transient capture predictions.
Dispersivity	Longitudinal dispersivity will cause transport faster and slower than the average linear groundwater velocity. Larger dispersivities will cause plume spreading and are conservative for plume capture predictions.
Specific Storage / Specific Yield	Small specific yield / specific storage values result in a faster establishment of the drawdown cone when pumping is initiated. Larger specific yield values are more conservative under intermittent pumping conditions while predicting plume capture.
Extraction Well Pumping Rate	An extraction well pumping rate will affect the size of the zone of capture. Increased pumping creates a larger zone of capture.
Recharge (Landfill)	Landfill recharge will affect the quantity of contaminant that infiltrates into the aquifer. Larger landfill recharge rates result in increased mass loading to the aquifer and are conservative while predicting plume capture.
Recharge (Ambient)	Ambient recharge will affect an extraction well's capture zone. Increased recharge will decrease the size of the capture zone. While predicting plume capture larger ambient recharge estimates are conservative.

WHI conducted a sensitivity analysis on the parameters listed in Table 2 to determine their importance to the MWDS Summer Pumping Plan. To address the associated uncertainty, the parameters values were varied over probable ranges through a number of simulations to assess plume capture.

3.2.2 Zone 1 Local Scale Model Set-up

The groundwater flow system was modeled using the U.S. Geological Survey modular finite-difference groundwater flow model (MODFLOW) (McDonald and Harbaugh, 1988). Contaminant transport simulations were performed using MT3D (Zheng, 1996), a modular three-dimensional transport model for simulation of advection, dispersion and chemical reactions in groundwater systems.

The local scale numerical model for groundwater flow consists of the following:

- general head boundary condition at north and south boundaries;
  - Resulting pre-pumping gradient = 0.001;
- 12000 feet by 12000 feet model domain;
  - 30 feet by 30 feet grid blocks in the vicinity of the extraction wells; and
- 2 stress periods each year corresponding to the MWDS Summer Pumping Plan, with 10 time steps per stress period and a multiplier = 1.2

The local scale numerical model for contaminant transport consists of the following:

- recharge concentration flux boundary condition at MWDS;
- initial conditions reflecting observed concentrations; and
- transport solved using the Method of Characteristics (MOC) technique and a Courant number = 0.5

Utilizing the field results obtained by SHARP and parameter values reported in hydrogeological research literature, base case values and ranges for the parameters of interest were determined and are listed in Table 3.

Table 3: Model parameter values

Model Parameter	Base Case Value	Probable Range	Basis for Probable Range
Hydraulic Conductivity	290 ft/day	250 to 320 ft/day	MWDS extraction well pumping tests
Porosity	0.25	0.25 to 0.40	Freeze and Cherry, 1979
Specific Storage / Specific Yield	0.20	0.01 to 0.35	Freeze and Cherry, 1979
Recharge (ambient)	5 in/year	2 to 8 in/year	from SHARP
Recharge (landfill)	1 in/year	0.5 to 2 in/year	from MWDS Landfill Design
Extraction well shutdown time	90 days	90 to 110 days	from SHARP
Z1-P1 pumping rate	45 GPM*	45 to 60 GPM	from SHARP
Z1-P2 pumping rate	45 GPM*	45 to 60 GPM	from SHARP
Landfill recharge ammonia concentration	20,000 mg/L	1,000 to 20,000 mg/L	Preliminary calibration
Longitudinal Dispersivity (α_L)	40 ft	10 to 100 ft	based on Gelhar, et. al., 1992, $\alpha_L \cong 0.1 \times$ scale of study
Transverse Dispersivity (α_T)	4 ft	1 to 10 ft	based on Gelhar, et. al., 1992, $\alpha_T \cong 0.1 \times \alpha_L$

* Z1-P1 and Z1-P2 Base Case used for comparison purposes.

The sensitivity analysis was conducted by varying each parameter in Table 3 over the probable parameter range. The simulations that were conducted to evaluate the sensitivity of predicted plume capture with the MWDS Summer Pumping Plan are summarized in Table 4.

Table 4: Summary of simulations

Run Number	Condition
1	Base Case (See Table 3)
2	Dispersivity = 0 feet
3	Dispersivity = 100 feet
4	Specific Yield = 0.01
5	Recharge (ambient) = 2 inches/year
6	Recharge (ambient) = 8 inches/year
7	Recharge (landfill) = 2 inches/year
8	Hydraulic Conductivity = 250 ft/day
9	Hydraulic Conductivity = 320 ft/day
10	Time extraction wells off = 100 days
11	Time extraction wells off = 110 days
12	Time steps per stress period = 1
13	Number of model layers = 4
14	No Initial Plume
15-28	Same as 1-14, but with a total pumping rate of 120 GPM

3.2.3 Sensitivity Analysis Results

For each of the simulations listed in Table 4 the degree of plume capture was evaluated using the 34 mg/L stipulated ammonia concentration (listed in Table 10 of the ROD). The estimated time until the plume was completely broken off and separated from the downgradient section south of the Zone 1 extraction wells was also determined. These results are listed in Tables 5 and 6, for total pumping of 90 and 120 GPM, respectively.

Table 5: Sensitivity analysis results with total Zone 1 pumping of 90 GPM

Simulation Number	Simulation Condition*	Plume Capture	Time for Plume Separation
1	Base Case	yes	6 years
2	Longitudinal Dispersivity = 0 feet	yes	11 years
3	Longitudinal Dispersivity = 100 feet	yes	4 years
4	Specific Yield = 0.01	yes	6 years
5	Recharge (ambient) = 2 inches/year	yes	7 years
6	Recharge (ambient) = 8 inches/year	yes	7 years
7	Recharge (landfill) = 2 inches/year	yes	8 years
8	Hydraulic Conductivity = 250 ft/day	yes	7 years
9	Hydraulic Conductivity = 320 ft/day	yes	6 years
10	Time extraction wells off = 100 days	yes	6 years
11	Time extraction wells off = 110 days	yes	7 years
12	Time steps per stress period = 1	yes	6 years
13	Number of model layers = 4,	yes	N/A

	0 mg/L initial concentrations		
14	0 mg/L initial concentrations	yes	N/A

*Z1-P1 and Z1-P2 Pumping at 45 GPM each (total Zone 1 pumping rate of 90 GPM)

Table 6: Sensitivity analysis results with total Zone 1 pumping of 120 GPM

Simulation Number	Simulation Condition *	Plume Capture	Time for Plume Separation
15	Base Case	yes	5 years
16	Longitudinal Dispersivity = 0 feet	yes	5 years
17	Longitudinal Dispersivity = 100 feet	yes	3 years
18	Specific Yield = 0.01	yes	5 years
19	Recharge (ambient) = 2 inches/year	yes	5 years
20	Recharge (ambient) = 8 inches/year	yes	4 years
21	Recharge (landfill) = 2 inches/year	yes	5 years
22	Hydraulic Conductivity = 250 ft/day	yes	5 years
23	Hydraulic Conductivity = 320 ft/day	yes	4 years
24	Time extraction wells off = 100 days	yes	5 years
25	Time extraction wells off = 110 days	yes	5 years
26	Time steps per stress period = 1	yes	5 years
27	Number of model layers = 4, 0 mg/L initial concentrations	yes	N/A
28	0 mg/L initial concentrations	yes	N/A

*Z1-P1 and Z1-P2 Pumping at 60 GPM each (total Zone 1 pumping rate of 120 GPM)

To facilitate the determination of the time required for plume separation and capture, animation of transient transport results was performed. Figures 9 through 21 depict the plume capture and transient drawdown cone under MWDS Summer Pumping Plan for the base case scenario. These figures illustrate that MWDS Summer Pumping Plan is able to maintain capture of the plume such that in the long term, concentrations downgradient do not exceed 34 mg/L for ammonia. The attached CD-ROM contains .AVI files for each of the above scenarios, depicting plume migration and capture.

3.2.4 Sensitivity Analysis Discussion

Intermittent pumping was shown to maintain plume capture under all scenarios tested. Under each of these scenarios, concentration above 34 mg/L does not persist downgradient of the Zone 1 wells.

The range of times required for plume separation ranged from 3 to 11 years reflecting the time required for initial concentrations to migrate downgradient of the Zone 1 stagnation point. Migration downgradient of the Zone 1 stagnation point is reduced relative to ambient groundwater flow due to the near zero hydraulic gradient at that location (see Figure 1).

3.2.5 Conclusions from Waterloo Hydrogeologic

- WHI confirmed that ammonia plume capture can be maintained with 90-110 days of shut-down;
- WHI tested a full range of the probable uncertainty in the physical parameters to demonstrate the reliability of the prediction that the plume could be captured under the MWDS Summer Pumping Plan;

- Reinforced that the time required to cut-off the source is between 3-11 years and the residual concentration in the downgradient vicinity of the Zone 1 wells is expected to persist until it has a chance to migrate to the zone 2 extraction wells.

3.3 Compliance with Part 201 Standards

The modeling simulations described above demonstrate that long term capture is accomplished by utilizing either continuous pumping or the MWDS Summer Pumping Plan. Analysis of the simulations shown in Figures 2 through 7 indicate that the size of the vinyl chloride contaminant plume does not increase over time with the MWDS Summer Pumping Plan. Therefore, compliance with the Part 201 Standards will be achieved with the MWDS Summer Pumping Plan.

4.0 OBSERVED CHEMICAL AND WATER LEVEL DATA TRENDS

4.1 Analytical Results

The analytical results for ammonia in the Glacial Aquifer are shown on Figure 9. The first three quarters of analytical data are posted for each well where available, and indicate that there are two areas where concentrations are declining faster than predicted by the model.

The first area is south of the Zone 1 extraction wells. The ammonia concentration in monitoring well MW-12D has declined from 49.3 mg/l to 18.9 mg/l in three quarters. This well was formerly mapped within the ammonia plume and now has defined the separation of the ammonia plume into two areas; one small area around Z1P2 and the main plume that is migrating toward Zone 2 to the south.

The second area is around and south of the Zone 2 extraction wells. Z2P1, Z2P2, MW-50, and MW-49 all exhibit a higher rate of decline than predicted. These results indicate that in some areas the model is conservative with respect to capture of the ammonia plume.

Analytical results for vinyl chloride show similar trends to those described above. These trends are less evidenced in Figure 10, in part because of the higher initial concentrations within the plume, and because of the lower boundary concentration.

4.2 Water levels

The potentiometric surface of the Glacial Aquifer is shown on Figure 11 for data collected during the second quarter of operation. Water levels within the Glacial Aquifer are generally close to those predicted in the model, indicating that the hydrogeologic parameters used in the model are generally well calibrated.

The exception to this is in the area of Zone 3, where the area influenced by the Zone 3 extraction wells extends further upgradient to the north, northeast and northwest than predicted. The reason that the model is more conservative with respect to measured groundwater flow and capture in this area is because of partial boundary conditions in this area that were identified during the boring and well installation program. The condition that has the most influence on groundwater flow is the amount of localized topographic relief on the base of the aquifer, with a subsequent decrease in saturated thickness. No attempt was made to incorporate this localized, high relief into the base of the aquifer in the model. Because of this, the model calculates a higher transmissivity for the area than exists in reality.

5.0 SUMMARY

Plume Capture
The current model has been utilized for an analysis of the effects of the MWDS Summer Pumping Plan on contaminant transport and capture in Zones 1 and 2. Pumping continued year round in Zone 3 with no abatement during the summer months in all simulations. The results indicate that we are able to maintain capture while utilizing the MWDS Summer Pumping Plan.

Field Data
The analytical results for ammonia in the Glacial Aquifer are shown on Figure 10. The first three quarters of analytical data indicate that there are two areas where concentrations are declining faster than predicted by the model. The groundwater flow influenced by the Zone 3 extraction wells extends further upgradient to the north, northeast and northwest than predicted. These results indicate that where differences exist, the model is more conservative.

Part 201
Contaminant transport and flow results show capture from all three zones is maintained with the MWDS Summer Pumping Plan in Zones 1 and 2. Figures 2 through 7 confirm that there is no increase in the size of the contaminant plume over time with either steady state pumping or the MWDS Summer Pumping Plan, except for the intended southerly migration of the plume toward the Zone 3 extraction wells. Therefore compliance with Part 201 Standards will be achieved with the MWDS Summer Pumping Plan.

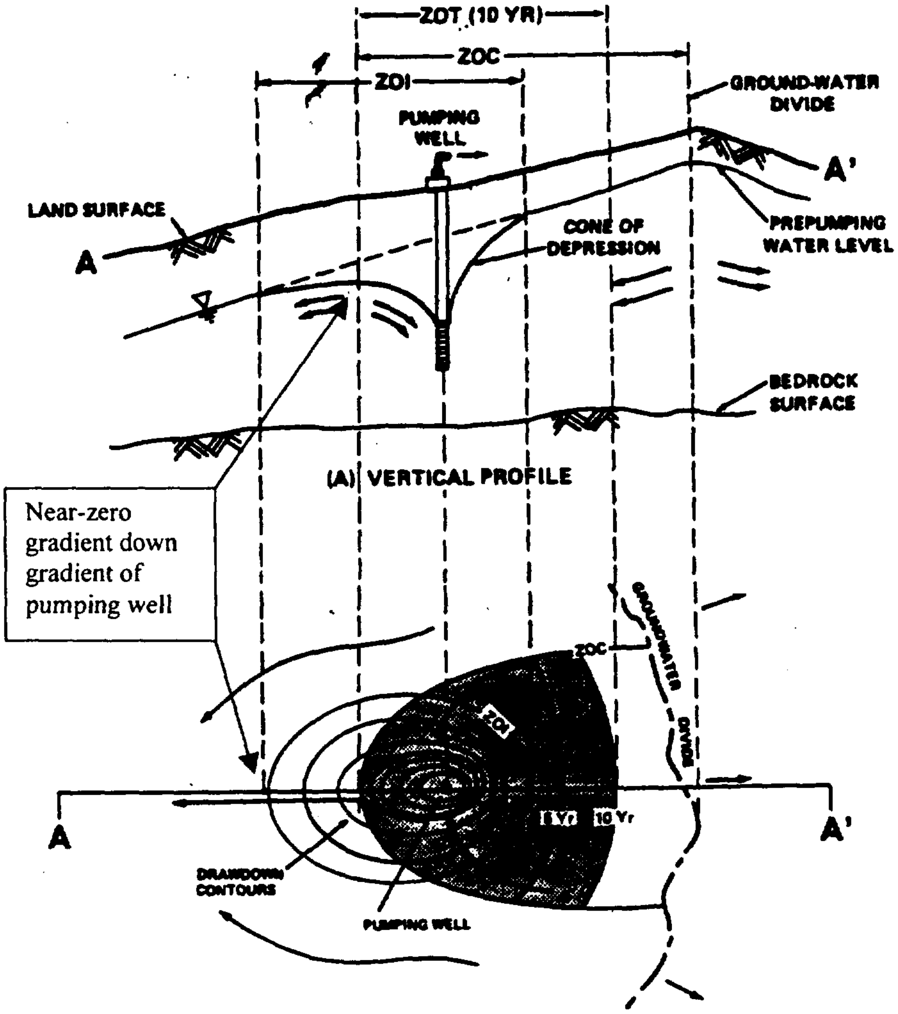
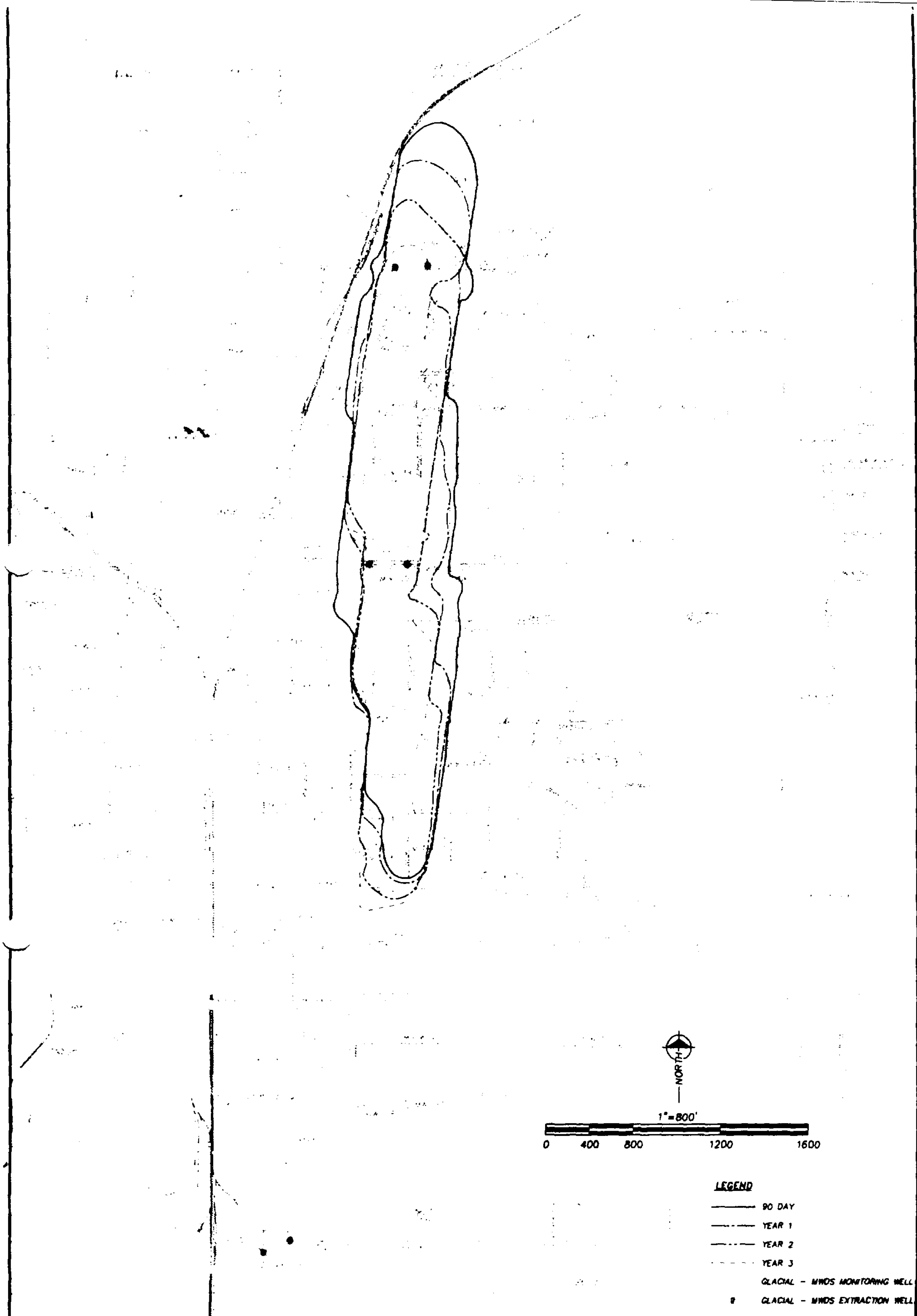


Figure 1. Near zero gradients in the vicinity of the stagnation point



2

VINYL CHLORIDE PLUME
GROUNDWATER SIMULATION
WITH CONSTANT PUMPING
0.25 TO 3 YEARS

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

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[illegible] CRUPPER AVE
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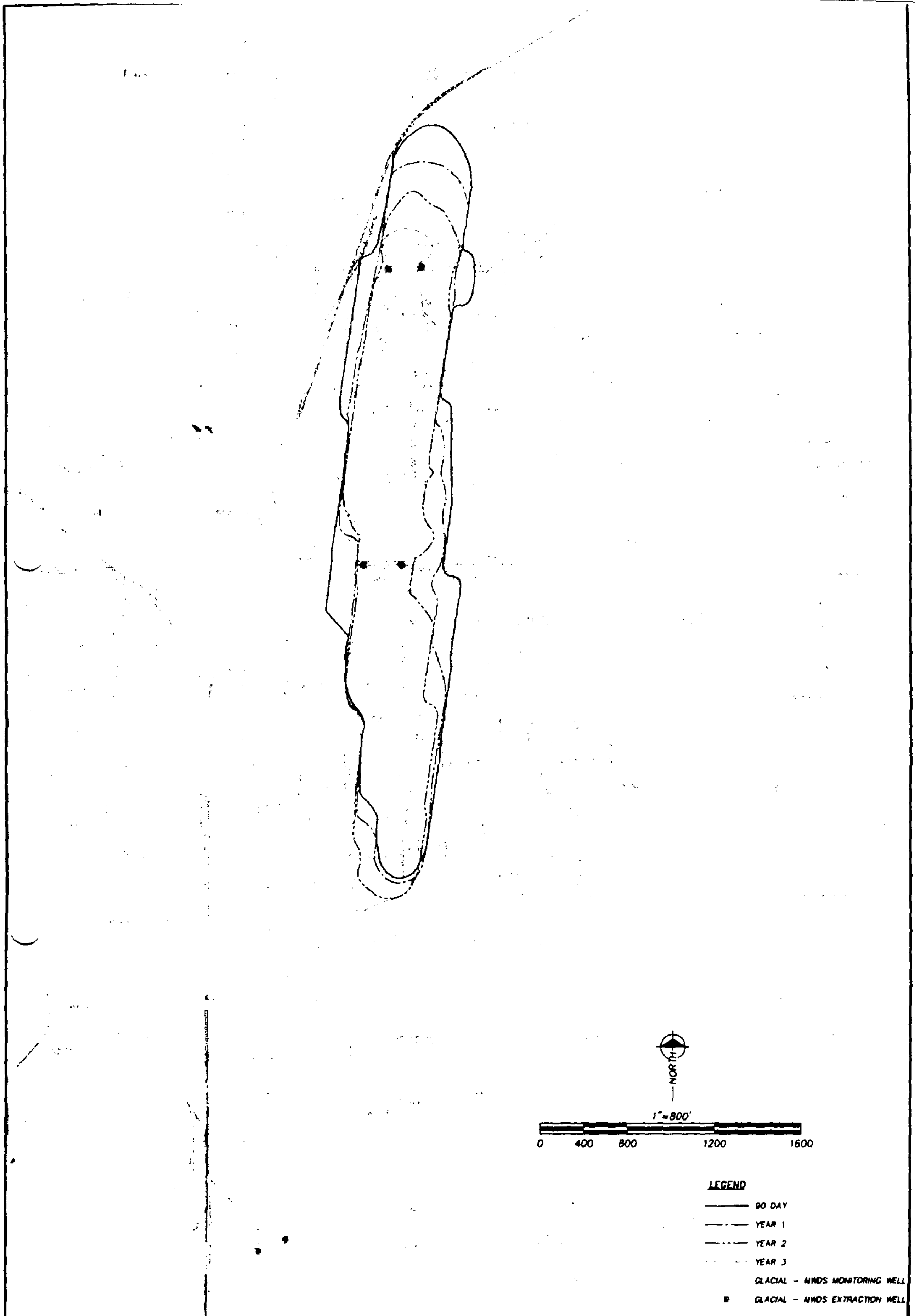


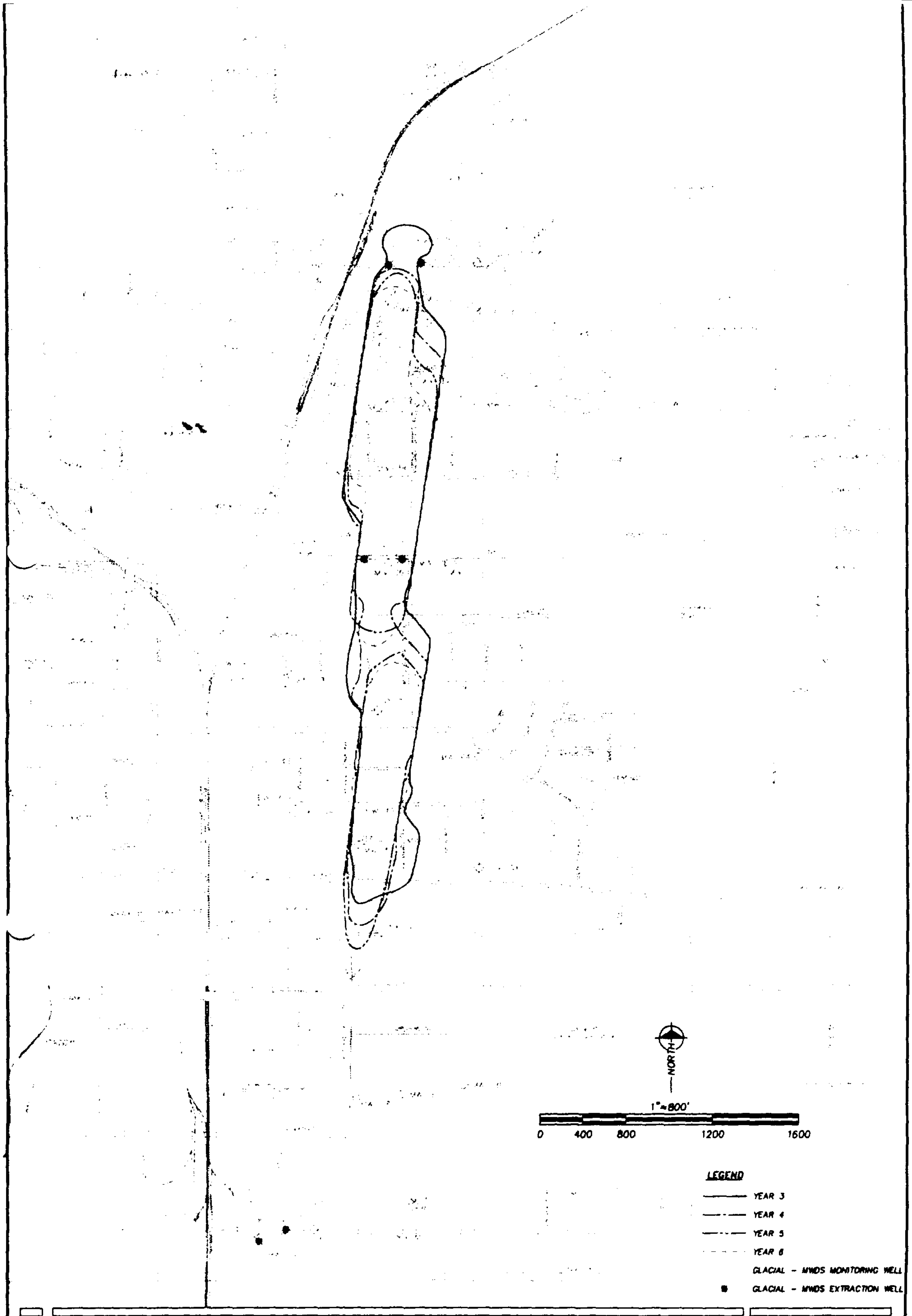
3

VINYL CHLORIDE PLUME
GROUNDWATER SIMULATION
WITH 90 DAY CESSATION
OF PUMPING
0.25 TO 3 YEARS

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.



