Aquifer Characterization Report

Former Chamberlain Manufacturing Corporation Facility
550 Esther Street
Waterloo, Iowa
May 5, 2011
Terracon Project No. 07107020

Prepared for:
Chamberlain Manufacturing Corporation
Elmhurst, Illinois

Prepared by:
Terracon Consultants, Inc.
Bettendorf, Iowa
May 5, 2011

United States Environmental Protection Agency
Region 7
Air, RCRA and Toxics Division
901 North 5th Street
Kansas City, KS 66101

Attn: Mr. Bruce Morrison

Re: Aquifer Characterization Report
Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo, Iowa 50703
Terracon Project No. 07107020

Dear Mr. Morrison:

Terracon Consultants, Inc. (Terracon) is pleased to submit this Aquifer Characterization Report (AC Report) for activities conducted at the above referenced site. The AC Report presents a summary of the activities conducted to evaluate the groundwater aquifer within unconsolidated geologic deposits and the underlying Silurian/Devonian bedrock. The activities conducted were performed in accordance with Terracon’s Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010.

If you have questions concerning the information in this report please contact us at 563-355-0702.

Sincerely,

Terracon Consultants, Inc.

[Signatures]

John F. Brimeyer, P.E.
Environmental Manager

Gerald T. Hentges, P.G.
Senior Project Manager

Enclosure
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1.0 INTRODUCTION

Terracon has developed this Aquifer Characterization (AC) Report to evaluate the results of 24-hour pump test conducted at the above referenced site in order to evaluate the response and recovery of the unconsolidated aquifer and the Silurian/Devonian aquifer at the former Chamberlain Manufacturing Facility (Facility). The information in this AC Report was collected in accordance with the schedule listed in the AC Work Plan dated May 20, 2010 as revised August 2, 2010.

1.1 Site Description

<table>
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<tr>
<th>Site Name</th>
<th>Former Chamberlain Manufacturing Corporation Facility</th>
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<tr>
<td>Site Location/Address</td>
<td>550 Esther Street, Waterloo, Blackhawk County, Iowa</td>
</tr>
<tr>
<td>General Site Description</td>
<td>The Facility is an irregularly shaped parcel containing approximately 22.8 acres.</td>
</tr>
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</table>

The Facility manufactured metal washer wringers and projectile metal parts from approximately 1919 until 1996 when it was sold to Atlas Warehouse L.C. for use as a storage facility. The City acquired the Facility from Atlas Warehouse L.C in 2005 in an effort to facilitate redevelopment and has demolished all of the buildings at the location.

The Facility is zoned Heavy Industrial (M-2) by the City. The Facility is adjoined by park land to the north and south, single family residential housing west, and Virden Creek followed by a golf course to the east. Virden Creek is within approximately 100 feet of the Facility at its closest point. Gates Park adjoins the Facility to the north across Louise Street, to the east across Virden Creek, and to the south across the railroad tracks. Single family residences are located across East 4th Street to the west of the Facility. Single family residences are also located along the east side of East 4th between Anita and Louise Streets.

A topographic map and a site diagram are included as Figure 1 and Figure 2 of Appendix A, respectively.

Subsurface soils at the site consist of approximately 60 to 65 feet of sand and gravel deposits above Silurian and Devonian-aged limestone bedrock. The Devonian-age limestone deposits are about 125 feet thick and are composed of the Wapsipinicon and Cedar Valley formations. The Silurian-
Age limestone deposits are about 100 feet thick. A continuous confining layer is not present between the sands and gravels and the limestone bedrock, so these units are believed to be hydraulically connected. The Devonian aquifer in this area is intensely fractured and has karst development.

Based on field observations, the upper groundwater unit, which underlies a large portion of the Facility, is a perched aquifer created by fill material overlying native soils. Depth to groundwater at the Facility ranges from less than 10 feet bgs in the area of the perched aquifer to 20 feet bgs. Depth to groundwater off the Facility ranges from approximately 10 feet bgs to greater than 20 feet. Groundwater in both the unconsolidated deposits and the Silurian-Devonian bedrock units likely flows to the southwest toward the Cedar River.

