Ashman Center
March 17, 2003

The Dow Chemical Company
Midland, Michigan 48674

Mr. Sam Nalluswami
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

SUBJECT: TDCC Responses to December 26, 2002, NRC Comments on the Supplement to the Decommissioning Plan (Docket No. 040-00017)

In a letter dated December 26, 2002, the Nuclear Regulatory Commission provided a request for additional information (RAI) to The Dow Chemical Company (TDCC) regarding the Supplement to the Decommissioning Plan for the Bay City Site (Supplement). We have completed a detailed review and analysis of the RAI's and conclude that formal resolution of RAIs #2 and #17.b are needed before TDCC can proceed with the response to the remaining RAI's.

RAI #2 addresses future land use of the site. Since the Bay City site is "grandfathered" under the License Termination Rule, the concentration based SDMP Action Plan criteria apply and no dose assessment is necessary. It is our understanding that NRC needs the future land use information to conduct a dose assessment internally. There have been multiple discussions and correspondence related to land use and TDCC seeks closure of this issue before providing additional RAI responses. As described in the enclosure, TDCC concludes that the Recreational Scenario is the most reasonable future land use for the site. Further, after additional evaluation, TDCC has concluded that it is not credible to assume that the shallow groundwater on the site will be used now, or in the future, as a water source (drinking water or irrigation) for the recreational, or any other scenario. Therefore, the future land use scenario described in the Enclosure does not include the use of the shallow groundwater.

The TDCC position that the shallow groundwater is not a viable drinking water source is a modification to the land use scenario provided in the Supplement. The assumption that the shallow groundwater could be a drinking water source was intended to be a very conservative position that would facilitate rapid approval of the Supplement and was not intended to imply that the use of the shallow groundwater was credible. In the process of developing the response to RAI #2, TDCC concluded that the drinking water assumption was overly conservative and was therefore removed from the future land use scenario.

TDCC requests formal NRC approval of two items: 1) that the applicable future land use scenario for a site dose assessment is recreational, and 2) that site groundwater is not an exposure pathway and will not be included in a dose assessment. We believe that these two items can be approved by NRC independently if necessary.

Another issue that requires early resolution is that pertaining to the need to remediate groundwater at each well location that exceeds the MCL as stated in RAI #17.b. The remediation of isolated groundwater locations with radium concentrations slightly exceeding the MCL's, when the average groundwater concentration on the site is well below the MCL's, does not appear to be ALARA under the SDMP Action Plan. In addition, the approach does not appear to be risk-informed considering the low potential exposure from licensed material in the shallow groundwater at the Bay City site, particularly when background radium concentrations are included in the evaluation (note that some of the background well concentrations also exceed the MCL's). TDCC proposes to apply the average total radium concentration from several wells, as

opposed to the highest individual well, to demonstrate compliance with the MCL's at the time of license termination. A formal NRC decision on this proposal is needed before TDCC can proceed with responding to the remaining RAI's.

The Enclosure provides detailed responses to RAI's #2 and 17.b. Also enclosed is the report "Hydrogeological Assessment, Dow Thorium Site, Bay City, MI", April 2001, in response to RAI #1, which requested additional data on Site Hydrogeology.

TDCC is committed to the effective and safe decommissioning of the Bay City site. We believe that a risk-informed resolution of the above three issues can lead to completion of site decommissioning by the end of 2004. We project that completion will be delayed until at least 2006 if more complex site-specific submittals and approvals are required. The probability is very low that the resulting delay and expenditure of additional resources would result in any real dose savings to an actual future occupant. This is due to the inherent conservatisms built into the risk assessment process and the already low levels of residual radioactivity remaining on the site.

Please contact me at (989) 636-0787 or David Fauver at (772) 492-0163 if you have any questions.