4

VINYL CHLORIDE PLUME
GROUNDWATER SIMULATION
WITH 90 DAY CESSATION
OF PUMPING
YEARS 3 TO 6

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

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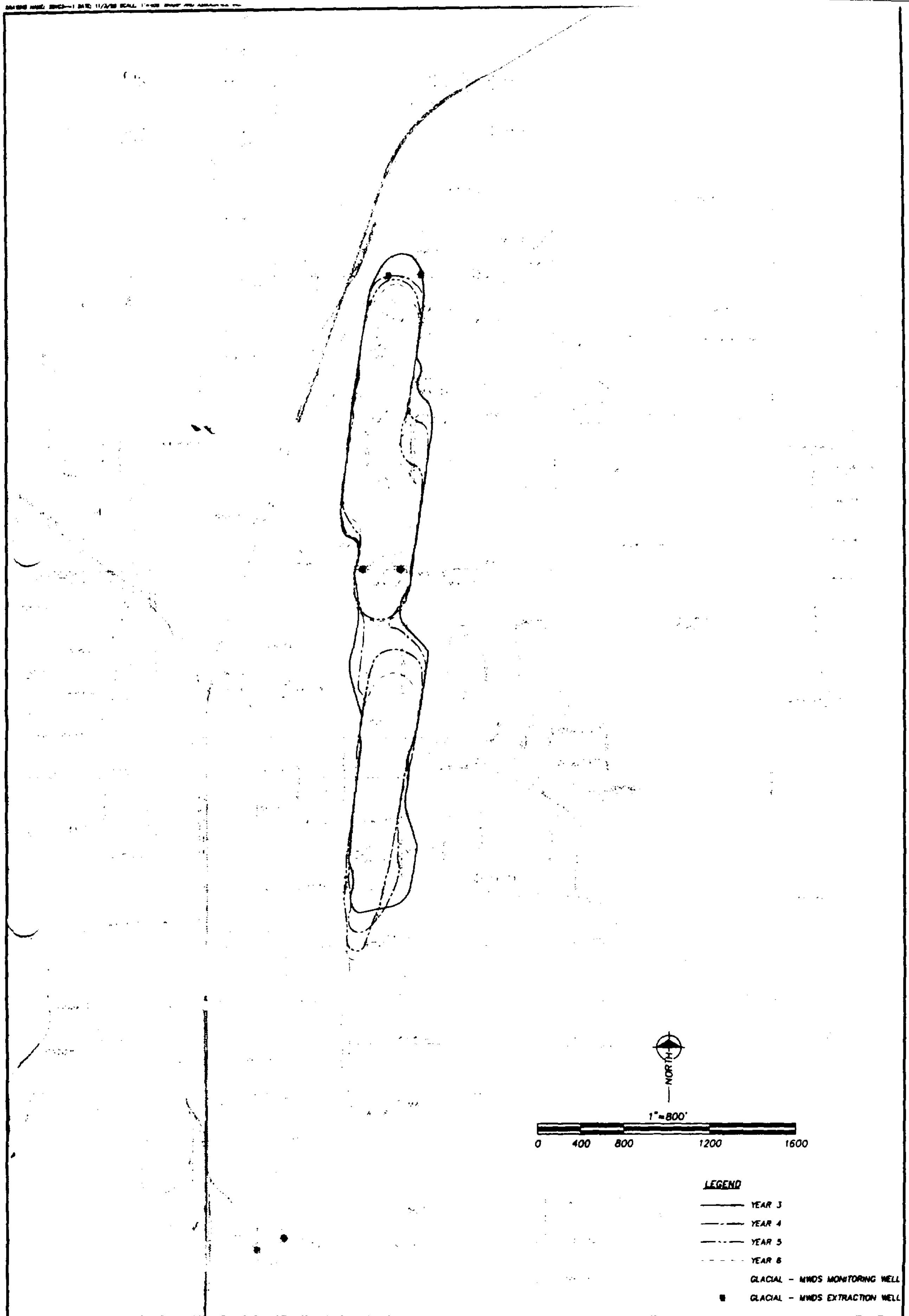


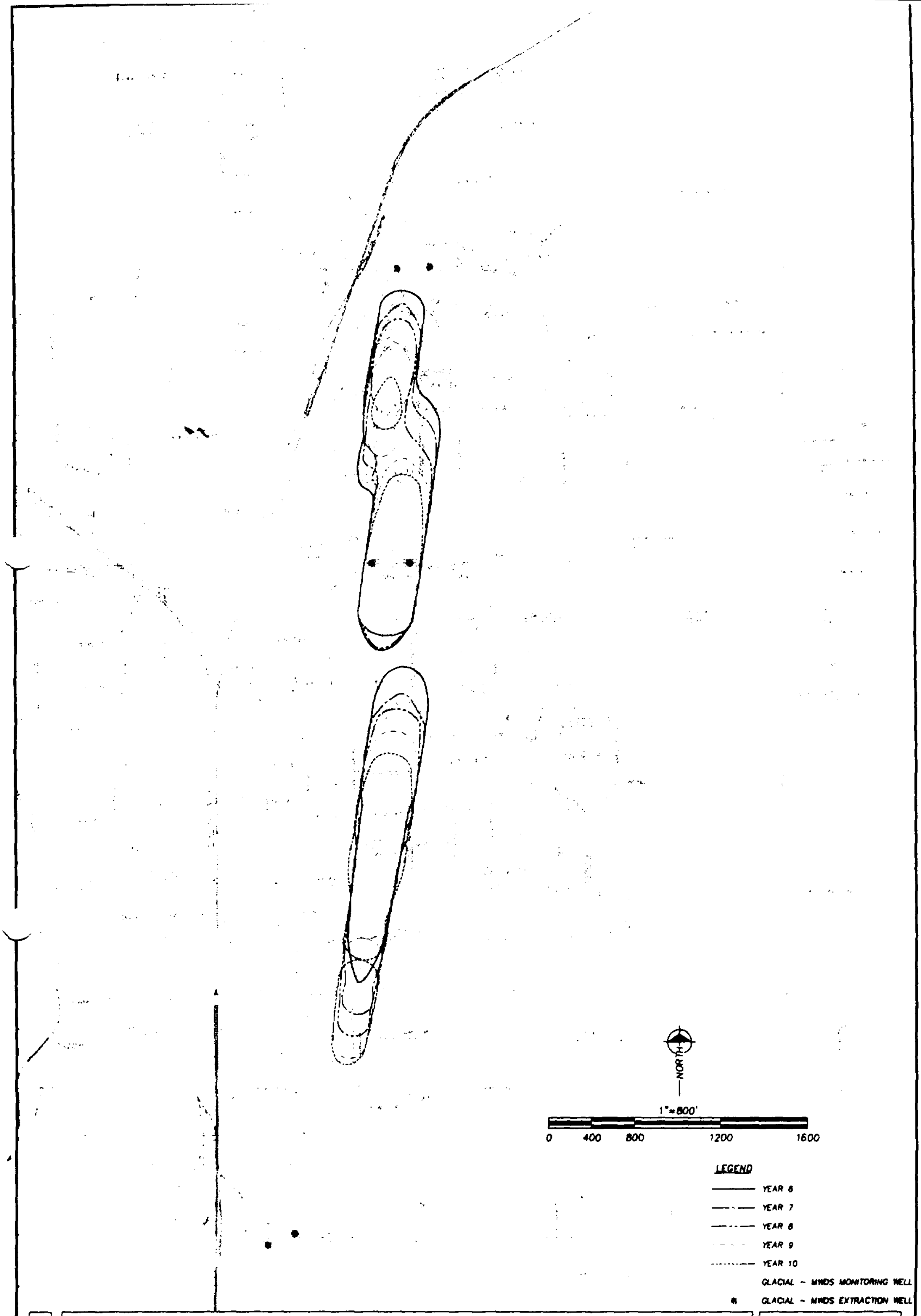
5

VINYL CHLORIDE PLUME
GROUNDWATER SIMULATION
WITH CONSTANT PUMPING
YEARS 3 TO 6

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
COLUMBUS, OHIO



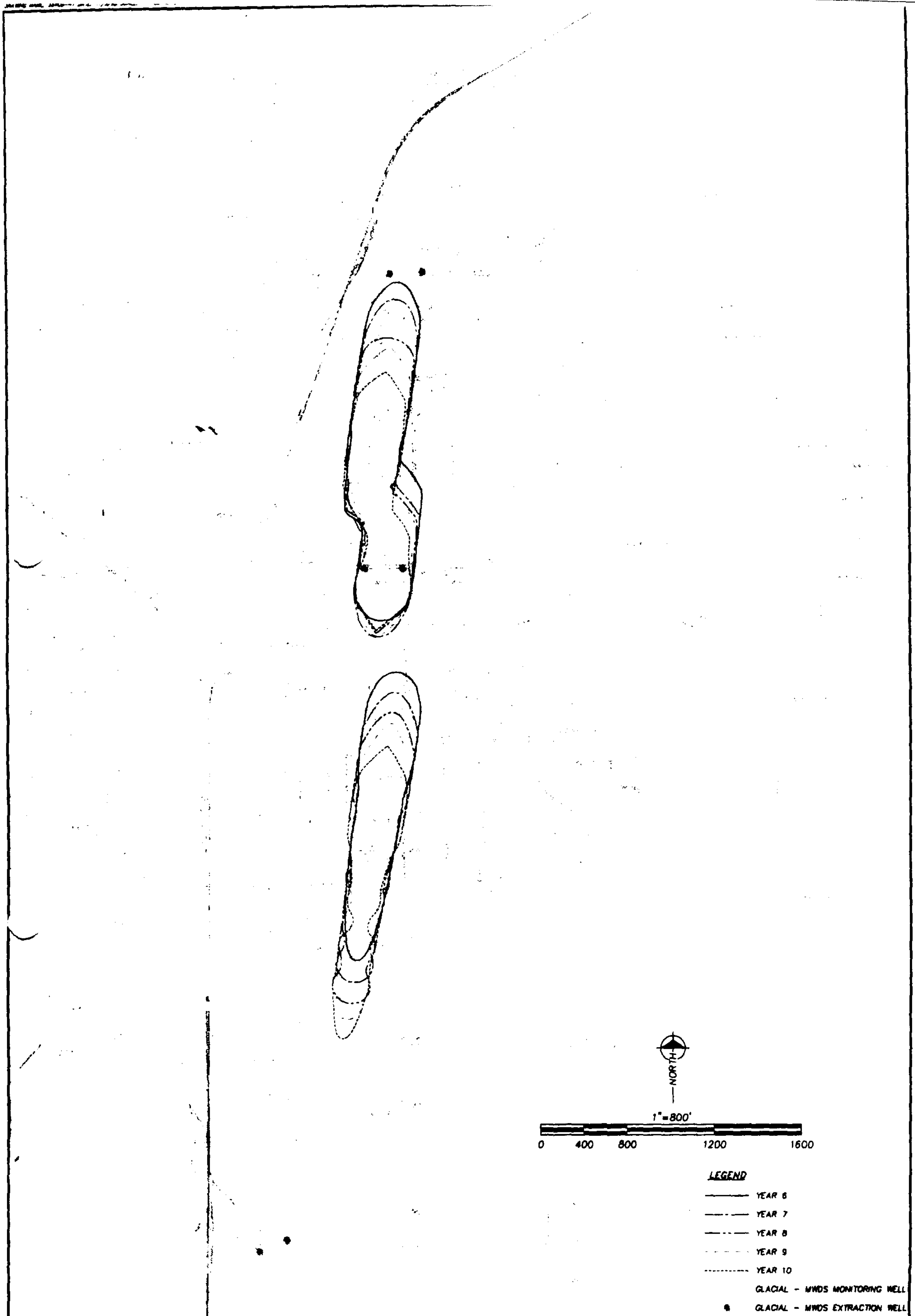
6

VINYL CHLORIDE PLUME GROUNDWATER SIMULATION WITH 90 DAY CESSATION OF PUMPING 6 TO 10 YEARS

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.



7

VINYL CHLORIDE PLUME
GROUNDWATER SIMULATION
WITH CONSTANT PUMPING
6 TO 10 YEARS

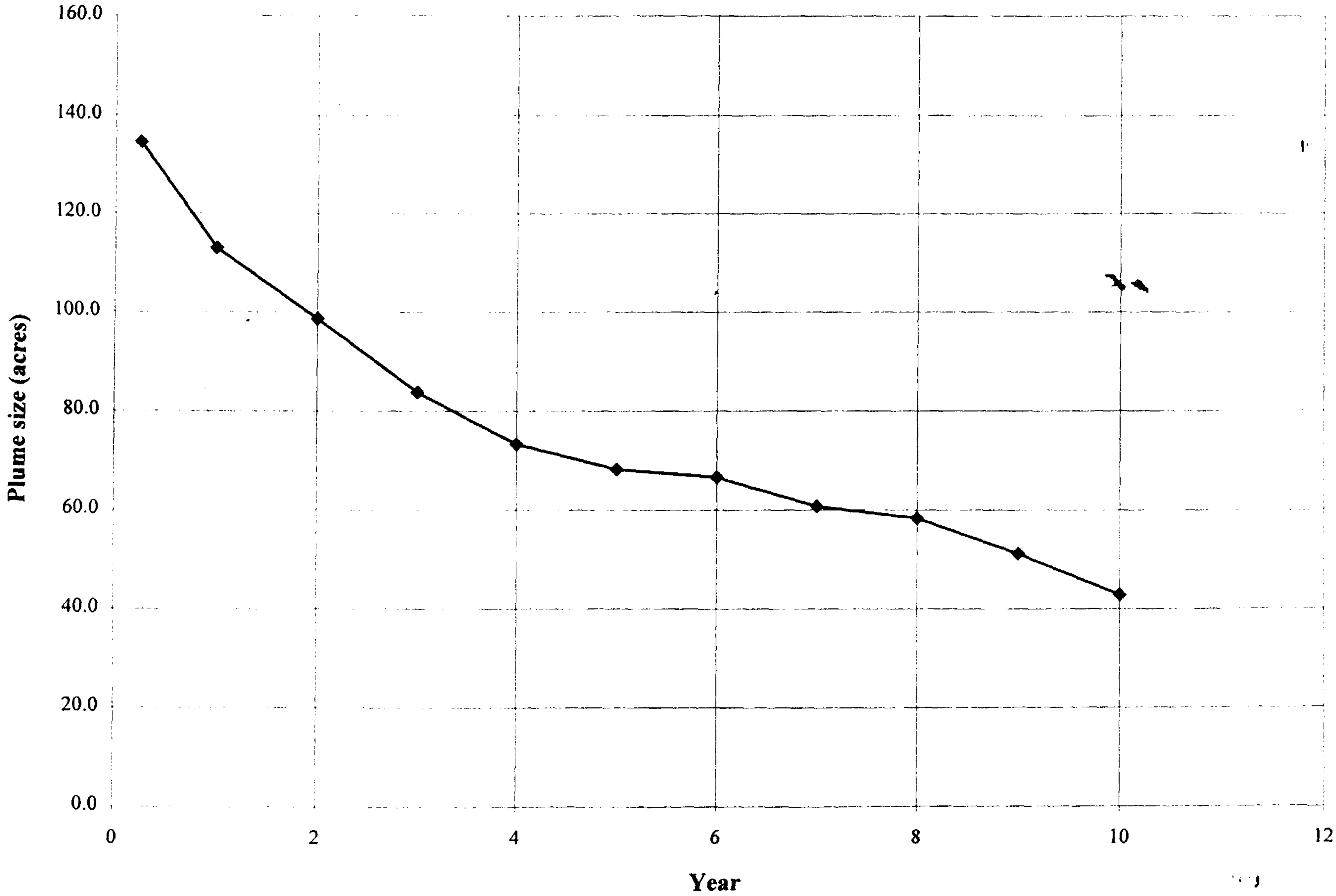
Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.

Figure 8

Simulated Vinyl Chloride Plume Size vs time Since Start of Pumping, MWDS Summer Pumping Plan