A municipal water supply well, used primarily as a peak well during periods of high demand (City Well No. 22), is located approximately 600 feet north of the Facility within Gates Park. The City Well No. 22 fully penetrates the Silurian-Devonian system. In addition, geothermal wells located at the Carver Academy School (formally Logan Middle School) and Allen Memorial Hospital, located west and northwest of the Facility, respectively, are developed in the Silurian-Devonian aquifer. The Carver Academy geothermal system discharges extracted groundwater into an injection well located between the geothermal well and the Facility. The Allen Hospital geothermal system discharges the groundwater to the storm sewer system. The locations of the wells are depicted on Figure 2, Appendix A.

1.2 Previous Aquifer Characterization Activities

In December 2008, following completion of the Carver Academy geothermal wells, an aquifer test was conducted to evaluate the system performance. In conjunction with aquifer testing activities, transducers were installed in groundwater monitoring wells at and near the Facility to evaluate the effects of groundwater withdrawal on the contaminant plume. Although a direct correlation could not be established between the operation of the geothermal system and the groundwater monitoring wells, the IDNR, IGS, and USGS concluded that sub-regional flow under large withdrawal conditions was not well defined and that additional testing was warranted. Letters requesting access to the various wells in the area were sent to Allen Hospital, the Waterloo School District and the City of Waterloo. A copy of the correspondence is contained in Appendix B.

1.3 Monitoring Well Installation

On February 15, 2011, Terracon installed two groundwater monitoring wells along Louise Street between Boston Avenue and Sherman Avenue (OSMW-15) and along East Dale Street between Hope Avenue and Logan Avenue (OSMW-16). A 4½-inch inside-diameter (8¾-inch borehole) hollow stem auger was used to advance the boreholes through the un-consolidated deposits to the top of bedrock. Sections of flush-jointed, two-inch outside diameter, schedule 40, polyvinyl chloride (PVC) threaded pipe was used for installation of the monitoring wells. The monitoring wells were screened over the bottom ten feet of the well with 0.01-inch slotted PVC pipe. After installation of the
monitoring wells, a depth to water was taken by electronic tape. OSMW-16 was observed to be dry at time of measurement. The soil boring logs and monitoring well construction diagrams for OSMW-15 and OSMW-16 are contained in Appendix C.

2.0 PUMP TEST ACTIVITIES

On February 21, 2011, Terracon installed transducers in the Allen geothermal well and at the proposed monitoring points MW-12, MW-15, MW-16, OSMW-9, OSMW-15, Facility Well No. 3, City Well No. 22, and Carver Academy Geothermal Well Nos. 1 and No. 2. Prior to installing the transducers, Terracon measured the depth to water in each well using an electric water tape. The water level measurements were converted to elevations.

On February 23, 2011 at 11:40 AM, Terracon began an aquifer pumping test at the Allen Hospital geothermal well No. 3 for approximately 25 hours. The well was operated at 1,100 gallons per minute (gpm) and the water was discharged to the City of Waterloo storm sewer system. The Carver Academy Geothermal Wells operated during the aquifer testing activities.

Groundwater levels in the instrumented pumping well and observation wells were measured continuously using pressure transducers and a data logger. A graph representing the groundwater elevations measured at the observation points during aquifer testing are displayed in Figure D-1 of Appendix D.

Following the completion of the pumping activities, the aquifer recovery was monitored in the Allen geothermal well for approximately 24 hours.

3.0 DATA EVALUATION

Allen Hospital’s Geothermal Well No. 3 was used as the test pumping well. This well was pumped at a constant rate of 1,100 gallons per minute for approximately 25 hours while time-draw down measurements were collected at the shallow on-site well MW-12, deep on-site wells MW-15 and MW-16, shallow off-site wells OSMW-9 and OSMW-15, the former on-site production well No. 3, City Well No. 22 in Gates Park and at the Carver Academy geothermal wells No. 1 and No. 2. A summary of the groundwater elevations measured at the observation points is presented in Figure D-1.

The data on Figure D-1 indicates that no drawdown occurred in the wells with the exception of the Carver Academy geothermal wells No. 1 and No. 2. Following the completion of the pumping activities, the aquifer recovery was monitored for approximately 24 hours. Recovery at the Allen Hospital Geothermal Well No. 3 approached pre-pumping levels within about two hours after the end of the test. Throughout the pumping test, the Carver Academy Geothermal Well No. 1 (west) was pumping while Geothermal Well No. 2 (east) was recharging. The result appears to be cyclical decreases and increases of approximately 1 foot in the groundwater elevation measured in Geothermal Well No. 1.
3.1 Aquifer Characterization