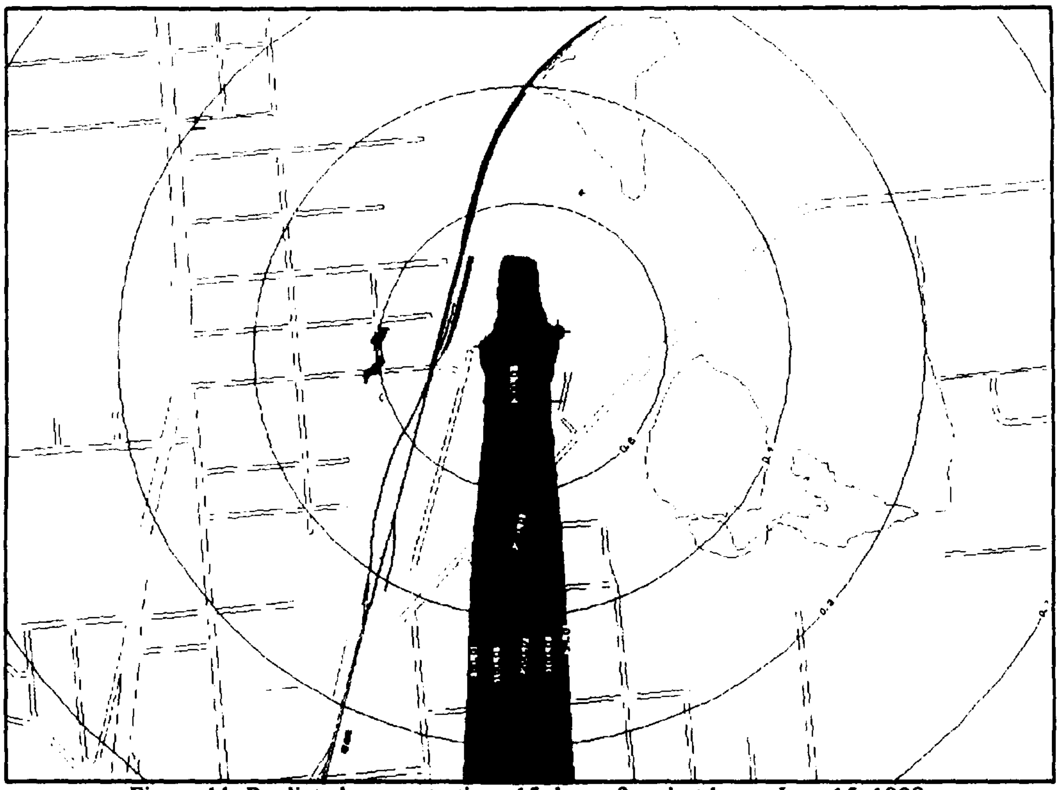


Figure 11. Predicted concentrations 15 days after shutdown: June 15, 1998

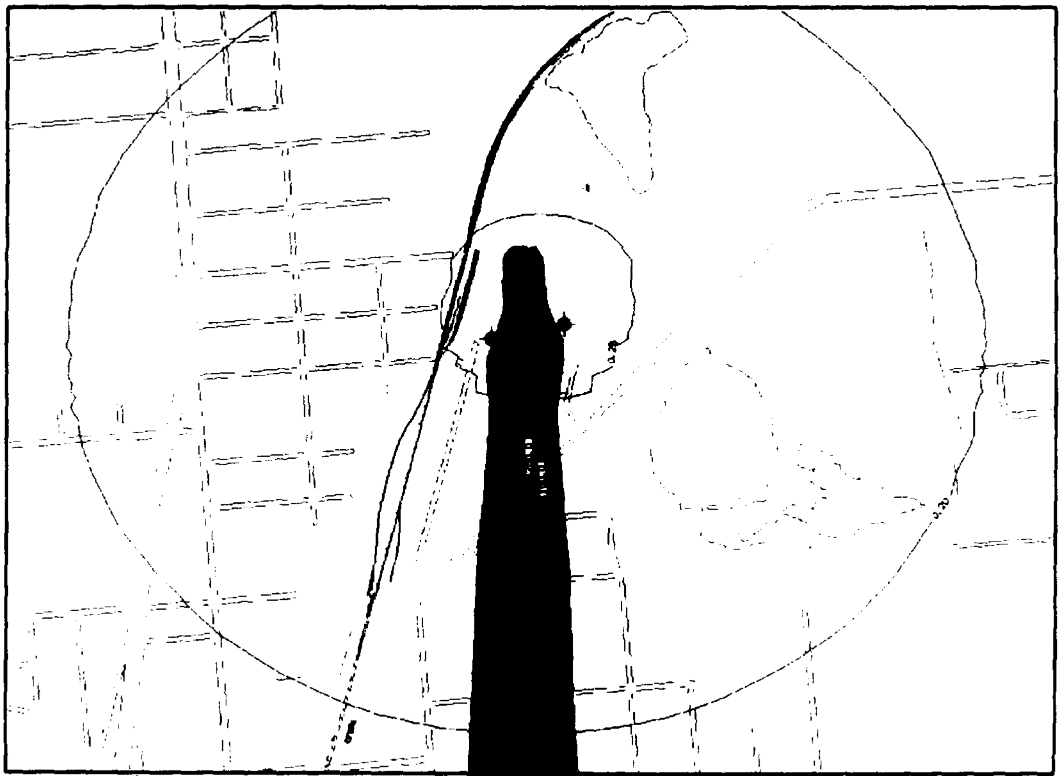


Figure 12. Predicted concentrations 90 days after shutdown: September 1998

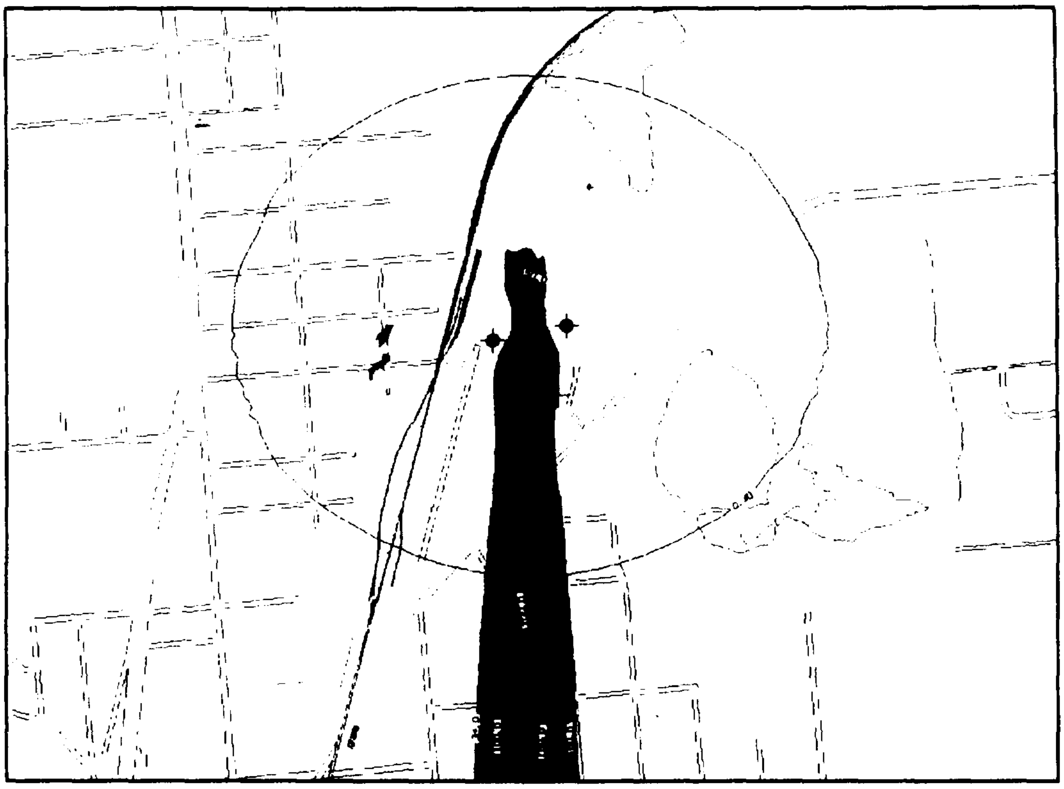


Figure 15 Predicted concentrations after the 2nd -90 day shutdown: September 1999

Zone 1

Zone 2

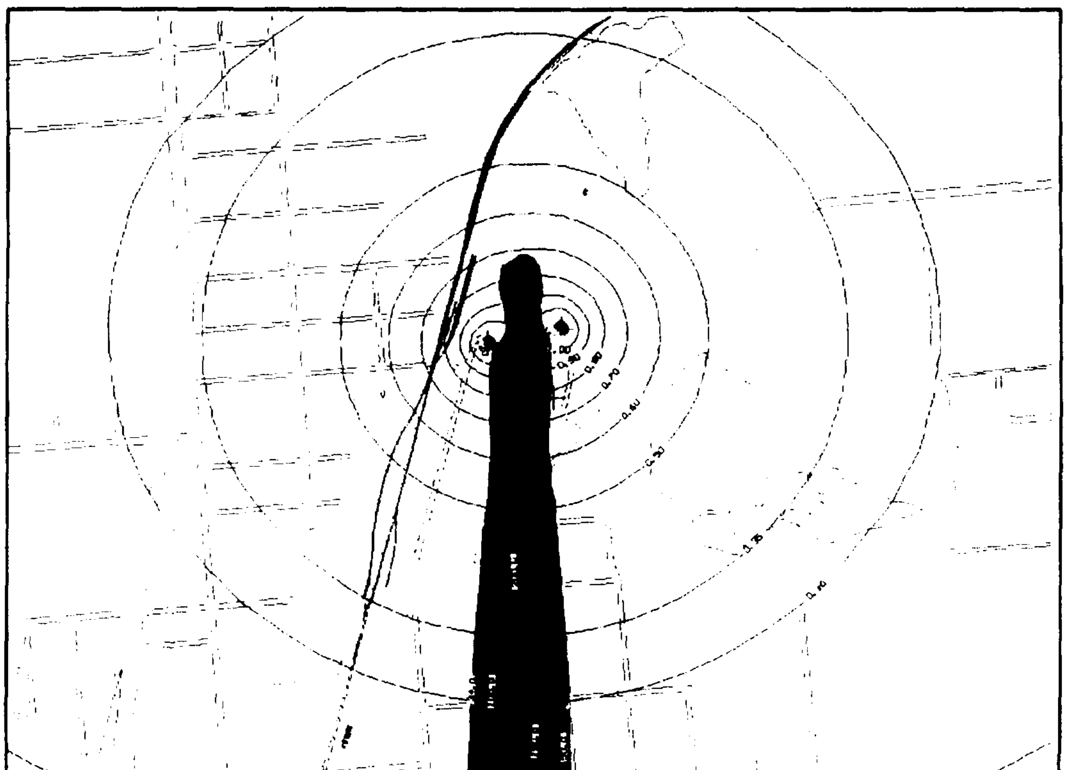


Figure 16. Predicted concentrations 1 month after pumping restarted: October 1999

Zone 1

Zone 2

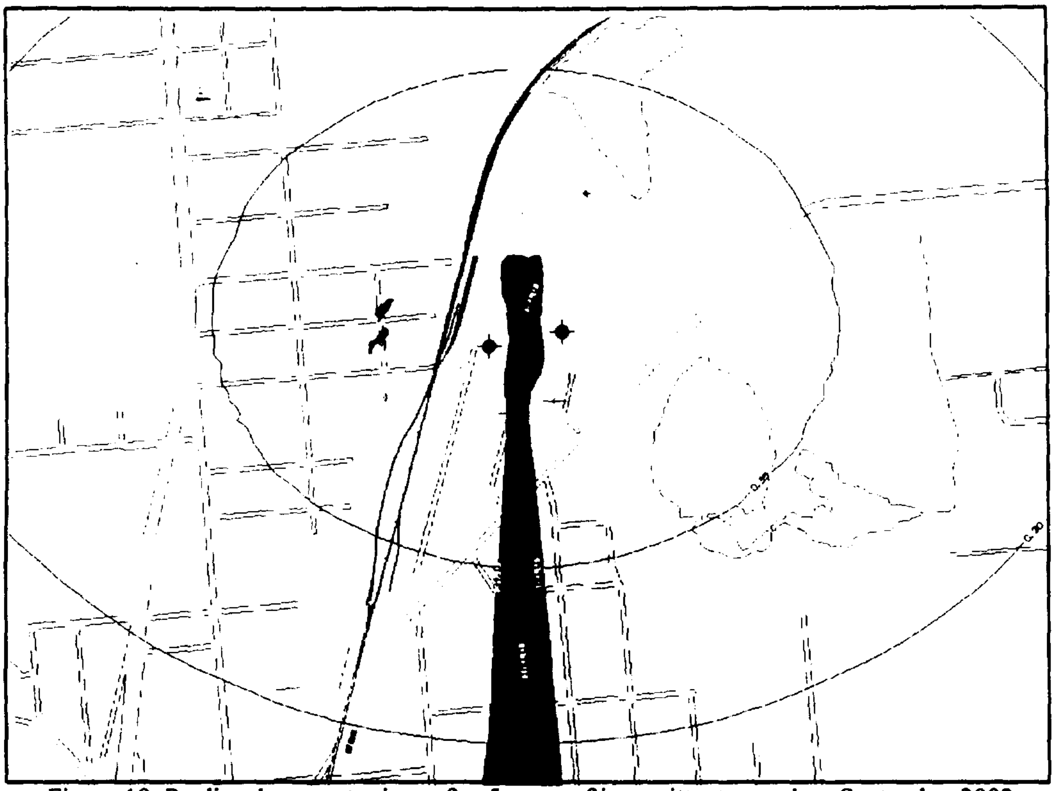


Figure 19. Predicted concentrations after 5 years of intermittent pumping: September 2002

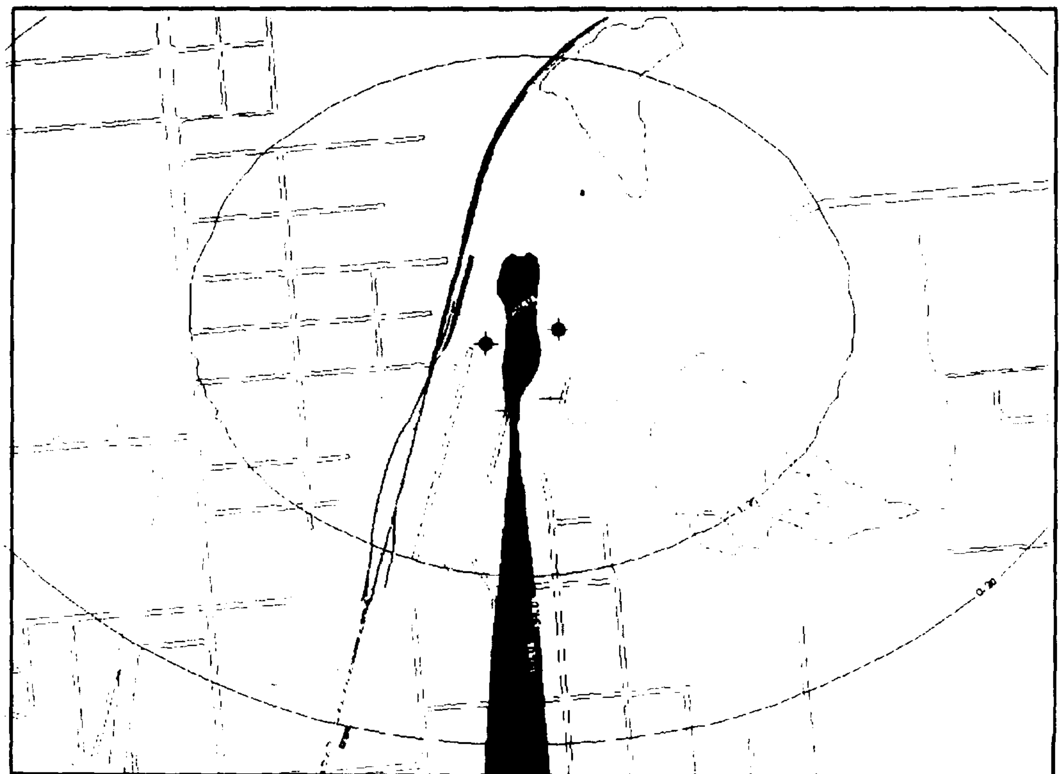
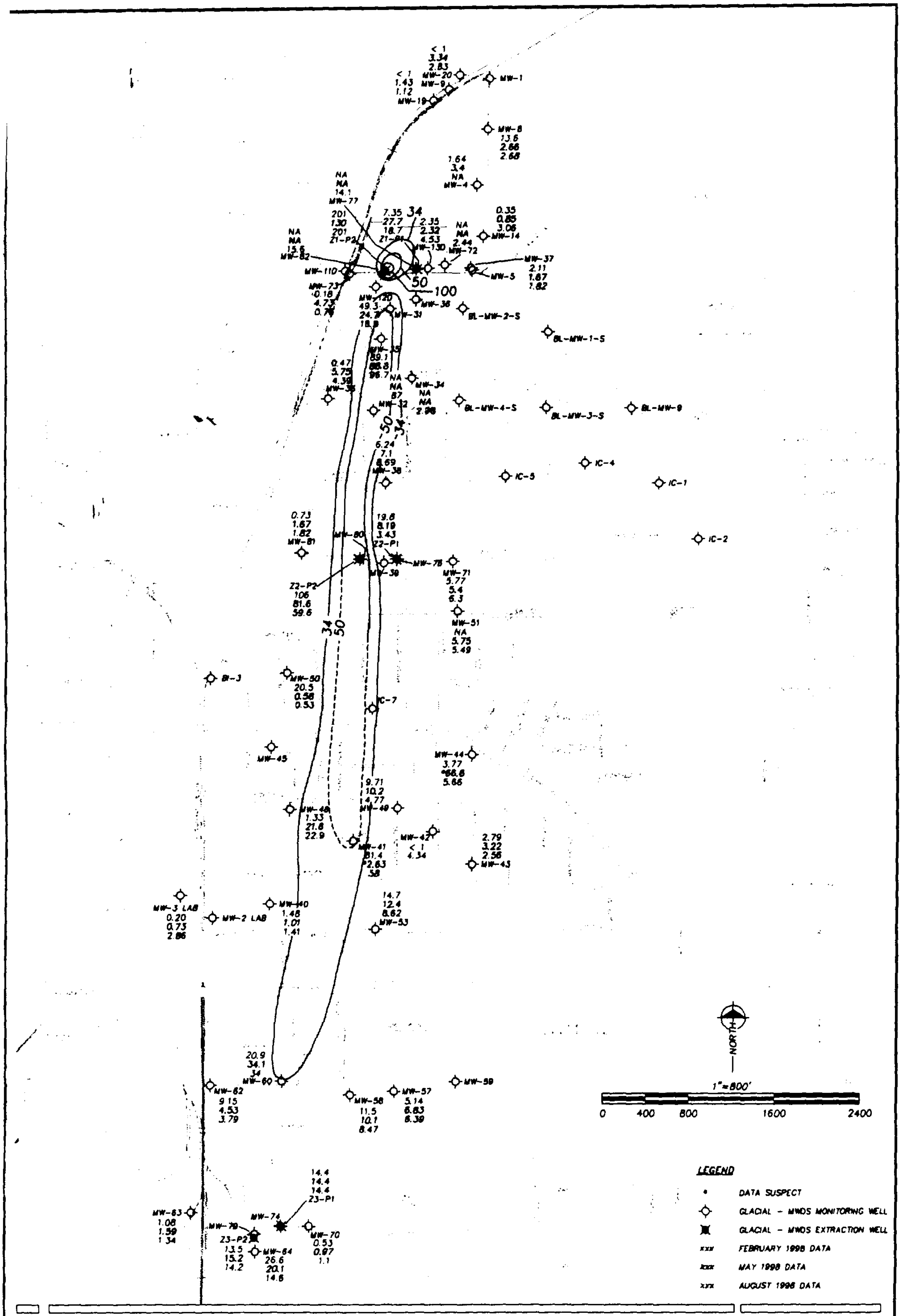


Figure 20. Predicted concentrations after 6 years of intermittent pumping: September 2003



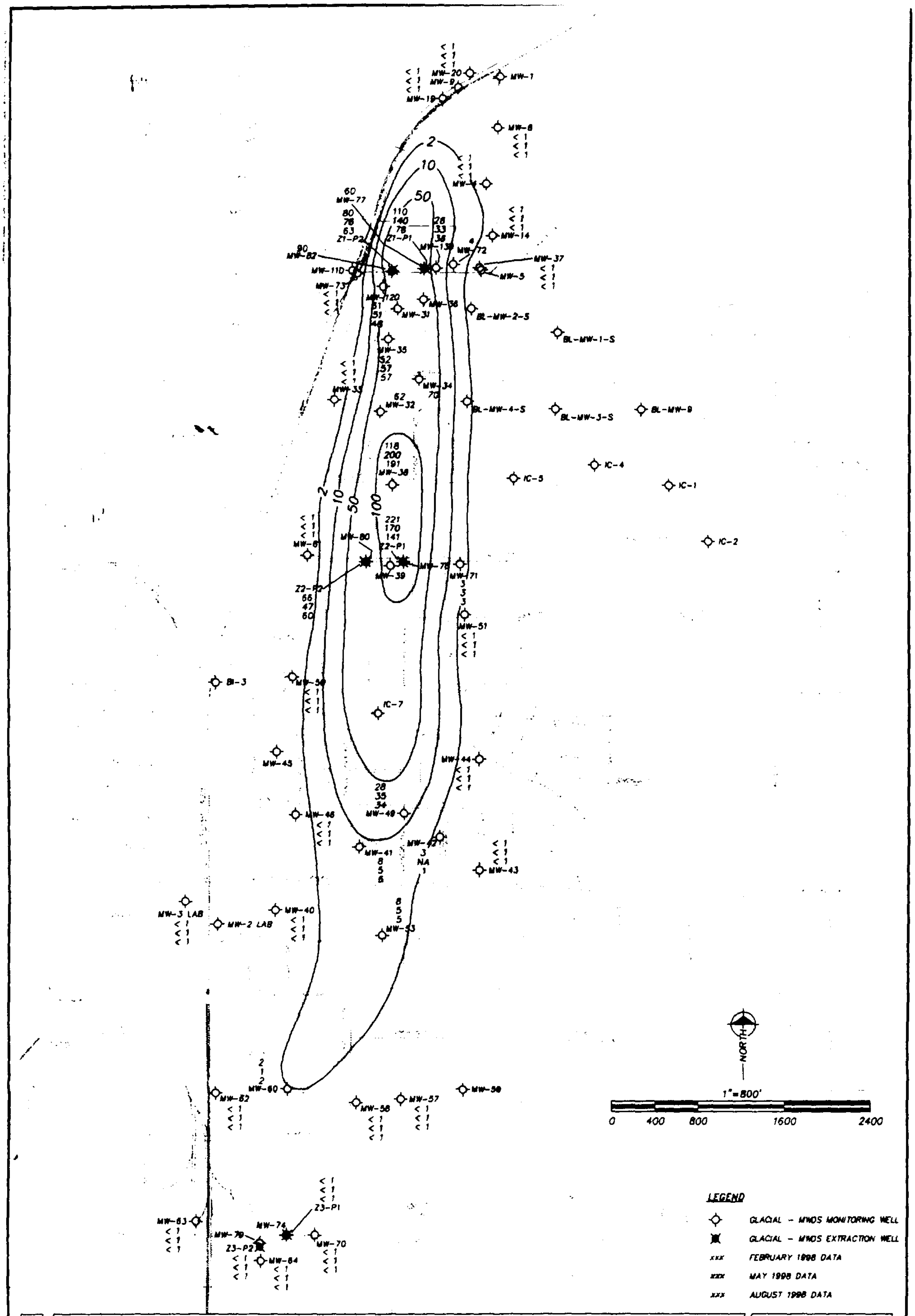
23

GLACIAL AQUIFER
AMMONIA
ISOCONCENTRATION MAP
BASELINE AUGUST 1998

Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4680 / FAX (614) 841-4680



Project Reference: #5104

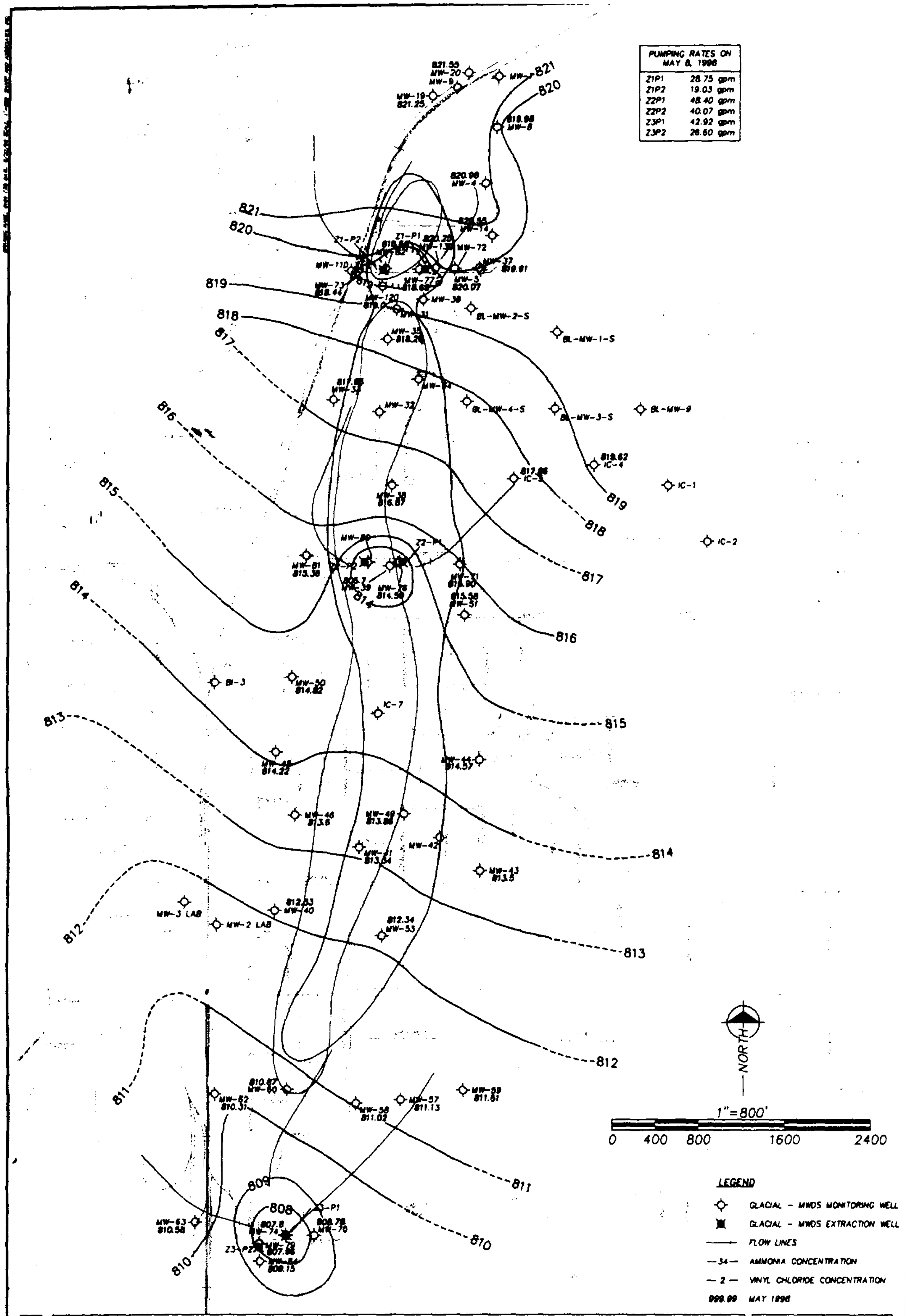
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