After the data was collected in the field, the aquifer parameters were evaluated. Typically, time distance draw down measurements for the observation points would be analyzed. Since no draw down was observed at the observation points, secondary methods were used to estimate the aquifer transmissivity (T). The Theis Recovery Test method was used to estimate the transmissivity of the aquifer. Theis indicates that if a well is pumped for a known period of time, the well will recharge with the same flow properties. This principle sets up the governing equations for the response to pumping a confined or semi-confined aquifer as shown below:

\[ s' = \frac{Q}{4nT} [W(u) - W'(u')] \]  

(1)

Where:

\[ u = \frac{r^2 s}{4T} \quad \text{and} \quad u' = \frac{r^2 s'}{4T} \]  

(2)

The value "t" is the time from the beginning of the pumping period until time pumping ceases, and "t'" is the time from when well recharge begins until the water level reaches the original non-pumping level (static level). Theis indicates for small r and large t', the well functions, W(u) and W(u'), can be approximated in Equation 1 as:

\[ s' = \frac{2.30Q}{4nT} \log \frac{r}{s'} \]  

(3)

where s' is the residual drawdown and,

\[ T = \frac{2.30Q}{4n\Delta s'} \]  

(4)

The pumping rate (Q) and the residual drawdown per log cycle of the time ratio (t/t') were obtained from the data collected during well testing. The pumping rate, in gallons per minute (gpm), was 1,100 gpm, and the residual drawdown per log cycle (Δs') was 0.35 ft. Figure D-2 in Appendix D demonstrates how Δs' was determined. Based on the well recovery data the transmissivity of the aquifer was estimated to be approximately 110,769 feet-squared per day (ft²/day).

3.2 Groundwater Occurrence and Movement

The horizontal hydraulic conductivity (K) is related to transmissivity and aquifer thickness by the following relationship:

\[ T = Kb \]  

(5)
where: \( T = \) Transmissivity (ft²/day)
\( b = \) Aquifer thickness (ft)

Using the transmissivity and aquifer thickness data collected at the test well the estimated horizontal hydraulic conductivity for the aquifer is about 615 feet per day (ft/d) or about 0.217 centimeters per second (cm/sec).

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is apparent from the data collected that pumping and injection did not impact elevations at the remaining monitoring points. The results of the characterization indicate that pumping at Allen Hospital and pumping and injection at the Carver Academy geothermal system does not influence groundwater elevations or flow at MW-12, MW-15, MW-16, OSMW-9, OSMW-15, Facility Well No. 3, and City Well No. 22 because drawdown was not observed at these locations. Observed water levels at these locations fluctuate uniformly due to variations in atmospheric pressure. Water level variations due to drawdown or recharge at the Allen and Carver Academy Wells cannot be detected in the observation wells.

5.0 GENERAL COMMENTS

The analysis and opinions expressed in this report are based upon data obtained from aquifer test and other wells installed at the indicated locations and from other information discussed in this report. This report does not reflect any variations in subsurface stratigraphy, hydrogeology, or aquifer parameters which may occur between production or injection wells or across the site. Actual subsurface conditions may vary and may not become evident without further exploration.

The estimated aquifer parameters listed are subject to uncertainties. Variations in well efficiency from those assumed in the analysis can result in discrepancies between aquifer transmissivity and hydraulic conductivity values estimated, and those which actually occur. The intermittent discharge and recharge of the wells at the Carver Academy geothermal system further complicate the data analysis.

In the event any changes in nature or location of production wells or pumping wells or other surface or subsurface conditions as outlined in this report are observed, the conclusions and recommendations contained in this report cannot be considered valid unless the changes are reviewed and the opinions of this report are modified or verified in writing by the hydrogeological engineer.
APPENDIX A
July 22, 2011

Mr. Mike Dolan
Jones, Day
77 West Wacker
Chicago, Illinois 60601-1692


Dear Mr. Dolan:

The Iowa Department of Natural Resources, Contaminated Sites Section, (Department) has received and reviewed the requested pump test data for the above referenced report. During the review two major flaws were discovered, the transducer data was not compensated for changes in atmospheric pressure and the pump in the test well was running (cycling) several hours leading up to and then not running continuously during the 25 hour pump test.

The type of transducer used was 'non-vented' giving results as absolute pressure (water pressure plus atmospheric pressure). It is quite common for pump test data in observation wells to be masked by barometric pressure changes in the atmosphere. Terracon should have used a barometric pressure logger in order to subtract the change in atmospheric pressure from the transducer's absolute pressure reading. A 'vented' transducer has a cable with a small diameter tube that runs from the transducer to the surface automatically compensating the back side of the pressure sensor to changes in atmospheric pressure.

Because the pumping well pump was cycling on and off, the pump test was more like 41 mini-pump tests with durations of 36 minutes each (approximately 18 minutes run time and 18 minutes recover time). During the 25 hour pump test the well was off half the time. In the report the ripples in the Allen well transducer data, during the pump test, were noted as connectivity to the Carver wells. If the ripples found in the Allen well during the pump test were caused by the Carver wells the ripples would also be present in the Allen well prior to the pump test, but this is not the case. Since the aquifer was not truly stressed the transmissivity and horizontal hydraulic conductivity calculations are most likely wrong because of the artificial equilibrium caused by the cycling pump.

The Department is also concerned with the data indicating an almost - insignificant drawdown - in both the Allen well during the pump test and the Carver West well...
when it was pumping. During the Allen well development in 1991 the drawdown for
the pump test was 21 feet; the drawdown for this test was around 2 feet.

At this time the Department is rejecting the Aquifer Characterization Report as
written, it is the Department's opinion the report does not truly describe the actual
conditions found in the aquifer.

If you have any questions or need further information please feel free to call or e-
mail at (515) 281-4171 or dan.cook@dnr.iowa.gov.

Sincerely,

Daniel Cook
Environmental Specialist Senior
Contaminated Sites

c: Bruce A. Morrison US Environmental Protection Agency, 901 North 5th Street, Kansas City, Kansas 66101
John Brimeyer Terracon Consultants, 870 40th Avenue, Bettendorf, Iowa 52722
Deb Tinker Iowa DNR Field Office 1
Appendix B
APPENDIX B

Project Correspondence
January 31, 2011

City of Waterloo
Planning & Zoning Development
715 Mulberry Street
Waterloo, Iowa 50703

Attn: Mr. Chris Western
City Planner

Re: Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo Iowa
EPA Docket Nos. RCRA-07-2010-002 and CERCLA-07-2010-0005
Project No. 07107020

Dear Mr. Western:

Chamberlain Manufacturing Corporation (Chamberlain) has entered into a Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (USEPA) dated April 20, 2010. In accordance with the terms of the UAO, Chamberlain is required to conduct aquifer characterization testing to evaluate the effects of geothermal wells in the area on observed groundwater contamination at the site. Terracon Consultants, Inc. (Terracon), on behalf of Chamberlain, has developed an Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010 which presents proposed aquifer testing activities. The AC Work Plan was approved by the USEPA on January 6, 2011.

Terracon and Chamberlain are requesting your cooperation in completing the aquifer testing activities. In accordance with the approved AC Work Plan, and consistent with an Iowa Department of Natural Resources (IDNR) memorandum dated March 29, 2009, we are proposing to conduct a 24-hour pump test. The proposed test will consist of the pumping of the Allan Memorial Hospital Geothermal Well No. 2 or No. 3 and monitoring of water levels in six groundwater monitoring wells at and near the Chamberlain site, a former production well on the Chamberlain site, City of Waterloo Well No. 22 located in Gates Park, and Carver Academy Geothermal Wells No. 1 and No. 2.

Terracon will be responsible for coordinating the pump test activities including the removal of well equipment from the former Chamberlain production well and the placement of pressure transducers in existing monitoring, production, and geothermal wells or arranging for Terracon staff to manually monitor altitude gauges on existing wells if they cannot be accessed for
transducer installation. Following the completion of the pump test, the wells will continue to be monitored through a 24-hour recovery period at which time, pressure transducers will be removed from the wells. Groundwater samples may also be collected for analysis of contaminants of concern. The data collected will be reviewed and compiled by Terracon and presented to the USEPA as an Aquifer Characterization Report.

It is anticipated that the pump test will be completed during February 2011.

Terracon and Chamberlain are requesting your assistance in coordinating pump test activities.

Thank you for your consideration of this issue. Should you have any questions concerning this request, please contact us at (563) 355-0702.

Sincerely,
Terracon Consultants, Inc.