GLACIAL AQUIFER VINYL CHLORIDE ISOCONCENTRATION MAP BASELINE AUGUST 1998

24

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
982 CRUPPER AVE
COLUMBUS, OHIO 43229
(614) 841-4600 / FAX (614) 841-4660



Project Reference: #5104
MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

25 POTENTIOMETRIC SURFACE
GLACIAL AQUIFER
MAY 1998

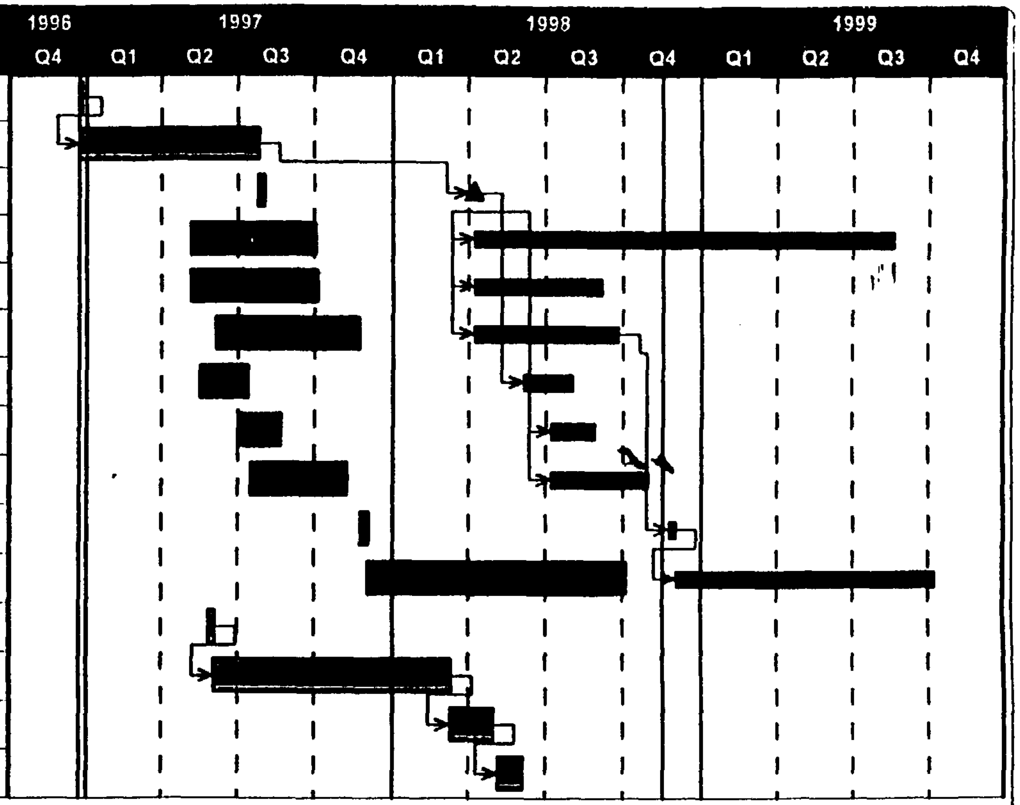
Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.
COLUMBUS, OHIO 43229

Exhibit C

Timeline Schedule for the Motor Wheel Disposal Site RD/RA

Task Name	Start Date	Duration	Start Variance	End Date
Submit pre-final design	12/23/96	1.00d		12/23/96
EPA Review and Approve Design	12/24/96	149.00d		7/25/97
EPA approval of Final Design	4/6/98	0d	-175.00d	4/6/98
Construction	4/8/98	345.00d	-233.00d	8/17/99
Landfill Construction	4/8/98	105.00d	-233.00d	9/3/98
Ground Water System Construction	4/6/98	120.00d	-211.00d	9/23/98
Install Glacial wells	6/4/98	40.00d	-266.00d	7/30/98
Install Saginaw wells	7/8/98	35.00d	-257.00d	8/25/98
Build Treatment Building	7/7/98	81.00d	-247.00d	10/28/98
Startup System	11/23/98	5.00d	-252.00d	11/30/98
System Optimization	12/3/98	214.00d	-255.00d	10/6/99
Transient Pumping Memo	5/27/97	5.00d		6/2/97
EPA evaluation and response	6/3/97	193.00d		3/9/98
Design Discharge to MSV Pit	3/10/98	36.00d		4/28/98
EPA and MDEQ review Design	5/5/98	20.00d		6/2/98



Printed: 11/17/98 TJS
Actual schedule PRP Group Followed (LARGER GRAY BARS)
Schedule if PRP Group waited until Final Design was approved (accounting for April to October Construction season) in BLACK SOLID BARS

April 09, 1999

Ms Heather Nelson
United States Environmental Protection Agency (USEPA)
Region V, SR-J6
77 West Jackson Boulevard
Chicago, IL 60604-3590

SUBJECT: Responses to February 16, 1999 Comments on the *Groundwater Modeling Follow-up to the August 25, 1998 Meeting* memorandum, the *Supplemental Ground Water, Modeling Report (Exhibit B)*, and *Visualization of Groundwater Flow and Transport Model in Zone I* prepared by Sharp and Associates, Inc. and Waterloo Hydrogeologic. Inc. for the Motor Wheel Disposal Site (MWDS) in Lansing, Michigan.

Dear Ms. Nelson:

The MWDS PRP Group is responding to your comments on the documents listed above. This correspondence is part of the informal dispute resolution for the Notice of Violation (NOV) issued in 1998.

We believe that the reduced summer pumping and on-site pit discharge alternatives to continuous pumping comply with the consent decree. Nevertheless, to reach an amicable resolution to the summer pumping NOV for the summer of 1999, the MWDS PRP Group is installing a tie-in connection to the City of Lansing WWTP. The MWDS PRP Group has received approval from the City of Lansing for the WWTP tie-in. Construction for this tie-in began on March 22, 1999. This tie-in will be completed in mid-June. This will allow for continued operation of the ground water treatment system despite the restricted discharge limits of the NPDES permit during the summer of 1999. This approach is considered a solution for this summer only. As we have stated in the past, we request a trial period during the summer months to discharge to the on-site pit. We are committed to coming to an agreement on an acceptable monitoring plan prior to this trial period, so that the data are acceptable to MDEQ and USEPA and address their concerns. The data collected will be used to further verify and refine the site models, allowing us to field verify the technical viability of discharge to the on-site pit.

We have responded to each of the comments on a point by point basis (see attachments). A summary of the differences between the USEPA comments and the Responses by the MWDS PRP group are presented below.

Gradient throughout the Glacial Aquifer

There have been a number of iterations between MDEQ and the MWDS PRP group on the appropriate gradient to be used in the Glacial Aquifer. As stated in the attached comments, we do not believe that the gradient suggested by MDEQ is physically realistic in light of the high hydraulic conductivity within Zone 1. Stepping back from the individual modeling iterations and modifications to input parameters, the key issue is the total flow through the Glacial Aquifer that affects the capture width from an extraction zone. The flow is a function of hydraulic conductivity, area, and gradient (i.e., $Q=KAi$). There has not been any disagreement with the values of hydraulic conductivity determined through constant rate pumping tests nor the porosity of the Aquifer. The difference is in the observed gradient. Variations in model parameters, such as the gradient, are appropriate as long as they are within the realm of reasonable possibilities consistent with the actual field data. If there were little data to support and calibrate these models, the sensitivities performed by MDEQ would have been appropriate. However, the sensitivities must still be checked to actual field observations.

One parameter that has not been addressed by either of the model variations to date is the back check of conservation of water for the Glacial Aquifer. In mathematical terms, $Q_1 = Q_2 + Q_{pumping(z1)} - Q_{recharge(z1\ to\ z2)}$ where, $Q_2 = K_2 A_2 i_2$. Considering the observed field data as follows:

K_2 = 185 ft/day (from pumping tests)
A_2 = 148821.56 ft^2 (see attached Figures)
i_2 = 0.00048 to 0.0012 (for Nov/98 and Feb/99 water levels, see attached Figures)
$Q_{pumping(z1)}$ = 80 GPM (15400 ft^3/day) (for Nov/98 to Feb/99)
$Q_{recharge(z1\ to\ z2)}$ = 2964 ft^3/day (recharge = 1.5 inches/year)

$\therefore Q_1$ = 25651.3 ft^3/d to 45474.4 ft^3/d

Given $Q_1 = K_1 A_1 i_1$ and $i_1 = Q_1/(K_1 A_1)$, with
K_1 = 290 ft/day (from pumping tests)
A_1 = 128464 ft^2 (see attached Figures)

$\therefore i_1$ = 0.00069 ft/ft to 0.00122 ft/ft.

Honoring conservation of water, the predicted gradient for Zone 1 (i_1) is between 0.00069 ft/ft and 0.00122, averaging 0.00096. A comparison of the gradients is listed below.

Model	Gradient (ft/ft)
SHARP model gradient	0.0010
FTC&H Gradient (1994)	0.0010
MDEQ model gradient sensitivity	0.0023
Observed gradient	0.0008
Predicted gradient in Zone 1 based on conservation of water	0.00096

Both the observed and the predicted gradient are much closer to what is included in the SHARP and WHI models. Doubling the gradient, as suggested by MDEQ, is not within the variability in the observed field data and would produce physically unrealistic flows through the Glacial Aquifer.

Model Boundary Conditions

USGS comments on the boundary conditions were focussed primarily on the Saginaw Aquifer and are being addressed through additional modeling. Note that this issue does not affect the capture in the Glacial Aquifer or the capture in the Saginaw Aquifer under similar Lansing Board of Water & Light (BWL) pumping conditions. The boundary conditions in the Saginaw Aquifer, which were derived from the USGS tri-county model, are representative of the BWL pumping for the period of 1992 to 1994. The regional pumping conditions have been similar since that time. However, if there are large changes in the relative pumping rates of the BWL wells, the boundary conditions need to be revised. This issue does not affect the resolution of the NOV, which only addresses plume capture within the Glacial Aquifer.

The USGS also made some comments on the Glacial Aquifer boundary conditions. However, due to the regional nature of the tri-county model the values from the USGS model do not reflect field observations in these areas (See attached Figures).

Capture/ Plume Interpretation

Our obligation under the consent decree is to capture the plume, and the plume is the area of groundwater that is in excess of clean-up standards. Our modeling shows that no areas above the clean-up standards escape the extraction well's capture area and continue to persist down-gradient. Contaminant concentrations within the Glacial Aquifer in the areas down-gradient of Zone 1 will continue to decrease until they are below the clean-up standard. Further to the modeling predictions, the field observations of ammonia indicate that the plume is cleaning up faster than model simulations predict.

On this issue, the MWDS PRP Group disagrees with USEPA's interpretation of plume capture.

Although we are in professional disagreement with USEPA on our compliance with the technical and legal issues relating to the remedial action, we have committed to discharge to the WWTP for an interim period. During this interim period, we need to evaluate the impacts of various combinations of actively managing our discharge water, including reduction in summer pumping, discharge to the on-site pit, discharge to WWTP, and the overall total extraction rate.

Sincerely,
The Motor Wheel Disposal Site PRP Group

Mark Whitmore/th

Mark Whitmore
Project Manager

Enclosures

cc: Sally Averill, U.S. EPA
Nola Hicks, U.S. EPA
Bill Porter, W. R. Grace Company
Phil Brown, Textron Automotive
Rob Franks, MDEQ
Todd Struttmann, Sharp
Dave Tripp, Dykema Gossett
Paul Martin, Waterloo Hydrogeologic, Inc.
Dave Lawton, SHARP

Response to Comments from Heather Nelson,
on the MWDS Groundwater computer models
April 09, 1999
Motor Wheel Disposal Site, Lansing Michigan

The following comments are from Heather Nelson, with regard to the groundwater computer models developed by Sharp and Associates, Inc. (Sharp), and Waterloo Hydrogeologic, Inc. (WHI) as the technical support group for the Motor Wheel Disposal Site (MWDS) Group. The comments are followed by responses from the technical support group.

Groundwater Modeling Follow-up to the August 25, 1998 Meeting:
General Comments

Comment 1.

The boundary conditions and the hydraulic properties (i.e., transmissivity, river leakage and areal recharge) used in the model result in a lower influx of water through the system than suggested by existing data. The reduced influx of water through the system causes the predicted capture zone to be larger than what would actually occur. Analyses should be performed to determine the sensitivity of the model results on the selected values for aquifer properties used in the modeling.

Response 1.

<u>Boundary Conditions</u>
The USGS comparison report (USGS, 1998) compared boundary conditions for both the Glacial and Saginaw Aquifers between the SHARP and USGS tri-county models. The main boundary conditions of concern in their comparison apply to the Saginaw Aquifer. Conditions regarding the Saginaw Aquifer are discussed with respect to the BW&L wells that are close to the boundaries on the western side of the SHARP model. Sharp and Waterloo Hydrogeologic (WHI) are currently evaluating the effects within the Saginaw Aquifer and possible changes to these boundary conditions. Any changes to these conditions have no effect on the Glacial Aquifer capture due to the distance of the Glacial Aquifer extraction wells from the Saginaw boundary in question.

The USGS report also discussed the variation in constant head boundaries within the Glacial Aquifer. At the northern end of the Sharp model the head values calculated in the USGS tri-county model varied in elevation from high in the east to lower in the west (see Figure 1). The values used in the Sharp model were based on observed water levels for the area (see Figures 1 and 2) and are closer to observed values than those calculated in the USGS tri-county model.

For the southern boundary of the model within the Glacial Aquifer, the USGS tri-county model predicted water level elevations above the Grand River stage (see Figure 3). Conversely, observed water levels near this area show that the actual values are closer to those utilized in the Sharp model, than those predicted by the USGS tri-county model (see Figure 4).

In addition, river elevations along the Grand and Red Cedar Rivers are higher than groundwater levels in the underlying aquifers (see Figure 5), indicating that these rivers lose water to the underlying aquifer (losing streams). Available streamflow data (from Holtschlag et al., 1996) also suggests that this portion of the Grand River loses a considerable amount of water to the underlying aquifer (see Table 1).

Note also that the boundary conditions currently used in the model simulate a north-south flow direction, which is consistent with the observed Glacial Aquifer ammonia and vinyl chloride plumes and hydraulic head distributions. As demonstrated in Appendix C of *The Results of the Saginaw Aquifer Investigation at the Motor Wheel Disposal Site*, March 16, 1998, the model is calibrated to both the observed water levels and the vinyl chloride/ammonia plume evolution. This is strong evidence that the model correctly simulates site conditions.

Glacial Aquifer Transmissivity

The hydraulic properties, primarily the Glacial Aquifer hydraulic conductivity, specified in the SHARP model is greater than 10 times larger than that specified in the USGS tri-county model (USGS, 1996) and is based upon pumping test data observed on-site (transmissivity is estimated to be greater than 4 times larger). We consider the Glacial Aquifer hydraulic properties in our model to be more realistic. Since the USGS and SHARP models have distinctly different purposes, and because of the regional nature of the USGS model, less care has been taken by the USGS to match observed conditions local to the MWDS.

Areal Recharge

We consider the recharge from precipitation that was used within the Sharp and WHI models to be representative, due to the presence of about 30 feet of low permeability till between the ground surface and the aquifer (based on over 60 monitoring wells completed within the area). Note that the USGS model simplified the geology of the Glacial Aquifer for the Tri-County region and therefore the recharge values specified by the USGS are not locally reliable. Reduced recharge at the MWDS is supported by Mr. Rick Mandel, MDEQ, in his "Comments on the USGS and SHARP Groundwater Model" (included with Heather Nelson's letter of November 12, 1998). In his comments he indicated that it was his opinion (based upon his on-site experience), that the USGS "overestimated the rate of recharge through the overlying glacial till to the glacial aquifer".

A sensitivity analysis of the capture zone performance under increased recharge conditions has been completed in the WHI model. WHI concluded that areal recharge has little effect on the capture zone delineations (Sharp and WHI, 1998).

Flow Through the Glacial Aquifer

The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (as suggested by MDEQ included with Heather Nelson's letter of February 16, 1999), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrate that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

Comment 2.

The model results indicate that the vinyl chloride plume is not being contained in the upper aquifer that could potentially cause a vertical extension of hazardous substance concentrations in the Saginaw aquifer. Upon migrating to the lower Saginaw aquifer, the vinyl chloride appears to migrate to the south, away from the northern extraction wells which may constitute a horizontal extension of hazardous substance concentrations in the aquifer above the higher of either the concentration allowed by Rule 299.5707 of the Michigan Environmental Response Act or the concentration allowed by Rule 299.5709.

Response 2.

Based on our site experience, there is no evidence supporting the southerly migration of vinyl chloride in the Saginaw Aquifer. Data from the Glacial Aquifer (see 4th quarter report, 1998) indicate that the vinyl chloride is only present in the lower portion of the Glacial Aquifer, up-gradient of the shale discontinuity (water from the Glacial Aquifer enters the Saginaw Aquifer at the shale discontinuity). Based on these data the vinyl chloride plume migrates into the Saginaw Aquifer north of the Saginaw Aquifer divide, as depicted in the attached cross-section (Figure 6). The hydraulic gradient within the Saginaw Aquifer at this location is northward (see 4th quarter report, 1998) and as the field data demonstrate, this prevents vinyl chloride migration toward the south.

Observed data from wells MW-55, MW-56, MW-65, MW-66, and MW-78 show that vinyl chloride has not been detected in the last four quarterly sampling rounds. Wells MW-65 and MW-66, located in the leakance region, have previously detected vinyl chloride, as expected based on their location. However, wells MW-55, MW-56 and MW-78 (south of the leakance region) have never detected vinyl chloride. This is strong evidence that vinyl chloride is migrating northward, toward SEW-1 and SEW-2, and does not constitute uncontrolled horizontal extension of hazardous substance concentrations in the aquifer above the higher of either the concentration allowed by Rule 299.5707 of the Michigan Environmental Response Act or the concentration allowed by Rule 299.5709.

Specific Comments

Comment 1.

An extraction well (located in layer 2 row 36 column 6) was assigned a positive pumping rate of 8,000 cubic feet/day. In MODFLOW, extraction wells are assigned a negative flow rate (volume/time) and injection wells are assigned a positive flow rate (Harbaugh & McDonald, 1996). The injection of water at this rate and location may affect the flow and transport model results.

Response 1.

We recognize the error and it has been corrected. The location of the well was far enough away from the capture zones developed by SEW-1 and SEW-2 that flow and transport predictions of the contaminant plume were not impacted by the mistake. Model results show that there is very little influence (i.e. no mounding) by this particular well on the hydraulic head distribution in the surrounding Saginaw Aquifer (see attached Figure 7), indicating that there would not be an effect on the SEW-1 / SEW-2 capture zones.

Comment 2.

U. S. EPA concurs with the USGS review that the constant head boundary conditions used in the model are questionable (Luukonen et al. 1998). In five time steps (1, 5, 10, 20, and 30 years) modeled as part of this review, the cone of depression created by the extraction wells extended to the constant head boundaries. As a result, steep gradients were developed at the boundaries, which most likely would not occur under natural conditions. Thus, the imposed flux across the constant head boundaries may not accurately represent the flow system for the modeled area.

Response 2.

Boundary Conditions

The USGS comparison report (USGS, 1998) compared boundary conditions for both the Glacial and Saginaw Aquifers between the SHARP and USGS tri-county models. The main boundary conditions of concern in their comparison apply to the Saginaw Aquifer. Conditions regarding the Saginaw Aquifer are discussed with respect to the BW&L wells that are close to the boundaries on the western side of the SHARP model. Sharp and Waterloo Hydrogeologic (WHI) are currently evaluating the effects within the Saginaw Aquifer and possible changes to these boundary conditions. Any changes to these conditions have no effect on the Glacial Aquifer capture due to the distance of the Glacial Aquifer extraction wells from the Saginaw boundary in question.

The USGS report also discussed the variation in constant head boundaries within the Glacial Aquifer. At the northern end of the Sharp model the head values calculated in the USGS tri-county model varied in elevation from high in the east to lower in the west (see Figure 1). The values used in the Sharp model were based on observed water levels for the area (see Figures 1 and 2) and are closer to observed values than those calculated in the USGS tri-county model.

For the southern boundary of the model within the Glacial Aquifer, the USGS tri-county model predicted water level elevations above the Grand River stage (see Figure 3). Conversely, observed water levels near this area show that the actual values are closer to those utilized in the Sharp model, than those predicted by the USGS tri-county model (see Figure 4).

In addition, river elevations along the Grand and Red Cedar Rivers are higher than groundwater levels in the underlying aquifers (see Figure 5), indicating that these rivers are losing streams. Available streamflow data (from Holtschlag et al., 1996) also suggests that this portion of the Grand River loses a considerable amount of water to the underlying aquifer (see Table 1).

Note also that the boundary conditions currently used in the model simulate a north-south flow direction, which is consistent with the observed Glacial Aquifer ammonia and vinyl chloride plumes and hydraulic head distributions. As demonstrated in Appendix C of *The Results of the Saginaw Aquifer Investigation at the Motor Wheel Disposal Site*, March 16, 1998, the model is calibrated to both the observed water levels and the vinyl chloride / ammonia plume evolution. This is strong evidence that the model correctly simulates site conditions.

Comment 3.

The transmissivity values used in the model (1,000 square feet/day) appear to be low compared to the range typically reported for the Saginaw Aquifer (2,000 to 3,000 square feet/day).

Response 3.

The transmissivity used in the Sharp model was based upon aquifer testing of the extraction wells (SEW-1 and SEW-2) and well MW-67 (Sharp, 1998a). These test results are considered more representative of local conditions within the modeled area than numbers reported from other areas (USGS, 1996).

Comment 4.

When similar cell sizes were compared, the river leakage values used by Sharp were as much as three orders of magnitude lower than the conservative estimates for the area used by the USGS (Luukonen et al., 1998).

Response 4.

Stream flow data from the Grand and Red Cedar Rivers shows that, contrary to the USGS tri-county model (USGS, 1996), this portion of the rivers provides recharge to the underlying aquifers, as demonstrated in Table 1. This is consistent with observed water level observations near these rivers which show that observed groundwater levels in the underlying aquifers are lower than the river stage (see Figure 5). Board of Water and Light pumping likely contributes to the losing river conditions in Lansing.

Consistent with field observations, the Sharp model simulates heads within the Glacial Aquifer as being below the river stage. Under these conditions, the application of low conductance values is appropriate.

Conductance values used in the Sharp model conservatively simulate less influx of water into the Glacial Aquifer. In this case, with losing rivers (flow from river to aquifer) the use of a higher conductance value would result in a greater influx of water to the underlying aquifer. A larger conductance in the Sharp model would have increased predicted heads near the rivers, reduced the predicted hydraulic gradient, and simulated larger capture zones. Clearly, since the rivers are losing streams, the use of larger river conductances, such as those used in the USGS model, would not have been conservative.

Comment 5.

The recharge applied to the majority of the modeled area (1.5 inches/year) will probably not significantly affect the model results, given the recharge estimated for the area (2 to 7 inches/year; Firouzian, 1962) and the potential reduction of recharge by pavement and storm sewers. However, it is another portion of the model that reduces the influx of water into the system compared to existing data and the regional USGS model (Luukonen et al., 1998).

Response 5.