John F. Brimeyer, PE
Environmental Manager

cc:  Mr. Bruce Morrison, USEPA Region 7
     Mr. Eric Reeves, Chamberlain Manufacturing
     Mr. Mike Dolan, Jones-Day
     Ms. Deb Tinker, IDNR Field Office No. 1
     Mr. Jim Caldwell, United States Geological Survey
     Mr. Mike Gannon, Iowa Geological Survey
January 31, 2011

Shawver Well Company, Inc.
2700 Stanley Avenue
Fredericksburg, Iowa 50630

Attn: Mr. Gary Shawver

Re: Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo Iowa
EPA Docket Nos. RCRA-07-2010-002 and CERCLA-07-2010-0005
Project No. 07107020

Dear Mr. Shawver:

Chamberlain Manufacturing Corporation (Chamberlain) has entered into a Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (USEPA) dated April 20, 2010. In accordance with the terms of the UAO, Chamberlain is required to conduct aquifer characterization testing to evaluate the effects of geothermal wells in the area on observed groundwater contamination at the site. Terracon Consultants, Inc. (Terracon), on behalf of Chamberlain, has developed an Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010 which presents proposed aquifer testing activities. The AC Work Plan was approved by the USEPA on January 6, 2011.

Terracon and Chamberlain are requesting your cooperation in completing the aquifer testing activities. In accordance with the approved AC Work Plan, and consistent with an Iowa Department of Natural Resources (IDNR) memorandum dated March 29, 2009, we are proposing to conduct a 24-hour pump test. The proposed test will consist of the pumping of the Allan Memorial Hospital Geothermal Well No. 2 or No. 3 and monitoring of water levels in six groundwater monitoring wells at and near the Chamberlain site, a former production well on the Chamberlain site, City of Waterloo Well No. 22 located in Gates Park, and Carver Academy Geothermal Wells No. 1 and No. 2.

Terracon will be responsible for coordinating the pump test activities including the removal of well equipment from the former Chamberlain production well and the placement of pressure transducers in existing monitoring, production, and geothermal wells or arranging for Terracon staff to manually monitor altitude gauges on existing wells if they cannot be accessed for transducer installation. Following the completion of the pump test, the wells will continue to be monitored through a 24-hour recovery period at which time, pressure transducers will be
removed from the wells. Groundwater samples may also be collected for analysis of contaminants of concern. The data collected will be reviewed and compiled by Terracon and presented to the USEPA as an Aquifer Characterization Report.

It is anticipated that the pump test will be completed during February 2011.

Terracon and Chamberlain are requesting your assistance in removing the well pump and appurtenances from the former Chamberlain production well and installing a cap on the well casing. Terracon has been provided a copy of your proposal dated April 22, 2009 to Ms. Stephanie Doolan, USEPA. Please update your proposal and forward to my attention.

Thank you for your consideration of this issue. Should you have any questions concerning this request, please contact us at (563) 355-0702.

Sincerely,
Terracon Consultants, Inc.

John F. Brimeyer, PE
Environmental Manager

cc: Mr. Bruce Morrison, USEPA Region 7
Mr. Eric Reeves, Chamberlain Manufacturing
Mr. Mike Dolan, Jones-Day
January 31, 2011

Waterloo Community School District
1516 Washington Street
Waterloo, IA 50702

Attn: Mr. Marty Metcalf
Director of Operational Services

Re:
Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo Iowa
EPA Docket Nos. RCRA-07-2010-002 and CERCLA-07-2010-0005
Project No. 07107020

Dear Mr. Metcalf:

Chamberlain Manufacturing Corporation (Chamberlain) has entered into a Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (USEPA) dated April 20, 2010. In accordance with the terms of the UAO, Chamberlain is required to conduct aquifer characterization testing to evaluate the effects of geothermal wells in the area on observed groundwater contamination at the site. Terracon Consultants, Inc. (Terracon), on behalf of Chamberlain, has developed an Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010 which presents proposed aquifer testing activities. The AC Work Plan was approved by the USEPA on January 6, 2011.

Terracon and Chamberlain are requesting your cooperation in completing the aquifer testing activities. In accordance with the approved AC Work Plan, and consistent with an Iowa Department of Natural Resources (IDNR) memorandum dated March 29, 2009, we are proposing to conduct a 24-hour pump test. The proposed test will consist of the pumping of the Allan Memorial Hospital Geothermal Well No. 2 or No. 3 and monitoring of water levels in six groundwater monitoring wells at and near the Chamberlain site, a former production well on the Chamberlain site, City of Waterloo Well No. 22 located in Gates Park, and Carver Academy Geothermal Wells No. 1 and No. 2.