<u>Areal Recharge</u>
We consider the recharge from precipitation that was used within the model to be representative, due to the presence of about 30 feet of low permeability till between the ground surface and the aquifer (based on over 60 monitoring wells completed within the area). Note that the USGS model

simplified the geology of the Glacial Aquifer for the Tri-County region and therefore the recharge values specified by the USGS are not locally reliable. Reduced recharge at the MWDS is supported by Mr. Rick Mandel, MDEQ, in his "Comments on the USGS and SHARP Groundwater Model" (included with Heather Nelson's letter of November 12, 1998). In his comments he indicated that it was his opinion (based upon his on-site experience), that the USGS "overestimated the rate of recharge through the overlying glacial till to the glacial aquifer".

A sensitivity analysis of the capture zone performance under increased recharge conditions has been completed in the WHI model. WHI concluded that areal recharge has little effect on the capture zone delineations.

Flow Through the Glacial Aquifer
The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (as suggested by MDEQ included with Heather Nelson's letter of February 16, 1999), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

Transport Model

Comment 1.

U.S. EPA did not find any technical issues or random errors with the MT3D transport model for vinyl chloride. It appears from the simulations that the entire vinyl chloride plume in the shallow glacial aquifer would be captured or removed to concentrations below 2 ug/L after 30 years. In addition, the plume does not appear to migrate past the two northern capture wells (SEW-1 and -2) to the north Lansing well field over the 30-year period. However, the model suggests the vinyl chloride plume would migrate from the upper glacial aquifer to the lower Saginaw Aquifer (i.e., it is not contained in the upper aquifer). Once in the lower aquifer, the plume appears to migrate south, away from the northern capture wells, toward the Lansing Board of Water and Light public-supply wells. Subsequently, the effect of such migration does not comply with Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 P.A. 45 1. as amended.

Response 1.

Based on our site experience, there is no evidence supporting the southerly migration of vinyl chloride in the Saginaw Aquifer. Data from the Glacial Aquifer (see 4th quarter report, 1998) indicates that the vinyl chloride is only present in the lower portion of the Glacial Aquifer, up-gradient of the shale discontinuity (water from the Glacial Aquifer enters the Saginaw Aquifer at the shale discontinuity). Based on this data the vinyl chloride plume migrates into the Saginaw Aquifer north of the Saginaw Aquifer divide, as depicted in the attached cross-section (Figure 6). The hydraulic gradient within the Saginaw Aquifer at this location is northward (see 4th quarter report, 1998) and as the field data demonstrates, this prevents vinyl chloride migration toward the south.

Observed data from wells MW-55, MW-56, MW-65, MW-66, and MW-78 show that vinyl chloride has not been detected in the last four quarterly sampling rounds. Wells MW-65 and MW-66, located in the leakance region, have previously detected vinyl chloride, as expected based on their location. However, wells MW-55, MW-56 and MW-78 (south of the leakance region) have never detected vinyl chloride. This is strong evidence that vinyl chloride is migrating northward, toward SEW-1 and SEW-2, and does not constitute uncontrolled horizontal extension of hazardous substance concentrations in the aquifer above the higher of either the concentration allowed by Rule 299.5707 of the Michigan Environmental Response Act or the concentration allowed by Rule 299.5709.

Supplemental Ground Water Modeling Report **(Sharp and Associates, Inc. and Waterloo Hydrogeologic, Inc.** ***[WHI], November 1998)***

General Comments

Comment 1.

The supplemental groundwater modeling focuses specifically on the capture because of cessation of pumping in Zones 1 and 2 from July through September, and whether the plume expands laterally or vertically because of reduced summer pumping. The verification modeling performed by WHI did not discuss or address the concerns of the model boundary conditions and selection of hydraulic properties used in the initial modeling performed by Sharp.

Response 1.

Boundary Conditions

The USGS comparison report (USGS, 1998) compared boundary conditions for both the Glacial and Saginaw Aquifers between the SHARP and USGS tri-county models. The main boundary conditions of concern in their comparison apply to the Saginaw Aquifer. Conditions regarding the Saginaw Aquifer are discussed with respect to the BW&L wells that are close to the boundaries on the western side of the SHARP model. Any changes to these conditions have no effect on the Glacial Aquifer capture due to the distance of the Glacial Aquifer extraction wells from the Saginaw boundary in question. Consequently, there was no need to address this concern within the scope of the Zone 1 model that was developed by WHI.

The USGS report also discussed the variation in constant head boundaries within the Glacial Aquifer. At the northern end of the Sharp model the head values calculated in the USGS tri-county model varied in elevation from high in the east to lower in the west (see Figure 1). . The values used in the Sharp model were based on observed water levels for the area (see Figures 1 and 2) and are closer to observed values than those calculated in the USGS tri-county model.

For the southern boundary of the model within the Glacial Aquifer, the USGS tri-county model predicted water level elevations above the Grand River stage (see Figure 3). Conversely, observed water levels near this area show that the actual values are closer to those utilized in the Sharp model, than those predicted by the USGS tri-county model (see Figure 4).

In addition, river elevations along the Grand and Red Cedar Rivers are higher than groundwater levels in the underlying aquifers (see Figure 5), indicating that these rivers are losing streams.

Available streamflow data (from Holtschlag et al., 1996) also suggests that this portion of the Grand River loses a considerable amount of water to the underlying aquifer (see Table 1).

Note also that the boundary conditions currently used in the model simulate a north-south flow direction, which is consistent with the observed Glacial Aquifer ammonia and vinyl chloride plumes and hydraulic head distributions. As demonstrated in Appendix C of *The Results of the Saginaw Aquifer Investigation at the Motor Wheel Disposal Site*, March 16, 1998, the model is calibrated to both the observed water levels and the vinyl chloride / ammonia plume evolution. This is strong evidence that the model correctly simulates site conditions.

Based upon this physical site data, the boundary values and hydraulic gradient across the site were not varied explicitly within the WHI sensitivity analysis because they are considered certain.

Hydraulic Properties

The aquifer properties (hydraulic conductivity, storativity, porosity) for the Glacial and the Saginaw Aquifers were selected from field data (Sharp and Associates, 1998b). Recognizing the potential range of these parameters, WHI did include sensitivity simulations with a conservative range of hydraulic properties (hydraulic conductivity, storativity, porosity) and the recharge boundary condition (which indirectly affects the simulated hydraulic gradient) (Sharp and WHI, 1998). The results of this conservative approach indicated that under all scenarios tested the plume was cut off, after approximately seven years, due to Zone 1 pumping.

Comment 2.

Comparing the modeling performed and the third quarter report raised the following concerns:

- The modeling assumes a continuous pumping rate of 45 gpm/well in Zones 1 and 2 of the Glacial aquifer, and 130 gpm/well in the Saginaw Aquifer for 9 months, and that the pumps are then turned off for 3 months. However, based on the production information provided in Quarterly Monitoring Reports the extraction during the first and second quarters has not been continuous nor has it been at the rates used in the model.

Response 2.

As intended, the first year of operation (Fall 97 – Fall 98) of the extraction system was used to detect and remove all of the technical operational difficulties (shake-down period). In that time period we have experienced and resolved a number operational difficulties:

- **equipment upgrade and repair/replacement (submersible well pumps, starters, transmitters, pressure transducers, chemical probes);**
- **biological activity/sheen issues with MDEQ/SWQD with regard to Outfall 002.**
- **reconfiguration of the treatment stream to include an in-line ammonia analyzer with attendant start-up problems; and**
- **interference from external parties (well damage from City of Lansing snow removal or street work, pipeline breaks from undocumented or mis-located construction activities)**

The fact that the MWDS Group experienced operational difficulties during the shakedown period is normal and not indicative of future operational difficulties.

Since the fall of 1998, pumping rates have increased such that in March 1999 uptime flow rates were 96 gpm (average 87 gpm) in Zone 1 and uptime flow rates of 99 gpm (average 90 gpm) in Zone 2 (see Table 1 of the March monthly operation report) and is exceeding the operational targets of 90 GPM for each zone. As shown in Figure 8, ammonia plume separation is predicted to occur in seven years with a total Zone 1 pumping rate of 77 GPM (from November 1998 monthly report, applied for the period October to June). This is within the range of plume separation times achieved under the 90 GPM pumping scenarios simulated by modeling (6 - 8 years). Based upon the current Zone 1 performance, the plume capture conclusions of the Sharp and WHI models (1998) are confirmed.

Recognizing the uncertainty inherent in the modeling results, the MWDS group is not solely relying upon this technical information. The strongest evidence of plume capture is in the physical water level monitoring data, which has demonstrated that capture exceeds that predicted in the model (Figure 9).

- It is unclear if the potentiometric levels during the cessation period used in the model were reasonable when compared to actual results (i.e., the levels presented in the third quarter report).

Response 2a.

Data from the third quarter was not available at the time the model was presented. However, as stated above, water level monitoring has demonstrated that capture exceeds that predicted in the model (Figure 9).

Comment 3.

The modeling performed focuses on only the Glacial aquifer and does not examine the potential affects the cessation of pumping in Zones 1 and 2 may have on the plumes in the Saginaw Aquifer which are pertinent to determining the vertical and lateral extent of an increase in plume concentrations. Reduced containment of the vinyl chloride plume in Zone 2 may lead to increased migration to and increases in the concentration and extent of the vinyl chloride plume in the Saginaw Aquifer over time.

Response 3.

The available data shows that the level of vinyl chloride in the Saginaw is more than one order of magnitude less than that observed at the Zone 2 pumping wells (see Figure 10) due to mass removal at the Zone 2 extraction wells. We recognize that under any Zone 2 operational scenario some vinyl chloride will migrate to the Saginaw Aquifer. However, upon entering the Saginaw Aquifer vinyl chloride is observed to migrate northward, towards SEW-1 and SEW-2 and is therefore within the capture zone of the extraction system. No increase in the horizontal or vertical extent of the vinyl chloride plume in the Saginaw Aquifer will result from the reduction of summer pumping.

Comments on the Supplemental Modeling Report

The supplemental modeling report was performed to examine the effects on hydraulic capture and the plume configuration from the cessation of pumping in Zones 1 and 2 from July through September of each year. The following observations were made on the modeling results:

Comment 1.

The January and September 1998 modifications to the Sharp model did not address the concerns on the boundary conditions or selection of hydraulic properties raised previously by the USGS or U.S. EPA.

Response 1.

Boundary Conditions

The USGS comparison report (USGS, 1998) compared boundary conditions for both the Glacial and Saginaw Aquifers between the SHARP and USGS tri-county models. The main boundary conditions of concern in their comparison apply to the Saginaw Aquifer. Conditions regarding the Saginaw Aquifer are discussed with respect to the BW&L wells that are close to the boundaries on the western side of the SHARP model. Sharp and Waterloo Hydrogeologic (WHI) are currently evaluating the effects within the Saginaw Aquifer and possible changes to these boundary conditions. Any changes to these conditions have no effect on the Glacial Aquifer capture due to the distance of the Glacial Aquifer extraction wells from the Saginaw boundary in question

The USGS report also discussed the variation in constant head boundaries within the Glacial Aquifer. At the northern end of the Sharp model the head values calculated in the USGS tri-county model varied in elevation from high in the east to lower in the west (see Figure 1). . The values used in the Sharp model were based on observed water levels for the area (see Figures 1 and 2) and are closer to observed values than those calculated in the USGS tri-county model.

For the southern boundary of the model within the Glacial Aquifer, the USGS tri-county model predicted water level elevations above the Grand River stage (see Figure 3). Conversely, observed water levels near this area show that the actual values are closer to those utilized in the Sharp model, than those predicted by the USGS tri-county model (see Figure 4).

In addition, river elevations along the Grand and Red Cedar Rivers are higher than groundwater levels in the underlying aquifers (see Figure 5), indicating that these rivers are losing streams. Available streamflow data (from Holtschlag et al., 1996) also suggests that this portion of the Grand River loses a considerable amount of water to the underlying aquifer (see Table 1).

Note also that the boundary conditions currently used in the model simulate a north-south flow direction, which is consistent with the observed Glacial Aquifer ammonia and vinyl chloride plumes and hydraulic head distributions. As demonstrated in Appendix C of *The Results of the Saginaw Aquifer Investigation at the Motor Wheel Disposal Site*, March 16, 1998, the model is calibrated to both the observed water levels and the vinyl chloride / ammonia plume evolution. This is strong evidence that the model correctly simulates site conditions.

Glacial Aquifer Transmissivity

The Glacial Aquifer hydraulic conductivity, specified in the SHARP model is > 10 times larger than that specified in the USGS tri-county model (USGS, 1996) (transmissivity is estimated to be > 4 times larger) based upon pumping test data observed on-site. We consider this to be a conservative approach to modeling the Glacial Aquifer. This is a result of the fact that the USGS and SHARP models have distinctly different purposes, and because of the regional nature of the

USGS model, less care has been taken by the USGS to match observed conditions local to the MWDS.

Areal Recharge

We consider the recharge from precipitation that was used within the model to be representative, due to the presence of about 30 feet of low permeability till between the ground surface and the aquifer (based on over 60 monitoring wells completed within the area). Note that the USGS model simplified the geology of the Glacial Aquifer for the Tri-County region and therefore the recharge values specified by the USGS are not locally reliable. Reduced recharge at the MWDS is supported by Mr. Rick Mandel, MDEQ, in his "Comments on the USGS and SHARP Groundwater Model" (included with Heather Nelson's letter of November 12, 1998). In his comments he indicated that it was his opinion (based upon his on-site experience), that the USGS "overestimated the rate of recharge through the overlying glacial till to the glacial aquifer".

A sensitivity analysis of the capture zone performance under increased recharge conditions has been completed in the WHI model. WHI concluded that areal recharge has little effect on the capture zone delineations.

Comment 2.

Based on time/concentration maps of the vinyl chloride transport simulations (Figures 2 through 6), and comparisons between the continuous pumping and the 90-day cessation scenarios in both Zones 1 and 2, the model predicts better containment under the continuous pumping scenario. In both zones, the plume separates more quickly, and there is greater distance in the separation over time, under the continuous pumping scenario.

A discussion should be added on the potential impacts over time to the plumes in the Saginaw Aquifer that may be caused by the cessation in pumping during the summer months. As noted from the results of 90-day cessation simulations, more vinyl chloride from Zone 2 would potentially migrate to the Saginaw Aquifer. Thus over time, the vinyl chloride plume in the Saginaw Aquifer will continue to increase in concentration and size.

Response 2.

Regardless, plume clean up is achieved with both pumping scenarios, and the size of the plume, relative to the original plume footprint, does not increase over time (Part 201 not violated).

The MWDS group will provide a discussion of this matter through subsequent modeling investigations. However, the available data shows that the level of vinyl chloride in the Saginaw is more than one order of magnitude less than that observed at the Zone 2 pumping wells (see Figure 10) due to mass removal at the Zone 2 extraction wells. We recognize that under any Zone 2 operational scenario some vinyl chloride will migrate to the Saginaw Aquifer. However, upon entering the Saginaw Aquifer vinyl chloride is observed to migrate northward, towards SEW-1 and SEW-2 and is therefore within the bounds of the extraction system.

Comment 3.

A local scale model in Zone 1 was extracted from the larger Sharp model by WHI. The local scale modeling was performed to examine the sensitivity of the cessation of pumping and hydraulic parameters on the ammonia results in the Glacial Aquifer. However, because of the apparent boundary effects observed in the larger Sharp model, the smaller model area used exaggerates the capture potential of the extraction wells, and does not provide a representative sensitivity analysis of the system.

Response 3.

Boundary Conditions

The USGS comparison report (USGS, 1998) compared boundary conditions for both the Glacial and Saginaw Aquifers between the SHARP and USGS tri-county models. The main boundary conditions of concern in their comparison apply to the Saginaw Aquifer. Conditions regarding the Saginaw Aquifer are discussed with respect to the BW&L wells that are close to the boundaries on the western side of the SHARP model. Sharp and Waterloo Hydrogeologic (WHI) are currently evaluating the effects within the Saginaw Aquifer and possible changes to these boundary conditions. Any changes to these conditions have no effect on the Glacial Aquifer capture due to the distance of the Glacial Aquifer extraction wells from the Saginaw boundary in question

The USGS report also discussed the variation in constant head boundaries within the Glacial Aquifer. At the northern end of the Sharp model the head values calculated in the USGS tri-county model varied in elevation from high in the east to lower in the west (see Figure 1). The values used in the Sharp model were based on observed water levels for the area (see Figures 1 and 2) and are closer to observed values than those calculated in the USGS tri-county model.

For the southern boundary of the model within the Glacial Aquifer, the USGS tri-county model predicted water level elevations above the Grand River stage (see Figure 3). Conversely, observed water levels near this area show that the actual values are closer to those utilized in the Sharp model, than those predicted by the USGS tri-county model (see Figure 4).

In addition, river elevations along the Grand and Red Cedar Rivers are higher than groundwater levels in the underlying aquifers (see Figure 5), indicating that these rivers are losing streams. Available streamflow data (from Holtschlag et al., 1996) also suggests that this portion of the Grand River loses a considerable amount of water to the underlying aquifer (see Table 1).

Note also that the boundary conditions currently used in the model simulate a north-south flow direction, which is consistent with the observed Glacial Aquifer ammonia and vinyl chloride plumes and hydraulic head distributions. As demonstrated in Appendix C of *The Results of the Saginaw Aquifer Investigation at the Motor Wheel Disposal Site*, March 16, 1998, the model is calibrated to both the observed water levels and the vinyl chloride / ammonia plume evolution. This is strong evidence that the model correctly simulates site conditions.

Flow Through the Glacial Aquifer

The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (as suggested by MDEQ included with Heather Nelson's letter of February 16, 1999), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data

conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

As discussed above, the Saginaw Aquifer boundary conditions have no effect on the Glacial Aquifer simulations. Also, the variable boundary values suggested by the USGS tri-county model (USGS, 1998) for the Glacial Aquifer are not as representative of local aquifer water level observations as those used in the Sharp and WHI models (see Figures 1-5). With regard to the flow through the Glacial Aquifer at the MWDS, because we have applied field based property values and boundary conditions, the total flow simulated across the MWDS within the WHI model is reasonable. The model was developed using conservative parameter values for hydraulic conductivity, aquifer thickness, aquifer storage, areal recharge, and transport properties to evaluate Zone 1 capture predictions under a broad range of sensitivity scenarios. All of the sensitivity scenarios tested showed that the Zone 1 extraction wells prevent the plume from persisting down-gradient under reduced summer pumping conditions, while including multiple levels of conservatism. Based on these results and the broad range of scenarios tested, the results of the sensitivity analysis are representative.

Comment 3a.

In addition, the sensitivity of river leakage, which the model should be relatively sensitive to, was not investigated by WHI.

Response 3a.

As designed, the WHI model does not extend to the Grand or Red Cedar Rivers and thus no river leakage sensitivity simulations could be performed. River leakage is considered to have a negligible impact on the capture zone model predictions within Zone 1 because the rivers are far removed from the influence of the Zone 1 extraction wells and they are losing streams. As discussed above, the available streamflow data (Table 1) and observed water levels (see Figure 5) both indicate that the Grand and Red Cedar rivers contribute flow to the underlying aquifers.

Comment 3b.

A sensitivity analysis should be performed using the lower extraction rates. The Zone 1 pumping rates used in the WHI model (90 and 120 gpm) are higher than what has been extracted to date from P- 1 and P-2. The maximum combined pumping rate for P- 1 and P-2 was reported to be about 60 gpm for the months of January through June 1998.

Response 3b.

As discussed under Response 2 (page 8) the first year of operation (fall 97 – fall 98) of the extraction system was used to detect and remove all of the technical operational difficulties (shakedown period). In that time period we have experienced and resolved a number operational difficulties:

- **equipment upgrade and repair/replacement (submersible well pumps, starters, transmitters, pressure transducers, chemical probes);**
- **Biological activity/sheen issues with MDEQ/SWQD with regard to Outfall 002.**

- reconfiguration of the treatment stream to include an in-line ammonia analyzer with attendant start-up problems; and
- interference from external parties (well damage from City of Lansing snow removal or street work, pipeline breaks from undocumented or mis-located construction activities)

Each of these events has hampered our ability to operate the system at full capacity during the start-up period.

Since the fall of 1998, pumping rates have increased to an average of 77 GPM in Zone 1 and 91 GPM in Zone 2 (see Table 1 of the monthly operation reports) and is approaching the operational targets of 90 GPM for each zone. While we do anticipate being able to achieve the 90 GPM target level for Zone 1 pumping in the near future, the current pumping rate of 77 GPM does produce sufficient capture. As shown in Figure 8, ammonia plume separation is predicted to occur in seven years with a total Zone 1 pumping rate of 77 GPM (October to June). This is within the range of plume separation times achieved under the 90 GPM pumping scenarios simulated (6 - 8 years). Consequently, the current pumping rate does not change the plume capture conclusions of Sharp and WHI (1998).

Recognizing the uncertainty inherent in the modeling results, the MWDS group is not solely relying upon this technical information. The strongest evidence of plume capture is in the physical water level monitoring data, which has demonstrated that capture exceeds that predicted in the model (Figure 9).

TABLE 1: Base Flow Upstream of and at Lansing, Michigan (Holtschlag et al., 1996)

Map index	USGS Gaging Station Index	Station Name	Base Flow (ft3/s)	Drainage Area (mi2)	Flow / Area (ft3/s/mi2)
C5 (continuous)	4112500	Red Cedar River at East Lansing	146	355	0.411
M9 (partial)	4112900	Sycamore Creek	49.8	96.2	0.518
M3 (partial)	4111033	Grand River	909	722	1.259
Total of Gaging Stations Upstream of Lansing:			**1104.8**	**1173.2**	**0.942**
C7 (continuous)	4113000	Grand River at Lansing	619	1230	0.503
Net Base Flow From Upstream Stations to Grand River at Lansing:			**-485.8**	**56.8**	**-8.553**

References

Holtschlag, D.J., Luukkonen, C.L., and Nicholas, J.R., 1996, Simulation of ground-water flow in the Saginaw Aquifer, Clinton, Eaton, and Ingham Counties, Michigan, U.S. Geological Survey Water-Supply Paper 2480, 49p.

Sharp and Associates, Inc., 1998a, The results of the Saginaw aquifer investigation at the Motor Wheel Disposal Site, Lansing Michigan, Final Report.

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Luukkonen, C.L., Grannemann, N.G., and Holtschlag, D.J., 1998, Comparison of Two Ground-Water Flow Models used to Simulate the Effectiveness of Extraction Wells near the North Lansing Well Field in Lansing, Michigan, U.S. Department of the Interior, and U.S. Geological Survey, Administrative Report, 44p.

Sharp and Associates, Inc., 1998b, The Results of the glacial and Saginaw Pumping Tests in the area of the Motor Wheel Disposal Site, Memorandum.

Sharp and Associates, Inc., 1999, Quarterly Monitoring Report, Fourth Quarter 1998 for the Motor Wheel Disposal Site (MWDS) Lansing Michigan.

**Response to Comments from Rob Franks,
on the MWDS Groundwater computer models
April 9, 1999
Motor Wheel Disposal Site, Lansing Michigan**

The following comments are from Rob Franks, with regard to the groundwater computer models developed by Sharp and Associates, Inc., and Waterloo Hydrogeologic, Inc. as the technical support group for the Motor Wheel Disposal Site (MWDS). The comments are followed by replies from the technical support group.

Comment 1.

The Michigan Department of Environmental Quality (MDEQ) has reviewed several groundwater computer models developed recently by Sharp and Associates and WHI for the Motor Wheel Disposal Site (MWDS) Potentially Responsible Party group. MDEQ's in-house modeling experts in the Land and Water Management Division reviewed the models in detail. In fact, as you may recall, the MDEQ staff person in charge of the model reviews, Mr. Rick Mandle is the same person who developed the original groundwater models for the MWDS in the early 1990's when he was working in the private sector. Mr. Mandle's comments are attached for your consideration.