Terracon will be responsible for coordinating the pump test activities including the removal of well equipment from the former Chamberlain production well and the placement of pressure transducers in existing monitoring, production, and geothermal wells or arranging for Terracon staff to manually monitor altitude gauges on existing wells if they cannot be accessed for transducer installation. Following the completion of the pump test, the wells will continue to be
Aquifer Characterization Testing
Chamberlain Manufacturing • Waterloo, Iowa
January 31, 2011 • Terracon Project No. 07107020

monitored through a 24-hour recovery period at which time, pressure transducers will be removed from the wells. Groundwater samples may also be collected for analysis of contaminants of concern. The data collected will be reviewed and compiled by Terracon and presented to the USEPA as an Aquifer Characterization Report.

It is anticipated that the pump test will be completed during February 2011.

Terracon and Chamberlain are requesting your permission to allow us to monitor water levels in the Carver Academy Geothermal Wells No. 1 and No. 2 for the duration of the 24-hour test period and to allow us to observe and record water levels throughout the test period and the 24-hour recovery period.

Thank you for your consideration of this issue. Should you have any questions concerning this request, please contact us at (563) 355-0702.

Sincerely,
Terracon Consultants, Inc.

John F. Brimeyer, PE
Environmental Manager

cc: Mr. Bruce Morrison, USEPA Region 7
Mr. Eric Reeves, Chamberlain Manufacturing
Mr. Mike Dolan, Jones-Day
Ms. Deb Tinker, IDNR Field Office No. 1
Mr. Jim Caldwell, United States Geological Survey
Mr. Mike Gannon, Iowa Geological Survey
January 31, 2011

Allen Memorial Hospital
1825 Logan Avenue
Waterloo, Iowa 50703

Attn: Mr. Terry Flynn
Director of Plant Services /Safety Officer

Re: Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo Iowa
EPA Docket Nos. RCRA-07-2010-002 and CERCLA-07-2010-0005
Project No. 07107020

Dear Mr. Flynn:

Chamberlain Manufacturing Corporation (Chamberlain) has entered into a Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (USEPA) dated April 20, 2010. In accordance with the terms of the UAO, Chamberlain is required to conduct aquifer characterization testing to evaluate the effects of geothermal wells in the area on observed groundwater contamination at the site. Terracon Consultants, Inc. (Terracon), on behalf of Chamberlain, has developed an Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010 which presents proposed aquifer testing activities. The AC Work Plan was approved by the USEPA on January 6, 2011.

Terracon and Chamberlain are requesting your cooperation in completing the aquifer testing activities. In accordance with the approved AC Work Plan, and consistent with an Iowa Department of Natural Resources (IDNR) memorandum dated March 29, 2009, we are proposing to conduct a 24-hour pump test. The proposed test will consist of the pumping of the Allan Memorial Hospital Geothermal Well No. 2 or No. 3 and monitoring of water levels in six groundwater monitoring wells at and near the Chamberlain site, a former production well on the Chamberlain site, City of Waterloo Well No. 22 located in Gates Park, and Carver Academy Geothermal Wells No. 1 and No. 2.

Terracon will be responsible for coordinating the pump test activities including the removal of well equipment from the former Chamberlain production well and the placement of pressure transducers in existing monitoring, production, and geothermal wells or arranging for Terracon staff to manually monitor altitude gauges on existing wells if they cannot be accessed for transducer installation. Following the completion of the pump test, the wells will continue to be
Aquifer Characterization Testing
Chamberlain Manufacturing • Waterloo, Iowa
January 31, 2011 • Terracon Project No. 07107020

monitored through a 24-hour recovery period at which time, pressure transducers will be removed from the wells. Groundwater samples may also be collected for analysis of contaminants of concern. The data collected will be reviewed and compiled by Terracon and presented to the USEPA as an Aquifer Characterization Report.

It is anticipated that the pump test will be completed during February 2011.

Terracon and Chamberlain are requesting your permission to allow us to operate the Allen Memorial Hospital Geothermal Well No. 2 or No. 3 for the duration of the 24-hour test period and to allow us to observe and record water levels throughout the test period and the 24-hour recovery period. We will be in contact with you to coordinate pump test activities.

Thank you for your consideration of this issue. Should you have any questions concerning this request, please contact us at (563) 355-0702.

Sincerely,
Terracon Consultants, Inc.

John F. Brimeyer, PE
Environmental Manager

cc: Mr. Bruce Morrison, USEPA Region 7
Mr. Eric Reeves, Chamberlain Manufacturing
Mr. Mike Dolan, Jones-Day
Ms. Deb Tinker, IDNR Field Office No. 1
Mr. Jim Caldwell, United States Geological Survey
Mr. Mike Gannon, Iowa Geological Survey
January 31, 2011

Waterloo Water Works
325 Sycamore Street
P.O. Box 27
Waterloo, Iowa 50704

Attn: Mr. Dennis Clark
General Manager

Re: Chamberlain Manufacturing Corporation
Former Facility at 550 Esther Street
Waterloo, Iowa
EPA Docket Nos. RCRA-07-2010-002 and CERCLA-07-2010-0005
Project No. 07107020

Dear Mr. Clark:

Chamberlain Manufacturing Corporation (Chamberlain) has entered into a Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (USEPA) dated April 20, 2010. In accordance with the terms of the UAO, Chamberlain is required to conduct aquifer characterization testing to evaluate the effects of geothermal wells in the area on observed groundwater contamination at the site. Terracon Consultants, Inc. (Terracon), on behalf of Chamberlain, has developed an Aquifer Characterization Work Plan (AC Work Plan) dated August 2, 2010 which presents proposed aquifer testing activities. The AC Work Plan was approved by the USEPA on January 6, 2011.

Terracon and Chamberlain are requesting your cooperation in completing the aquifer testing activities. In accordance with the approved AC Work Plan, and consistent with an Iowa Department of Natural Resources (IDNR) memorandum dated March 29, 2009, we are proposing to conduct a 24-hour pump test. The proposed test will consist of the pumping of the Allan Memorial Hospital Geothermal Well No. 2 or No. 3 and monitoring of water levels in six groundwater monitoring wells at and near the Chamberlain site, a former production well on the Chamberlain site, City of Waterloo Well No. 22 located in Gates Park, and Carver Academy Geothermal Wells No. 1 and No. 2.

Terracon will be responsible for coordinating the pump test activities including the removal of well equipment from the former Chamberlain production well and the placement of pressure transducers in existing monitoring, production, and geothermal wells or arranging for Terracon staff to manually monitor altitude gauges on existing wells if they cannot be accessed for...
transducer installation. Following the completion of the pump test, the wells will continue to be monitored through a 24-hour recovery period at which time, pressure transducers will be removed from the wells. Groundwater samples may also be collected for analysis of contaminants of concern. The data collected will be reviewed and compiled by Terracon and presented to the USEPA as an Aquifer Characterization Report.

It is anticipated that the pump test will be completed during February 2011.

Terracon and Chamberlain are requesting your permission to allow us to monitor water levels in the Gates Park Well No. 22 for the duration of the 24-hour test period and to allow us to observe and record water levels throughout the test period and the 24-hour recovery period. We will contact Mr. Travis Larson, Plant Operator to coordinate pump testing activities.

Thank you for your consideration of this issue. Should you have any questions concerning this request, please contact us at (563) 355-0702.

Sincerely,
Terracon Consultants, Inc.

John F. Brimeyer, PE
Environmental Manager

cc: Mr. Bruce Morrison, USEPA Region 7
Mr. Eric Reeves, Chamberlain Manufacturing
Mr. Mike Dolan, Jones-Day
Ms. Deb Tinker, IDNR Field Office No. 1
Mr. Jim Caldwell, United States Geological Survey
Mr. Mike Gannon, Iowa Geological Survey
Appendix C
APPENDIX C

Monitoring Well Logs
# LOG OF BORING OSMW-15

**CLIENT**

**SITE**

*550 Esther Street*

*Waterloo, Iowa*

**Boring Location:** About 15' west and 2' north of NW corner of house on 322 Louis Street

## DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Description</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.33</td>
<td>Sandy Gravel</td>
<td>Light Brown</td>
</tr>
<tr>
<td>12</td>
<td>Fine Sand</td>
<td>Brown</td>
</tr>
<tr>
<td>14</td>
<td>Fine Sand</td>
<td>Light Brown</td>
</tr>
<tr>
<td>17</td>
<td>Fine Sand, Trace Clay</td>
<td>Gray Brown</td>
</tr>
<tr>
<td>20.5</td>
<td>Clayey Fine Sand</td>
<td>Light Brown</td>
</tr>
<tr>
<td>24</td>
<td>Lean Clay with Sand</td>
<td>Light Brown</td>
</tr>
<tr>
<td>26.9</td>
<td>Sandy Lean Clay with Cobbles</td>
<td>Light Brown / Light Gray</td>
</tr>
</tbody>
</table>

Note: Soil boring was completed as a permanent monitoring well with flush mount well cover after completion.