As you will see, MDEQ does not agree with much of the modeling conducted by Sharp and WHI. As in other modeling reports submitted by Sharp, we disagree with some of the model input parameters and boundary conditions they establish. We also disagree with some of the conclusions Sharp and WHI draw on their modeling. For example, in the modeling conducted by WHI, they conclude that the model demonstrates that capture is maintained at zone 1 even during the three-month shutdown in the summer. In reviewing the model output it is clear to MDEQ that capture of the ammonia plume is not maintained when the pumps are turned off during the summer. The attached comments further illustrate this point.

Response 1.

While it is clear that the Zone 1 extraction wells do not capture every molecule of contaminant, this would be true of continuous pumping also. Our obligation under the consent decree is to capture the plume, which consists of the area of groundwater that is in excess of clean-up standards. Our modeling shows that no groundwater with concentrations above the clean-up standards escapes the extraction well area and continues to flow down gradient. By this, we mean that concentrations of ammonia and VOCs at locations within the Glacial Aquifer down gradient of Zone 1 will continue to decrease until they are below the clean-up standards set by the ROD. Further to the modeling predictions, the field observations of ammonia indicate that the Zone 1 wells are maintaining capture and that the plume is cleaning up faster than model simulations would predict.

As mentioned above, we submit that the simulations presented, which all indicate plume capture, contain multiple conservative assumptions as follows:

- **High aquifer hydraulic conductivity / transmissivity / total groundwater flow;**
- **High aquifer recharge conditions;**
- **High specific yield;**
- **High porosity;**
- **Conservative ammonia source with concentrations higher than currently observed;**
- **No decay / transformations / retardation.**

All of these simulations applied the design pumping rates for these wells, 90 GPM for Z1P1 and Z1P2 combined. While our goal is to obtain this pumping rate, the recent Zone 1 pumping rate since the fall of 1998 has averaged 77 GPM. As shown in Figure 8, ammonia plume separation is predicted to occur in seven years with a total Zone 1 pumping rate of 77 GPM (October to June). This is within the range of plume separation times achieved under the 90 GPM pumping scenarios simulated (6-8 years). Under all sensitivity scenarios tested with the conservative parameters outlined above, including a more representative pumping rate that will continue increasing, plume separation down gradient of Zone 1 is predicted.

Coupled with the existing ammonia observations, this condition shows that the reduced summer pumping plan, proposed by the PRP group, is effective in maintaining capture of the plume.

It is disappointing that after so many different modeling iterations submitted by the Potentially Responsible Parties (PRPs) that we are no closer to agreeing with them than we were at least a year ago. It is our opinion that the PRPs have been given ample opportunity to conduct their computer modeling. We believe that it is now time to move on and the PRPs should develop a new proposal; one that allows for pumping year round and at rates that provide constant capture of the contaminant plume.

It is equally disappointing to the PRP's and their technical support group that after so much time and effort spent demonstrating the technical feasibility of our proposals that the MDEQ group refuses to consider anything other than traditional, costly solutions at a time when other, technically practical, cost effective solutions are available.

Please contact me if you wish to discuss our comments.

We would again like to propose a technical meeting to discuss the proposed alternative scenarios with regard to actively managing the summer discharge from the MWDS treatment plant.

Response to Comments From Rick Mandel,
on the MWDS Groundwater computer models
January 11, 1999
Motor Wheel Disposal Site, Lansing Michigan

The following comments are from Rick Mandel, forwarded through Rob Franks, with regard to the groundwater computer models developed by Sharp and Associates, Inc., and Waterloo Hydrogeologic, Inc. as the technical support group for the Motor Wheel Disposal Site (MWDS). The comments are followed by replies from the technical support group.

SUBJECT: Motor Wheel Report and Models

The Hydrologic Studies Unit of the Land and Water Management Division has completed its review of these models. The models were used to simulate conditions at the Motorwheel Disposal Site. Two models were prepared by Sharp & Associates (Sharp). A third model was prepared by Waterloo Hydrogeologic Inc. (WHI). The models prepared by Sharp attempted to evaluate the impacts to predict capture of the plume if existing purge wells Z1-P1, Z1-P2, Z2-P1, Z2-P2, SEW-1 and SEW-2 are turned off for 90 days during the summer (Summer Schedule Model) or if the water from these wells, along with an additional well, is diverted to the pit (Pit Diversion Model). The model developed by WHI simulates the summer pumping schedule simulated in Sharp's Summer Schedule Model. These models are restricted to simulation of predicted contaminant movement in the glacial aquifer.

Summer Schedule - Sharp's Site Model

This review is not a thorough evaluation of the model. In particular, the modifications made by Sharp to the second layer, the layer representing the bedrock or Saginaw aquifer, have not and cannot be evaluated with the data made available to us. When this model was developed by Fishbeck, Thompson, Carr, and Huber (Fishbeck), the second layer was added to account for leakage from the first layer. The rate of leakage and the Saginaw transmissivity were never calibrated against any actual field data. We do not know if this has been done by Sharp. The constant heads at the boundaries of the Fishbeck model were estimated from a map that Sharp produced. The heads at this boundary do not change as municipal well field pumping changes with time. As developed by Fishbeck, this model was not intended to model flow in the Saginaw aquifer, partially because of issues relating to the choice and location of model boundaries.

The model has 125 rows and 68 columns, which are spaced progressively finer toward the Motor Wheel contaminant plume. The model domain covers a region of 15,675 by 27,755 feet. The model has two layers. The first layer represents the unconfined glacial aquifer. The second layer represents the confined Saginaw aquifer. The intervening aquitard is represented by the vertical leakance value. The model is a transient model in that pumping from six purge wells is cycled on for 275 days and off for 90 days for 40 years. The consultant made the following assumptions in modeling the groundwater flow at the site:

- horizontal hydraulic conductivity for layer 1 as shown in Figure 1,
- vertical hydraulic conductivity equal to 1/10 of horizontal hydraulic conductivity for layer 1,
- groundwater recharge of 36 inches per year for the landfill and pit and 1.5 inches per year for the remainder of the model for the first 90 days,
- no groundwater recharge for the remaining 39 years, 275 days,
- constant hydraulic heads, depicted in Figure 2, in layer 1of 806 feet along the southern boundary,
- constant hydraulic heads in layer 1 of 822 feet along the northern boundary,

- constant hydraulic heads in layer 1 which range from approximately 805.3 to 822 feet along the east and west boundaries,
- river cells in layer 1 with river stage elevations ranging from 808 to 825 feet representing the Grand River,
- seven pumping wells in the glacial aquifer and forty-one pumping wells in the Saginaw aquifer,
- effective porosity of 0.25 for the glacial aquifer and 0.15 for the Saginaw aquifer, distribution coefficient for the contaminant of 0.00164 cubic feet per pound,
- soil bulk density of 123 and 140 pounds per cubic feet for layers 1 and 2, respectively, and
- a half life value for the contaminant of 10 years.

The specified values for the contaminant are reasonable for vinyl chloride. Because of the specified distribution coefficient, the vinyl chloride is essentially not retarded in the model simulations, which is consistent with the observed characteristics of vinyl chloride.

Comment 1.

Sharp failed to include recharge to the model after the first ninety days. We have rerun the model with recharge for the first 90 days only, as supplied by Sharp, and with the recharge modified to cover the entire 40 years. Illustrations of model simulations for various time periods with and without recharge are shown in figures 3 through 14 for comparison purposes. The failure to assign recharge values after the first 90 days has an observable effect on the modeled potentiometric surface and particle tracking for those time periods. However, since recharge in the first 90 days accounts for less than 10% of the water entering the model, the effect of not including it is not that pronounced. Most of the water entering this model comes from the constant head boundaries. A very small volume comes from the river cells.

Response 1.

Sharp agrees that although the omission of recharge after the first 90 days has little effect on the model, it should be included for the entire model time. The omission happened when the model was converted from steady-state to transient, and will be included in future runs.

Comment 2.

As noted previously, the Sharp model sets the constant heads at the north end of layer 1 at 822 feet; the Fishbeck model sets them at 827 feet. The Sharp model set the constant heads at the south end of layer 1 at 806 feet; the Fishbeck model sets them at 805.03 to 805.71 feet. The Sharp model assigns constant heads to the east and west sides of the model; the Fishbeck model defined these cells as no-flow cells. The net effect of these changes is a lower hydraulic gradient through the model and the added potential for water to enter the model from the east and west sides.

Response 2.

<u>Model Boundary Values</u>
The north-south gradient across the total model domain in the Sharp model more accurately reflects observed site conditions (see Figures 1 to 4). In particular, the northern boundary value of 827 feet in the Fishbeck model is 5 feet higher than available observations from the MDNR water level data (see Figure 2). Furthermore, the Sharp model also allows for inflows and outflows along the ease and west boundaries, which is more realistic than the artificial impermeable boundaries applied along the east and west boundaries of the Fishbeck model.

Flow Through the Glacial Aquifer

The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (as suggested by MDEQ in correspondence, included with Heather Nelson's letter of February 16, 1999), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

Comment 3.

The lower hydraulic gradient reduces the modeled velocity of the contaminant plume.

Response 3.

This is an unsubstantiated conclusion. The velocity of the plume is controlled not only by the gradient but also by the porosity and hydraulic conductivity, which is higher in the Sharp model in the area of Zone 1 (290 feet/day) than in the Fishbeck model (250 feet/day). More importantly, the flow through the Sharp model has been shown to reflect field conditions.

Summer Schedule - WHI analysis and model

WHI reviewed the Sharp model and developed a smaller-scale four-layer model to represent only the glacial aquifer near the zone 1 purge wells. The WHI model is reportedly based on parameters consistent with the area around the zone 1 purge wells. Time-lapse results from twenty-four simulations developed using Visual Groundwater are presented from the Sharp model and the smaller-scale WHI model. The simulations are intended to illustrate the sensitivity of the model to a range of values for dispersivity, specific yield, recharge, hydraulic conductivity, well shutdown time, and pumping rates.

Comment 4.

The WHI model is of particular interest because it assumes no initial concentration of contaminant and therefore it is easier to observe the movement of the leading edge of the plume. The plume develops from the source area until it reaches the zone 1 purge wells as shown in Figures 17 through 22. After it reaches the purge wells, the effect of the summer schedule can be observed. Sharp claims that the summer schedule maintains capture of the contaminant plume. We interpret the simulation results differently. During the summer shutdown, we observe the plume's 34 mg/L leading edge move downgradient. This leading edge is not pulled back when pumping resumes. We interpret this observation as the expected movement of the plume during the summer shutdown, followed by dilution at the plume's 34 mg/L leading edge with clean water lateral to the plume. This dilution prevents any modeled break-off of a portion of the plume at a concentration above 34 mg/L. This is not the same as maintaining capture. Contaminants are getting past the wells because of the summer shutdown, but lateral dilution appears to reduce the downgradient concentrations below the 34 mg/L action limit.

Response 4.

As stated above, we submit that the Zone 1 extraction wells are the primary mechanisms that effectively prevent the plume from breaking off and continuing a southward migration. We do not dispute that the natural mechanisms of longitudinal, horizontal and vertical transverse dispersion play a role in preventing the further migration of the ammonia plume. The continuation of the plume is prevented and the plume does not extend beyond its initial footprint. This complies with the Consent Decree requirement of preventing the contaminant plume containing unacceptable concentrations of contaminants from migrating to the Saginaw Aquifer. Likewise this also complies with Michigan Part 201 which requires protection of, and remediation of the Glacial and Saginaw Aquifers.

Comment 5.

The Sharp report states that the modeled pre-pumping hydraulic gradient used in the WHI simulations is 0.001. Using the modeled values for effective porosity of 0.25 and hydraulic conductivity of 290 feet per day, the calculated groundwater velocity is 1.2 feet per day. Using the May 1998 potentiometric surface as depicted in figure 25, we calculated the hydraulic gradient through the area around the Zone 1 purge wells as 0.0023 feet per foot. Using the same values for effective porosity and hydraulic conductivity, the calculated groundwater velocity is 2.7 feet per day at this hydraulic gradient. During the proposed 90 day purge well shut down, the groundwater would thus move downgradient approximately 100 feet at the 0.001 hydraulic gradient or 240 feet at the observed gradient. It would be interesting to rerun the model at the higher gradient. The higher gradient will show more movement of the leading edge during the summer shutdown and may even show portions of the plume break-off, then reduce in concentration as a result of dilution, when pumping resumes.

Response 5.

While the overall gradient across the WHI model domain was established as 0.001, the effective gradient at the Zone 1 pumping wells was 0.0014 (base case simulation), due to the effects of pumping and areal recharge (see Figure 11). The gradient suggested above, 0.0023 ft/ft, is not a reasonable value since it was derived from schematic watertable contours from Figure 25 of Sharp and WHI (1998). As a result of the installed landfill cap, there is a lack of monitoring wells to the north of Zone 1 such that only schematic watertable contours are feasible in that area.

Interestingly, in the Final Additional Studies / Predesign Report Volume 1 (Fishbeck, Thompson, Carr, and Huber, 1996) the Glacial Aquifer groundwater velocity is simulated to be 0.9 feet/day. As noted above, WHI simulated a Glacial Aquifer velocity of 1.2 feet/day, which is 33% larger. This is further evidence that the parameters used in the WHI modeling were conservative. Nonetheless, the most important factor determining the validity of the simulations is not the gradient by itself, but rather the total flow through the Glacial Aquifer.

Flow Through the Glacial Aquifer

The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (0.0023 ft/ft), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer.

The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

Pit Diversion - Sharp Model

The model has 91 rows and 67 columns which are spaced progressively finer toward the pit. The model domain covers a region of 4,500 by 5,700 feet. The model has two layers. The first layer allows recharge only to the pit. The second layer represents the unconfined glacial aquifer. The model is a transient model in that recharge to the pit is increased for 90 days every year to simulate the diversion of water from the Motor Wheel purge wells to the pit. The model has been defined to run for five years. The consultant made the following assumptions in modeling the groundwater flow at the site:

- horizontal and vertical hydraulic conductivity of 5000 feet per day for layer 1,
- horizontal and vertical hydraulic conductivity of 290 feet per day for layer 2,
- groundwater recharge at a rate of 150-5 and 90 inches per year from the pit when water is being pumped into it during the summer and during the rest of the year, respectively,
- constant hydraulic heads in layer 2 of 814 and 824 feet along the southern and northern boundaries, respectively,
- five purge wells in layer 2 each pumping at 45 gpm,
- storativity of 1.00 and 0.20 for layers one and two, respectively, specific yield of 0.80 and 0.15 for layers one and two, respectively,
- effective porosity of 0.80 and 0.25 for layers one and two, respectively,
- distribution coefficient for the contaminant of 0.002 cubic feet per pound,
- soil bulk density of 123 pounds per cubic feet, and
- a half-life value for the contaminant of 20 years.

The specified values for the contaminant are similar to that specified in Sharp's site model and are reasonable for vinyl chloride. The high values for storativity, specific yield, and hydraulic conductivity are a reasonable approach to modeling the pit as a surface water body.

The model has added a third purge well to the zone one purge wells in an attempt to maintain capture of groundwater from the pit. The proposed summer schedule would divert the water produced by the five glacial aquifer purge wells each pumping 45 gpm each and by the two Saginaw aquifer purge wells pumping 130 gpm, each. This equals 93,400 cubic feet of water per day (cfd) added to the pit. Assuming a pit area of 279,000 square feet, the modeled recharge at the pit when water is diverted to the pit is 99,000 cfd. According to the consultant, the excess recharge of 5,600 cfd in the summer and 5,700 cfd at other times represents recharge for the entire model domain applied to the pit. Applying all of the recharge to the pit, although obviously not realistic, would be conservative. The recharge rate accurately accounts for the volume of water which would be supplied to the pit from the purge wells. The recharge rates were specified for all ten stress periods defined in the model.

Comment 6.

Sharp failed to define the general head boundaries, however, for stress periods five through ten in the model supplied to us. All water removed from the model after this point was removed only by the wells. Ninety days after the general head boundaries disappeared, the cells representing the pit were defined as dry by the model and all further recharge was also stopped. The only source of water was water stored in the simulated aquifer. Because of the failure to define the general head boundaries for all stress periods, MODPATH would not run successfully. We have rerun the model with general head boundaries specified for all ten stress periods. Illustrations of model simulation output are shown in Figure 23. These figures show that some particles from the pit area are not captured by the zone 1 purge wells. We also reran the model with 1.5 inches per year of recharge applied to the rest of the model. The results, illustrated in Figure 24, indicate that this revision has little effect on the capture zone.

Response 6.

The Sharp model contained conservative property values such as a uniform thickness, high hydraulic conductivity, and a high hydraulic gradient. Under these conditions model simulations indicated that the factor of safety in the capture predictions was low. We concur that a larger factor of safety on these capture predictions is desirable and we are currently evaluating alternative solutions that would ensure that a larger factor of safety is achievable. One of the ways to increase the factor of safety is to reduce the total volume of discharge to the MSV pit and divert the excess to the City of Lansing wastewater treatment plant. This is demonstrated in Figure 12, where the factor of safety associated with capturing pit discharge increases as pit discharge is decreased. Nonetheless, to evaluate the hydraulic and chemical affects of discharge to the pit we re-request permission to perform a pilot test of this alternative.

Comment 7.

As noted previously, the Sharp pit model sets 'the constant heads at the south and north ends of layer 2 at 814 and 824 feet. This produces an overall hydraulic gradient of 0.00175. This is closer to the observed hydraulic gradient of approximately 0.0023, as depicted in Figure 25 of the report, than the 0.001 used in the WHI site model, but still appears to understate the hydraulic gradient. We reran the model with a hydraulic gradient of 0.0023 by lowering the south general head boundary 3.1 feet to 810.9 feet. The results, shown in Figure 25, demonstrate that the higher hydraulic gradient reduces the modeled capture zone width.

Response 7.

The gradient suggested above, 0.0023 ft/ft, is not a reasonable value since it was derived from schematic water table contours from Figure 25 of Sharp and WHI (1998). As a result of the installed landfill cap, there is a lack of monitoring wells to the north of Zone 1 such that only schematic water table contours are feasible in that area. Nonetheless, the most important factor determining the validity of the simulations is not the gradient by itself, but rather the total flow through the Glacial Aquifer.

Flow Through the Glacial Aquifer

The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (0.0023 ft/ft), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

Conclusions and Recommendations

Sharp's site model (Summer Schedule Model) is too coarse to address the question of contaminant movement in the vicinity of the purge wells during the proposed summer purge well shutdown. We have noted some concerns about this model for general reference.

Comment 8.

The WHI four-layer site model does not demonstrate that containment of the plume is maintained during the proposed summer schedule. It appears that some contamination does move beyond the influence of the purge wells while they are shut down and that the concentrations in this contaminated region are then diluted by cleaner water dispersing laterally. Both the Sharp and WHI models understate the hydraulic gradient, resulting in an overly optimistic assessment of the capture zones. If the modeled hydraulic gradient were increased to match the observed hydraulic gradient, the capture width of the purge well system is reduced and the breakthrough of the contaminant would undoubtedly be more apparent in the modeling output.

Response 8.

While it is clear that the Zone 1 extraction wells do not capture every molecule of contaminant, this would be true of continuous pumping also. Our obligation under the consent decree is to capture the plume, which consists of the area of groundwater that is in excess of clean-up standards. Our modeling shows that no areas above the clean-up standards escapc the extraction well area and continue to flow down gradient. By this, we mean that locations within the Glacial Aquifer down gradient of Zone 1 will continue to decrease until it is below the clean-up standard. Further to the modeling predictions, the field observations of ammonia indicate that the Zone 1 wells are maintaining capture and that the plùme is cleaning up faster than model simulations would predict.

The gradient and the total flow through the Glacial Aquifer used in the modeling presented are representative of field conditions and the predictions of capture are realistic.

Comment 9.

The pit model does demonstrate the need for the additional proposed zone 1 purge well. At 45 gpm, however, it does not provide a wide enough capture zone. We suggest that two additional purge wells, properly located, may be required.

Response 9.

The Sharp model contained conservative property values such as a uniform thickness, high hydraulic conductivity, and a high hydraulic gradient. Under these conditions model simulations indicated that the factor of safety in the capture predictions was low. We concur that a larger factor of safety on these capture predictions is desirable and we are currently evaluating alternative solutions that would ensure that a larger factor of safety is achievable.

Comment 10.

The Department of Environmental Quality does not rely solely on modeling to predict capture or movement of contaminant plumes because the predictions are always estimates, dependent upon the quality and uncertainty of the input data. Furthermore, the physical processes governing groundwater flow and solute transport and parameters used as model input can only be approximated. Models may be used as predictive tools; however, the associated error in models as a result of assumptions and approximations requires that all model simulations be verified by field monitoring. It is our opinion that proper verification of the modeled hydraulic containment of contaminants will be required. By this, we mean that a monitoring network with a sufficient number of wells to demonstrate hydraulic containment is needed.

Response 10.

We concur with this recommendation and re-request permission to perform a pilot test of the proposed PIT discharge to evaluate the hydraulic and chemical affects. Recognizing the potential for ammonia transformation into nitrate and nitrite, we are also looking into the potential for this to occur and determining what effect, if any, this might have on the viability of the PIT discharge option.

Response to Comments from Rick Mandel,
On the Revised Motor Wheel Pit Diversion Model
April 09, 1999
Motor Wheel Disposal Site, Lansing Michigan

The following comments are from Rick Mandel, with regard to the Revised Motor Wheel Pit Diversion Model developed by Sharp and Associates, Inc., and Waterloo Hydrogeologic, Inc. as the technical support group for the Motor Wheel Disposal Site (MWDS). The comments are followed by replies from the technical support group.

The Hydrologic Studies Unit of the Land and Water Management Division has completed its review of the revised Motor Wheel Pit diversion model. The model was revised by Sharp and Associates (Sharp) to include stormwater recharge from Groesbeck Drain and refine the location of the proposed third purge well for zone 1.

Comment 1

The additional recharge is simulated by four injection wells, as shown in Figure 1, pumping at a rate of 45 gpm each. The additional recharge is based on stormwater runoff calculations for the northern half of the Groesbeck Drainage District (north of Lake Lansing Road) by Fitzgerald Henne & Associates, Inc. (Fitzgerald). They calculated a stormwater runoff rate of 306 acre-feet per year for the northern half of the drainage district. Sharp, after consulting with Fitzgerald, used double this volume for the entire district. It is not clear to us if the rate includes any deductions for evapotranspiration, surface runoff, or infiltration other than at the discharge from the storm sewers. It is our understanding that storm sewer design typically excludes these losses to assure a conservative design.

Response 1.

The stormwater runoff calculated by Fitzgerald Henne & Associates, Inc. (Fitzgerald) was used without modification regarding the potential losses from evaporation, surface runoff, and infiltration.

Comment 2.

The Groesbeck recharge rate used in the pit model is high enough to affect the capture zones of the zone 1 purge wells. The additional recharge improves the modeled capture effectiveness. If the recharge rate is too high, capture zone effectiveness would similarly be overstated.

Response 2.

The stated recharge is accurate with respect to current conditions. Please note that the effects of the Goesbeck recharge are more evident on the fourth quarter 1998 potentiometric surface map (Figure 9, attached) than shown by the model results. Because the hydraulic conductivity of the glacial aquifer in the pit model was set at 290 ft/day uniformly over the area, and the decreasing thickness to the east was not accounted for, the capture zone effectiveness as portrayed is conservative.

Comment 3.

We suggest that the modeling should disregard recharge from the Groesbeck Drainage District because a new stormwater sewer system is going to be built that will eliminate this recharge source within 2 years. Purge well design should not depend on a feature that will be eliminated in the very new future.

Response 3.

The 500 to 600 acre/ft of recharge from the Groesbeck Drainage District will not be eliminated for a period of 2 to 3 years. The most current estimate that has been given to us by the city (Fitzgerald) is that about 20% of the existing stormwater drainage load (120 acre feet per year) will continue to be diverted to the recharge indefinitely, for the purpose of continuing the wetland habitat present in the infiltration area. We believe that purge well design should take into account infiltration that will continue to have influence on the MWDS remediation system.

Comment 4.

The capture simulated by the revised model provided by Sharp is shown in Figure 1. The particles in the Sharp model were backtracked from locations around each purge well. In Figure 2, we have replaced those particles with a line of particles down gradient of the purge wells because this tends to highlight any gap in the capture zones. Gaps in the capture zones are apparent in Figure 2. Calibration data is included with these figures to illustrate the effects of the changes discussed below on the model calibration. Note that if the model simulation perfectly matched the calibration targets, the data points in the graphs would be right on the green line.

Response 4.

This method of placement will also result in particles mathematically backtracking between the individually developed zones of capture, regardless of the overlap of the capture zones between two wells. This can cause a misleading and unjustified portrayal of loss of capture between two (or more) wells.

Because the calibration targets are too high in the MDEQ's model, they are simulating too much total flow through the Glacial Aquifer system and that the calibration targets within Zone 2 are expected to be over-predicted in their model. Therefore, MDEQ's simulations are not considered as representative as those presented by the MWDS group. Notwithstanding, under the conditions simulated, the model indicates that the factor of safety in the capture predictions is low. We concur that a larger factor of safety on these capture predictions is desirable and we are currently evaluating alternative solutions that would ensure that a larger factor of safety is achievable.

Comment 5.

Figure 3 shows the capture zone with the Groesbeck recharge eliminated. The gaps are still evident, but the altered orientation of the capture zones also results in a loss of capture from the east site of the discharge pit.

Response 5.

As discussed above, the infiltration is going to be reduced after about three years, not eliminated. Thus the modeling is representative of the expected future conditions. Also, because the calibration targets are too high in the MDEQ's model, they are simulating too much total flow through the

Glacial Aquifer system and that the calibration targets within Zone 2 are expected to be over predicted in their model.

Complete capture can be maintained at a future time by increasing the pumpage from one or all of the extraction wells in the affected area. Also, Sharp recognizes that the only way to determine the optimum pumping rate for capture is to perform a pilot test for a long enough period to record the effects of discharging water to the pit.

Comment 6.

As mentioned in our January 11, 1999 response memo, there is also the issue of the hydraulic gradient in the vicinity of the zone 1 purge wells. In that memo, we calculated the hydraulic gradient in Sharp's pit model as .00175 ft/ft. This calculation was based on the heads specified at the general head boundaries in the model. Because of the way the model handles these heads, the actual hydraulic gradient in the model is closer to .0010 ft/ft. Figure 25 of Sharp's Supplemental Ground Water Modeling Report, dated November 1998, depicts a hydraulic gradient in the region near the zone 1 purge wells of approximately .0023 ft/ft. This hydraulic gradient was calculated from the 818 to the 821 contours. The steeper hydraulic gradient would reduce the width of the capture zones. Figure 4 illustrates the effect of increasing the hydraulic gradient from .0010 to .0013 ft/ft. Calibration data show the mean error to be improved from –1.08 feet, for the model simulation as provided by Sharp, to -.04 feet, for the increase hydraulic gradient simulation. The residual standard deviation divided by the observed range remains similar at 5.1% and 5.8%, respectively. Further increasing the hydraulic gradient in the region of the zone 1 purge wells would continue to reduce capture effectiveness.

Response 6.

<u>**Flow Through the Glacial Aquifer**</u>
The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (0.0023 ft/ft), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

CONCLUSIONS AND RECOMMENDATIONS

Comment 7.

The addition of the Groesbeck recharge to the model improves the modeled capture of groundwater from the discharge pit. However, incomplete capture is evident in the model, even with the Groesbeck recharge added. The Groesbeck recharge is expected to be eliminated within 2 years and therefore should not be a design factor in this remediation plan. Without the Groesbeck recharge, groundwater from the east side of the discharge pit is not captured.

Response 7.

The Sharp model contained conservative property values such as a uniform thickness, high hydraulic conductivity, and a high hydraulic gradient. As stated above, the addition of the Groesbeck recharge is considered representative of future conditions and is appropriate for inclusion in this model. Under these conditions, model simulations indicated that the factor of safety in the capture predictions was low. We concur that a larger factor of safety on these capture predictions is desirable and we are currently evaluating alternative solutions that would ensure that a larger factor of safety is achievable.

Comment 8.

The model may also understate the hydraulic gradient in zone 1. If the modeled hydraulic gradient is increased, the width of capture is further reduced.

Response 8.

<u>Flow Through the Glacial Aquifer</u>
The total flow through the Glacial Aquifer beneath the MWDS site has been calculated to verify that the flow through the model is realistic, as shown in the cover letter. Both field data, and water balance calculations using the available site data (hydraulic conductivity from pumping tests, Zone 2 hydraulic gradient from discrete water level observations, and aquifer thickness as delineated by the 60+ boreholes) show that the Zone 1 hydraulic gradient is approximately 0.00096 ft/ft. Application of a gradient more than twice as large as this (0.0023 ft/ft), while maintaining the same hydraulic conductivity would produce physically unrealistic flows through the Glacial Aquifer. The field data conclusively demonstrates that the flows simulated through the Glacial Aquifer by Sharp and WHI are realistic.

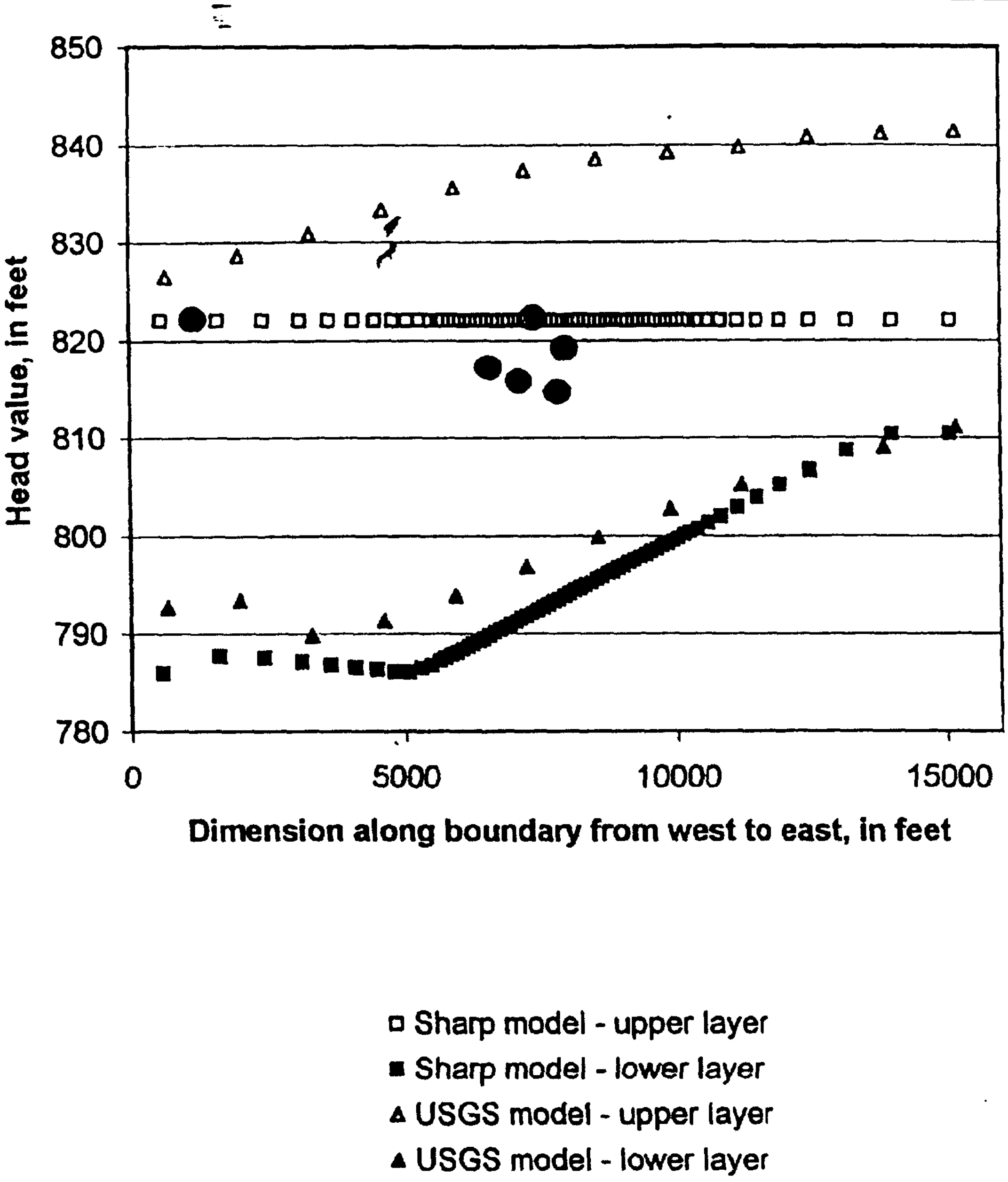


Figure 11. Relation between constant heads in Sharp's model and simulated heads in the USGS model along the north model boundary

● - MDNR, Statewide Groundwater Database Water Levels

Figure 1: Figure 11 from (Luukkonen, C.L., et al., 1998) with Projected MDNR Statewide Groundwater Database Water Levels

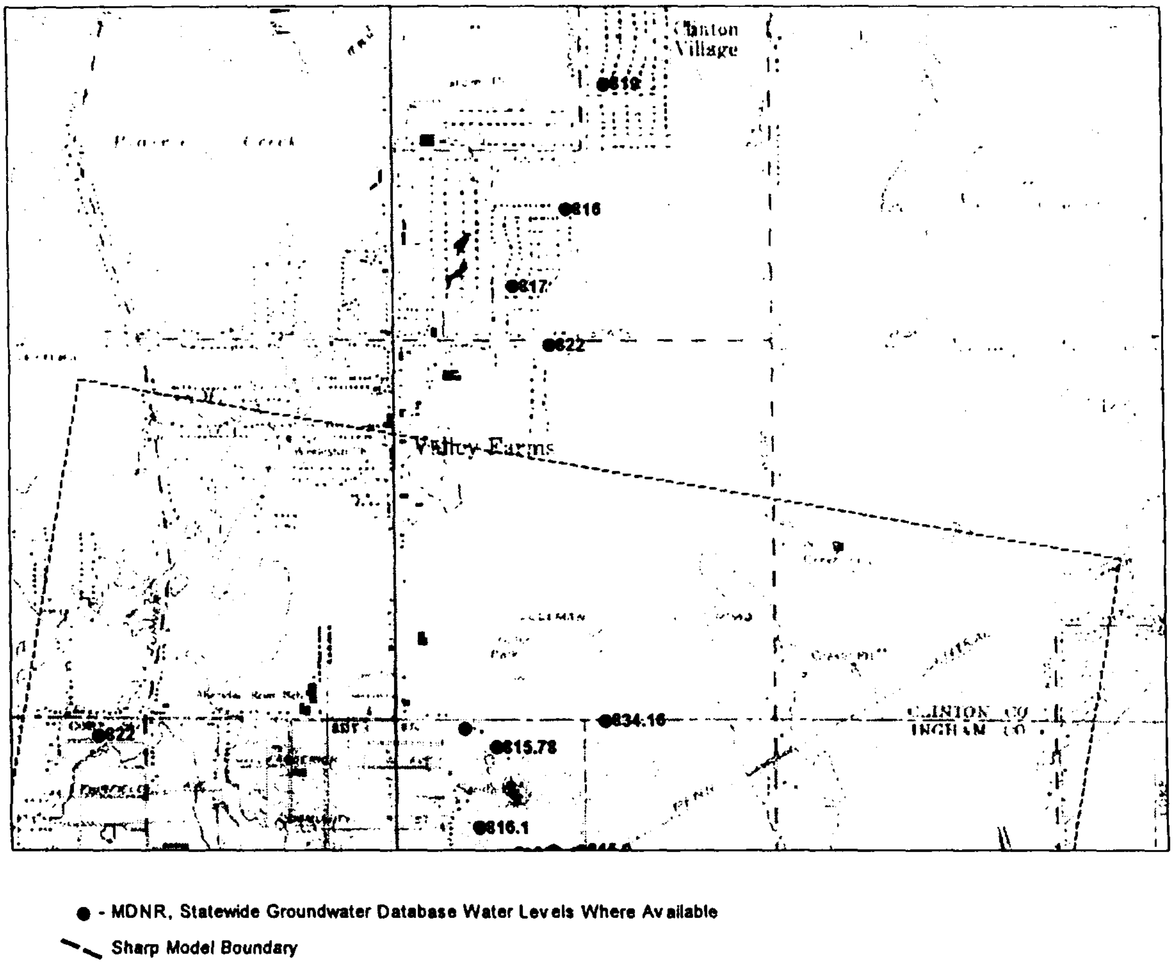


Figure 2: Site specific water levels for the Glacial Aquifer from the Statewide Groundwater Database near the Sharp model Northern Boundary

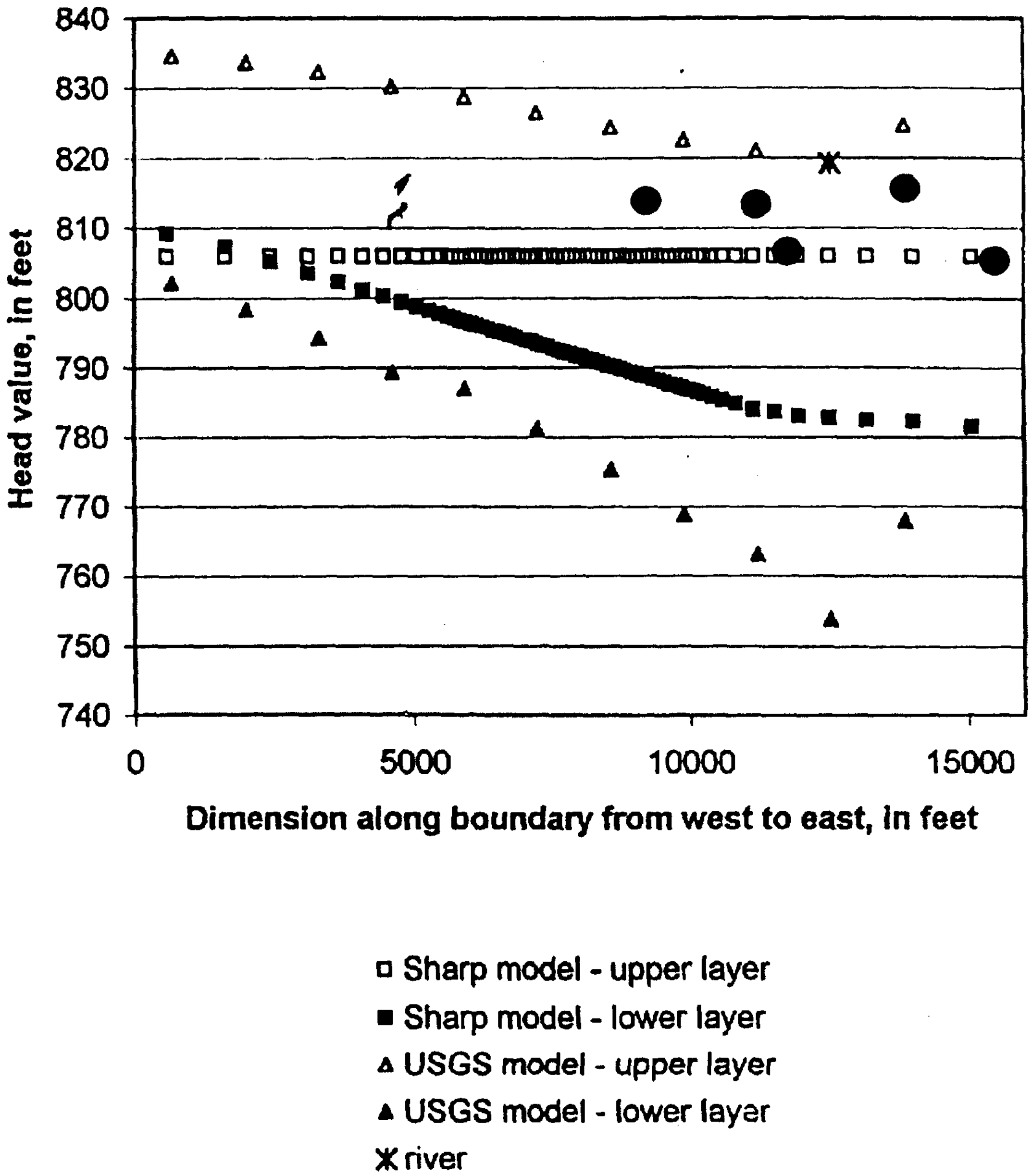
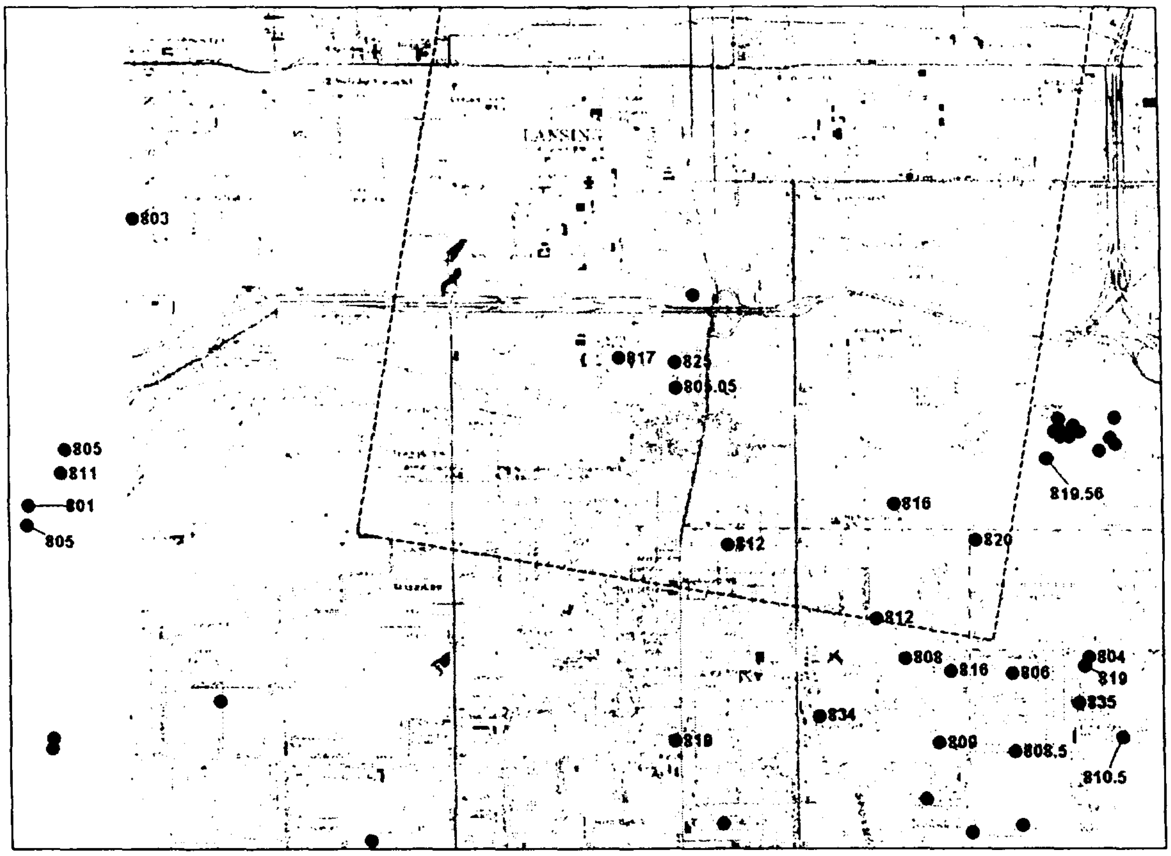


Figure 14. Relation between constant heads in Sharp's model, simulated heads in the USGS model, and river elevations along south model boundary

● MDNR, Statewide groundwater database water levels

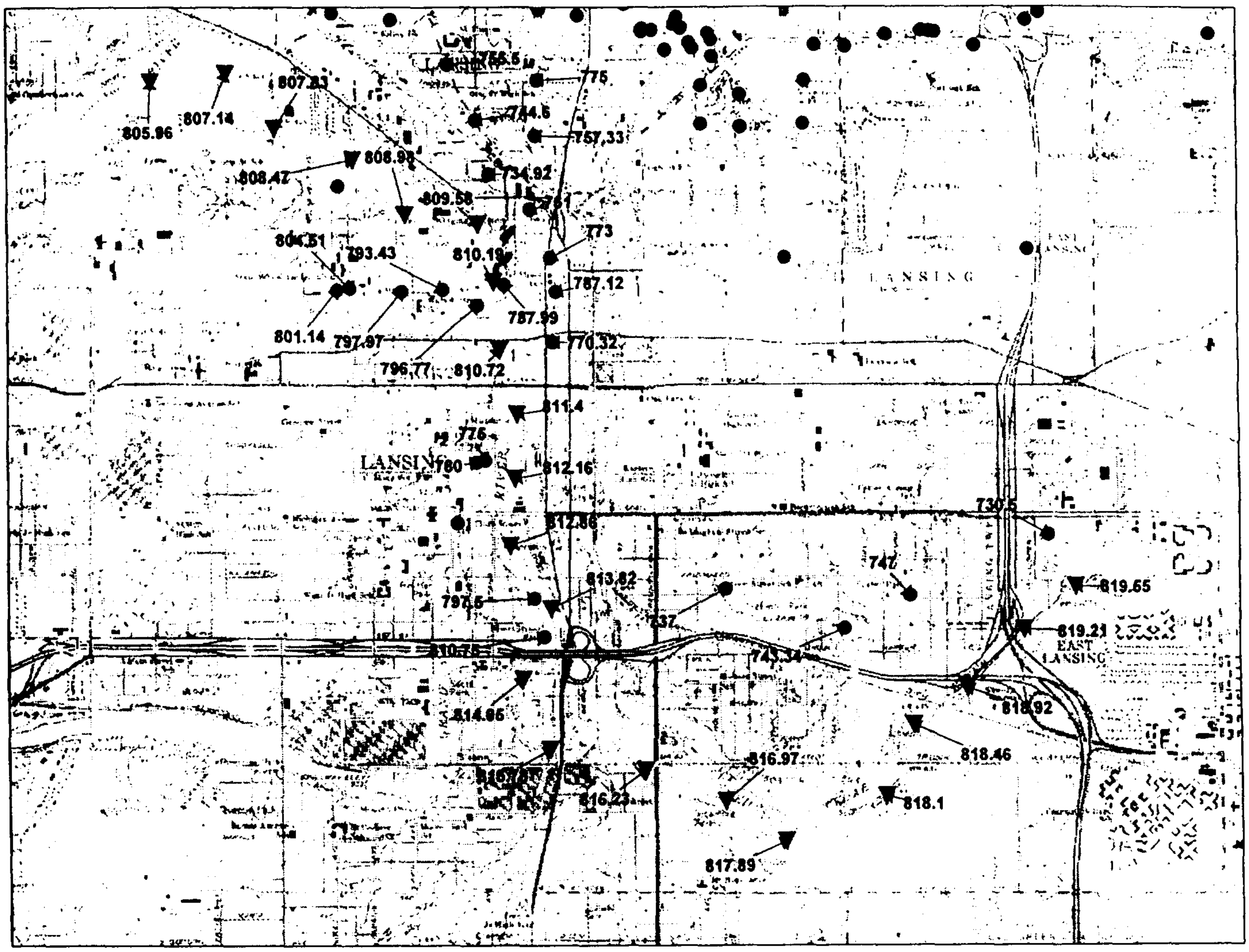
Figure 3: Figure 14 from (Luukkonen, C.L., et al., 1998) with Projected MDNR Statewide Groundwater Database Water Levels