---

**WATER LEVEL OBSERVATIONS, ft**

<table>
<thead>
<tr>
<th>WL</th>
<th>16</th>
<th>WD</th>
<th>15</th>
<th>AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>WL</td>
<td>22</td>
<td>2/21/11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**BORING STARTED** 2-15-11

**BORING COMPLETED** 2-15-11

**RIG** #14e

**FOREMAN** WE

**JOB #** 07107020

---

* ND indicates a reading of less than the field detection limit (FDL) of one (1) part per million isobutylene equivalents (ppm).*

---

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
# LOG OF BORING OSMW-16

**CLIENT**  

**SITE**  

550 Esther Street  

**Project**  

Former Industrial Property

<table>
<thead>
<tr>
<th>Boring Location: About 19' west and 16' south of SW corner of garage on 703 Hope Street</th>
</tr>
</thead>
</table>

## GRAPHIC LOG

<table>
<thead>
<tr>
<th>BOREHOLE DIA.</th>
<th>WELL DIA.</th>
<th>TOP OF PROTECTOR PIPE</th>
<th>TOP OF CASING</th>
<th>GROUND SURFACE ELEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in</td>
<td>2 in</td>
<td>877.40 ft</td>
<td>877.01 ft</td>
<td>877.39 ft</td>
</tr>
</tbody>
</table>

## DESCRIPTION

<table>
<thead>
<tr>
<th>Depth, ft.</th>
<th>USCS SYMBOL</th>
<th>TYPE</th>
<th>RECOVERY, %</th>
<th>BLOWNS/ ft.</th>
<th>WATER CONTENT, %</th>
<th>FIELD VAPOR TEST (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.17</td>
<td>PEA GRAVEL WITH SAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>FINE SAND</td>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>FINE SAND</td>
<td>Light Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LEAN CLAY WITH SAND</td>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>LEAN CLAY WITH SAND</td>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.5</td>
<td>FINE SAND, TRACE CLAY AND COBBLES</td>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>SANDY LEAN CLAY WITH SAND</td>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Soil boring was completed as a permanent monitoring well with flush mount well cover after completion.

---

*ND indicates a reading of less than the field detection limit (FDL) of one (1) part per million isobutylene equivalents (ppm).*

---

**WATER LEVEL OBSERVATIONS, ft**

<table>
<thead>
<tr>
<th>WL</th>
<th>10</th>
<th>WD</th>
<th>None</th>
<th>AB</th>
</tr>
</thead>
</table>

**BORING STARTED**  

2-15-11

**BORING COMPLETED**  

2-15-11

**RIG**  

# 14e

**FOREMAN**  

WE

**JOB #**  

07107020
APPENDIX D
APPENDIX D

Aquifer Test Analysis
Figure D-1: TIME VS DRAWDOWN OBSERVATIONS

- City 22
- Carver West
- Carver East
- Chamber 3
- MW-15
- MW-12
- MW-16
- OSMW-9
- OSMW-15
- Allen
- Pump Run

*Figure contains a graph showing water surface elevation over time for various locations.*

**Designated Elements:**
- Designed by: CAK
- Drawn by: CAK
- Terracon 870 40th Avenue Bettendorf, IA 52722
- Proj. 07107020
- File Name: 
- Date: 04-26-2011
Figure D-2: THEIS RECOVERY TEST METHOD

<table>
<thead>
<tr>
<th>Ground Surface Elevation (ASL)</th>
<th>901.00 FT</th>
<th>Thickness of Aquifer</th>
<th>180 FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth to Water Elevation (ASL)</td>
<td>854.00 FT</td>
<td>55 M</td>
<td></td>
</tr>
<tr>
<td>Pump Level Elevation (ASL)</td>
<td>850.90 FT</td>
<td>Transmissivity</td>
<td>110769 FT/D</td>
</tr>
<tr>
<td>Average Discharge</td>
<td>1100 GPM</td>
<td>10291 MGD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5995 MGD</td>
<td>Hydraulic Conductivity</td>
<td>615 FT/D</td>
</tr>
<tr>
<td>Residual Drawdown per log cycle</td>
<td>0.35 FT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.10668 M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REGRESSION ANALYSIS

\[ y = 0.1515 \ln(x) - 0.1467 \]

\[ R^2 = 0.9061 \]