● - MDNR, Statewide Groundwater Database Water Levels Where Available Close to the Southern B

Sharp Model Boundary

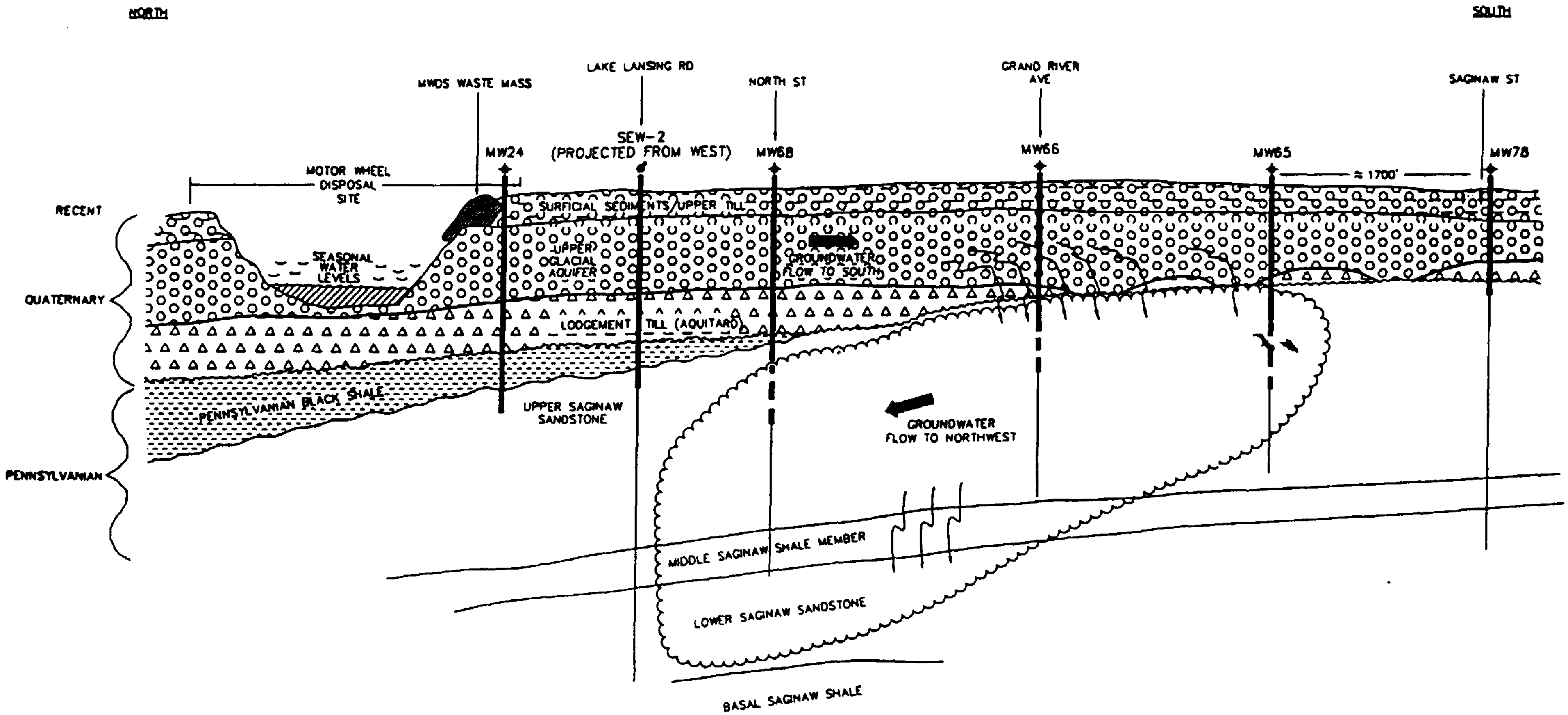
Figure 4: Site specific water levels for the Glacial Aquifer from the Statewide Groundwater Database near the Sharp model Southern Boundary



● - MDNR, Statewide Groundwater Database Water Levels

▼ - USGS Tri-county Model (1996) Specified River Stage

Figure 5: Comparison of site specific water levels with the Grand River stage from the USGS Tri-county model (1996)



SHARP AND ASSOCIATES, INC.
982 Crupper Avenue
Columbus, Ohio 43229

CONCEPTUAL CONTAMINANT TRANSPORT MODEL

MOTOR WHEEL DISPOSAL SITE
LANSING, MICHIGAN

PROJECT NUMBER	DATE	FILE NAME	SCALE	FIGURE
5104	11/24/97	5104SCHE	N.T.S.	6

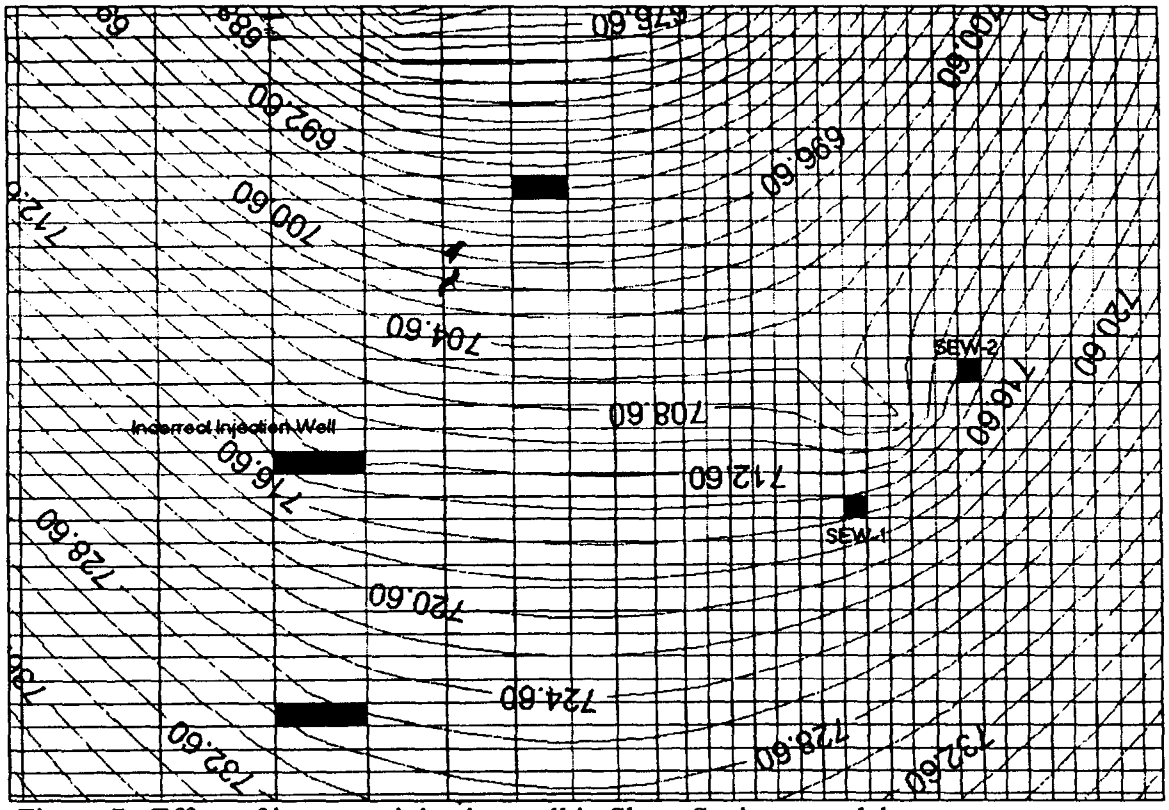
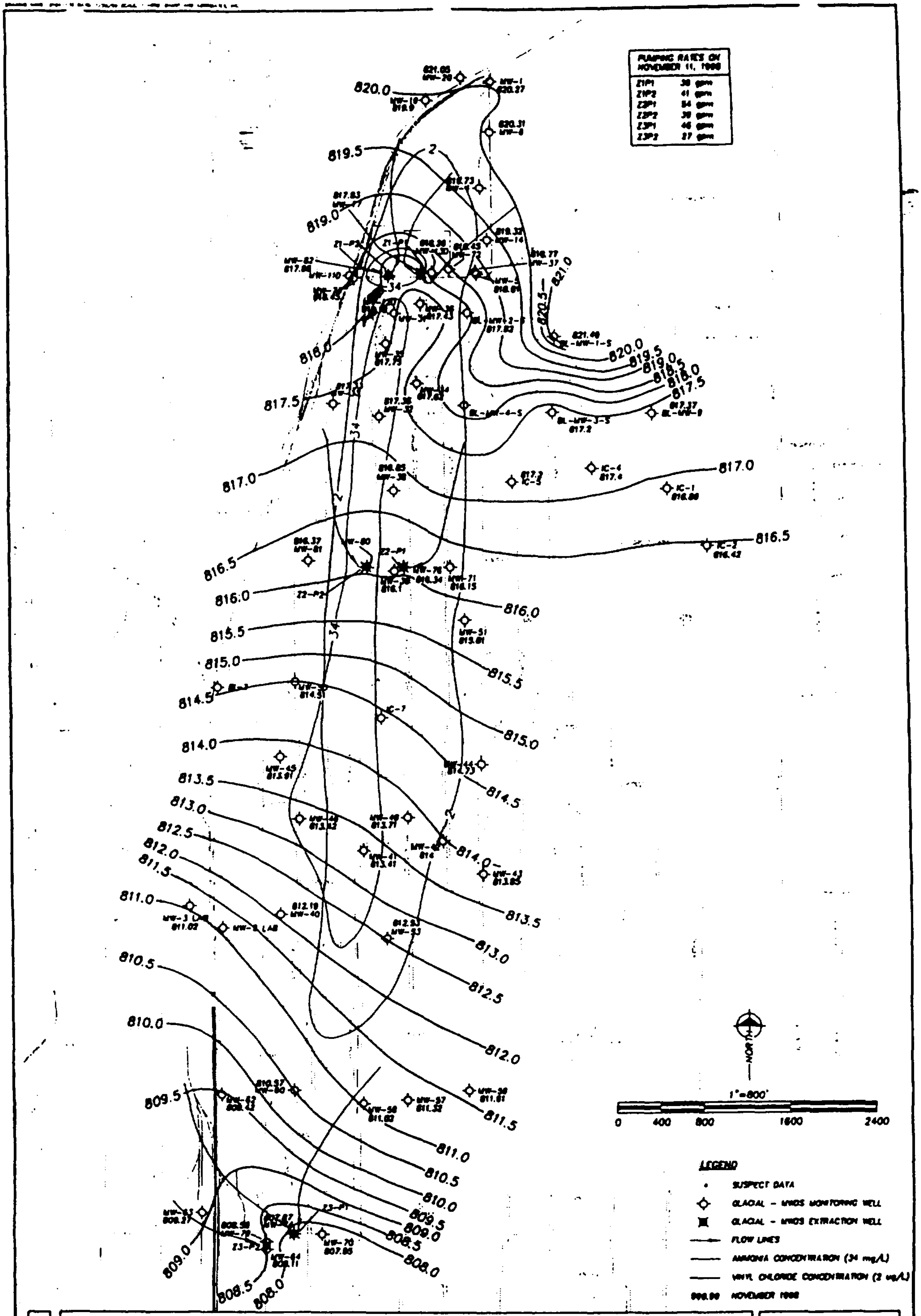


Figure 7: Effect of incorrect injection well in Sharp Saginaw model

Figure 8: Predicted ammonia plume separation after 7 years of reduced summer pumping with a total Zone 1 pumping rate of 77 GPM (October to June)



Project Reference: #5104

MOTOR WHEEL DISPOSAL SITE CLOSURE
LANSING, MICHIGAN

9 POTENTIOMETRIC SURFACE
GLACIAL AQUIFER
NOVEMBER 10-11, 1998

Client: MOTOR WHEEL PRP GROUP

SHARP AND ASSOCIATES, INC.

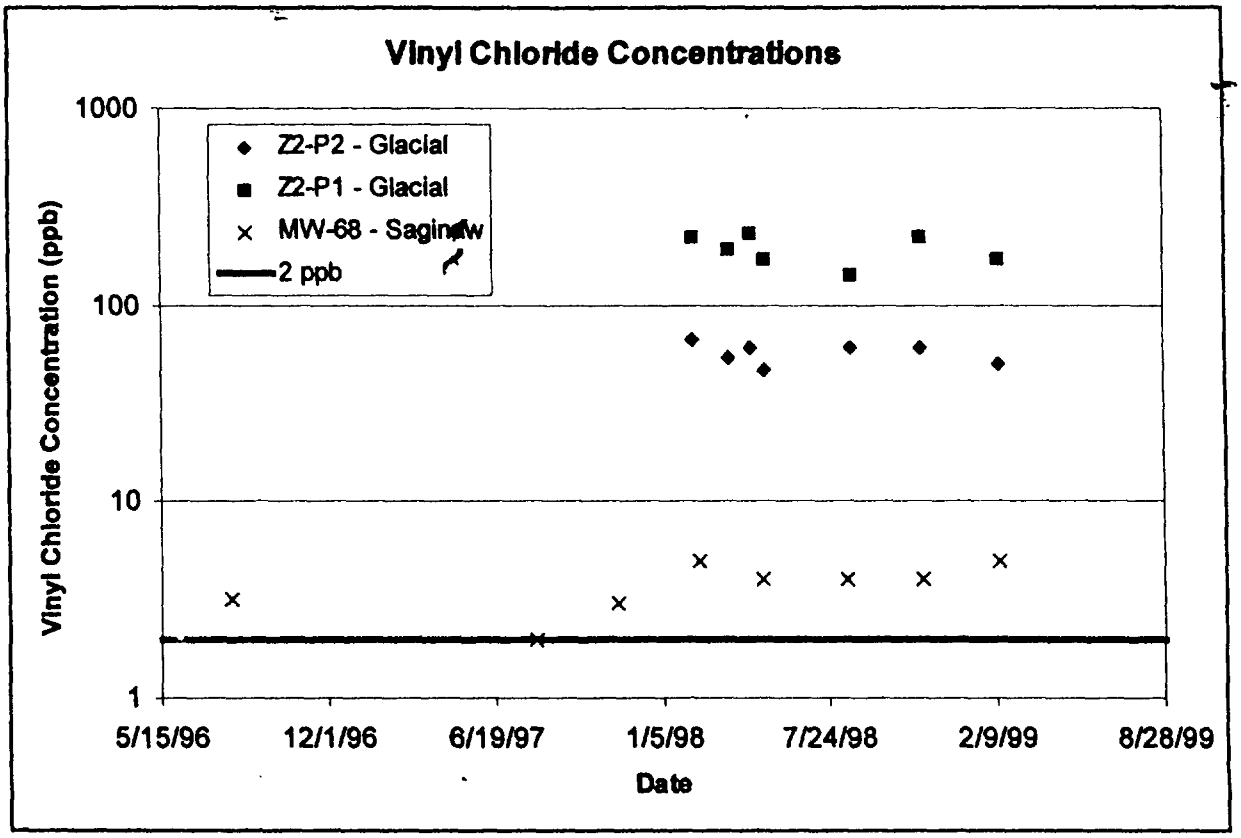


Figure 10: Difference in observed concentrations between the Glacial and Saginaw Aquifers.

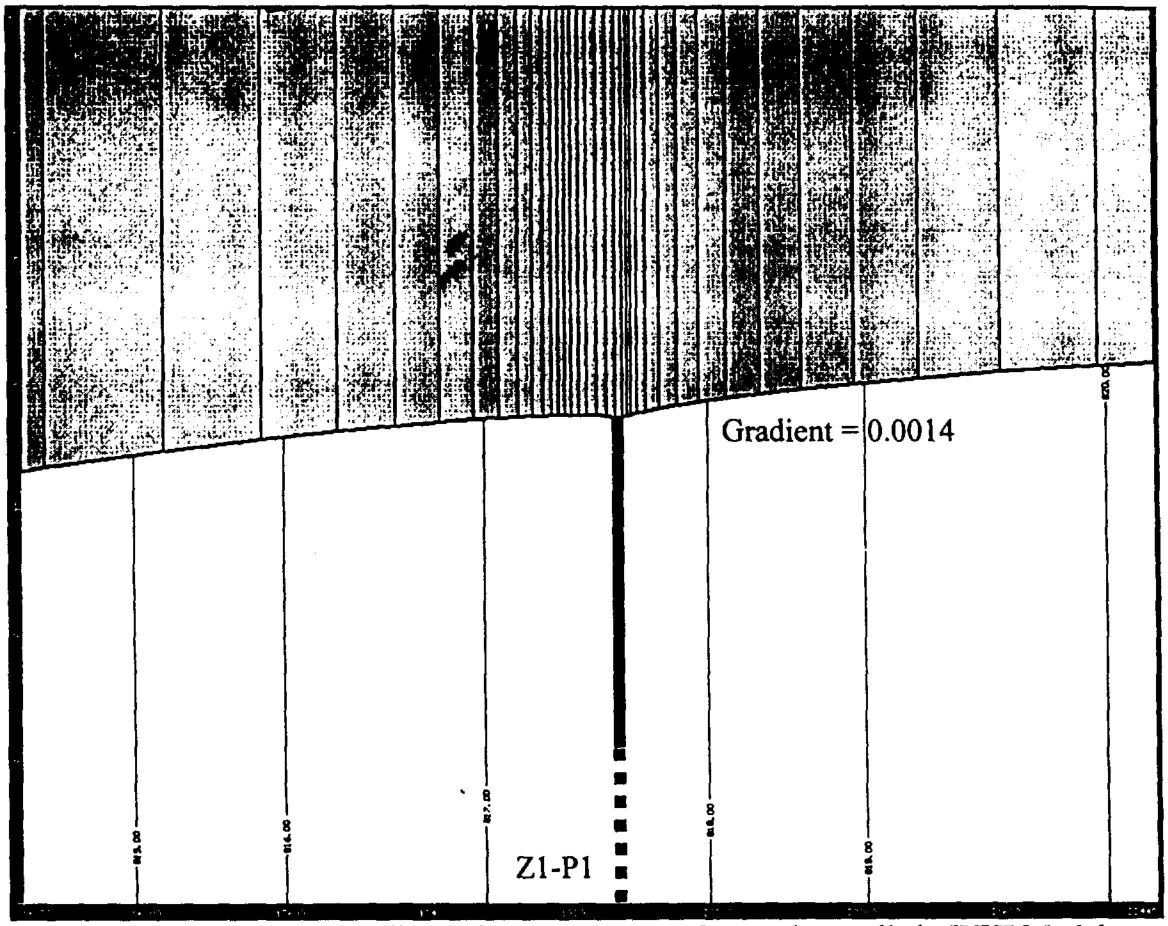


Figure 11: Simulated hydraulic gradient near Zone 1 Extraction wells in WHI Model

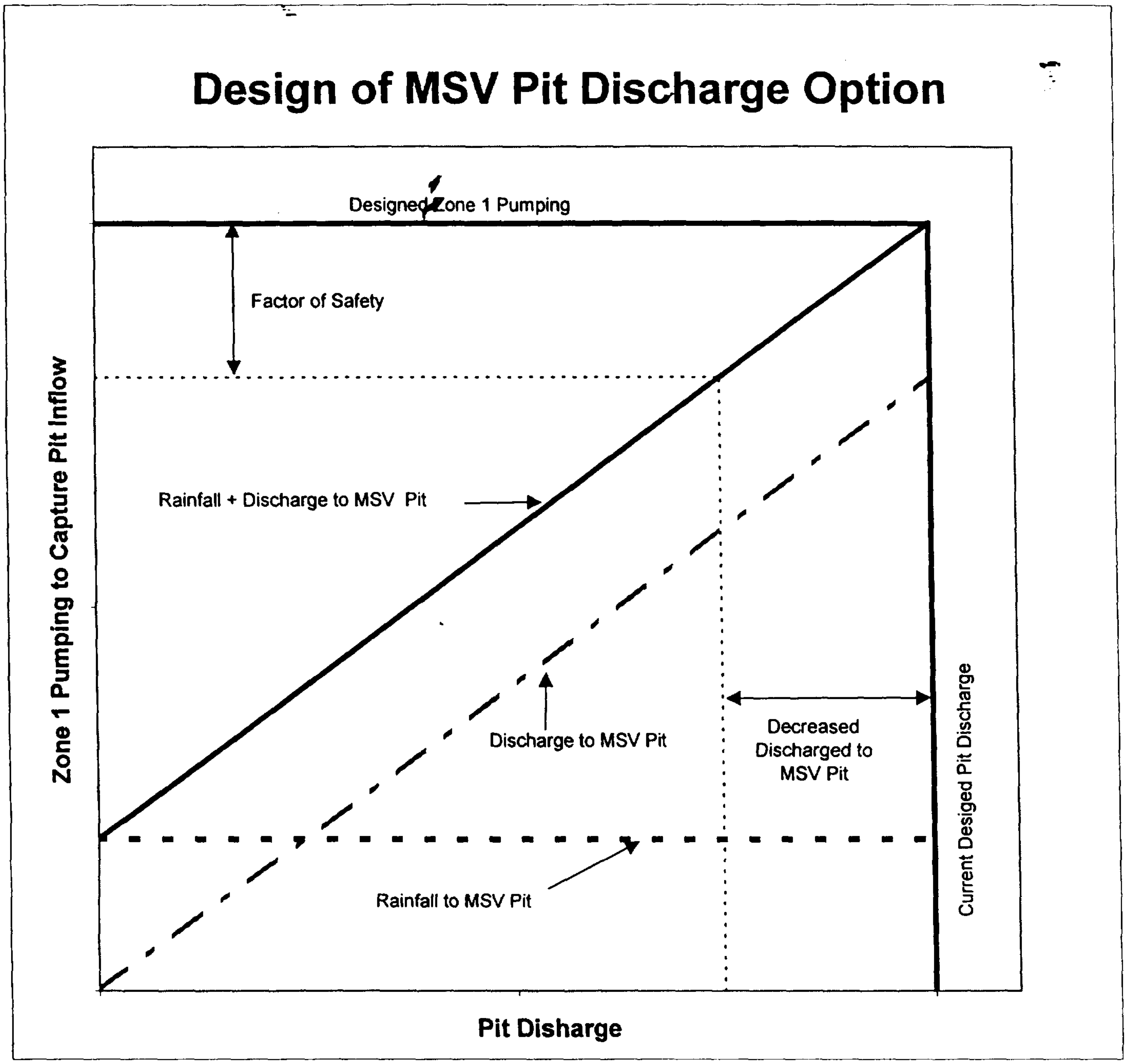


Figure 12: Factor of Safety Analysis for the Discharge to the MSV Pit.