Sincerely,

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Enclosures

Cc: Ed Kulzer, NRC Region III
Larry Camper, NRC Headquarters (w/o Hydrogeologic Report)
Claudia Craig, NRC Headquarters (w/o Hydrogeologic Report)
David Fauver, BSI (w/o Hydrogeologic Report)
Joseph Hezir, EOP Group (w/o Hydrogeologic Report)
Jerry Sgro, URS Corporation

TDCC RESPONSE TO NRC DECEMBER 26, 2002, RAI'S #2 AND #17.B REGARDING THE SUPPLEMENT TO THE DECOMMISSIONING PLAN

March 17, 2003

NRC Comment #2

Section 1.1.5, Future Land Use, pages 7 to 8 - TDCC has proposed a future unrestricted land use scenario where the critical group will most likely consist of either recreational users or individuals that consume drinking water from a well that draws water from the site. Under this scenario, TDCC notes that the saturated zone contamination is not expected to contribute a significant dose to the critical group. Also, in the supplemental decommissioning plan (SDP), Section 3.1, page 9, TDCC states "As described previously in Section 1.1.5, there is very low probability that the material in the saturated zone would be excavated and is not considered a plausible scenario." In contrast, NRC staff conversations with the Michigan Department of Environmental Quality, Land and Water Management Division in the Bay City District, indicated that there are other plausible land use scenarios that could involve the excavation or dredging of the saturated zone, such as development for a marina or condominium complex. TDCC needs to justify why recreational use should be considered as the bounding land use scenario.

TDCC Response To Comment #2

The Dow Chemical Company's (TDCC) response to NRC Comment #2 is provided in two parts. The first part provides the justification for the assumption that the site shallow groundwater will not be used as a domestic water source (drinking and irrigation). The second part provides the bases for assuming that the most likely future land use at the site will be recreational use. This response is intended to replace Section 1.5 of the Supplement in it entirety.

1.0 JUSTIFICATION FOR CONCLUSION THAT SITE SHALLOW GROUNDWATER IS NOT DRINKING WATER SOURCE

1.1 Summary/Conclusion

In order for shallow ground water to be realistically considered for use at the TDCC Thorium Site (Site) located in Bangor Township, Bay County, Michigan (Figure 1), a well penetrating the aquifer must be able to provide water of sufficient quantity and quality for potable use. The installation of a drinking water well must also be allowed under current and future regulations. In addition, the availability of other sources of drinking water must be considered when evaluating potential sources of drinking water.

The conclusion of this analysis is that it is highly unlikely that shallow ground water at the Site would be used as a potable or domestic source of water. The reasons for this conclusion are:

1. Michigan State regulations (R325.1622(1)) prohibit the installation of a water well in the shallow groundwater at the Site because shallow ground water occurs at a depth of no more than approximately 12 ft bgs.
2. Ground water at the Site is of poor quality and exceeds the aesthetic standard for TDS (R299.5744 Table 1) making the water undesirable for drinking water purposes
3. Alternative higher quality sources of drinking water are available including access to a treated municipal water and ground water in deeper aquifers that are hydraulically isolated from the shallow aquifer.
4. Ground water use as a drinking water resource at the Site will be prohibited by a deed restriction filed with Bay County as a part of the ongoing Resource Conservation and Recovery Act (RCRA) corrective action for Bay City sites.

5. No credible land use scenarios would involve the use the shallow aquifer as drinking water regardless of the water's potability.

1.2 Background Information

Information on the hydrogeologic conditions is presented in several reports, including:

- "Hydrogeological Assessment, Dow Thorium Site, Bay City, MI", April 2001 by URS Corporation;
- "Hydrogeologic Assessment of The Dow Chemical Company Thorium Contamination Site in Bay City Michigan", September 2000 by URS Corporation; and
- "Ground Water Elevation and Flow Study, Industrial Waste Site Perimeter, Dow Chemical Company USA", December 1977 by SAMTEST, Inc.

In addition, information on the hydrogeologic conditions in the area is described in "Dow Bay City Sites, Environmental Assessment of Groundwater and Soil", September 1990 by TDCC. Figure 2 shows the locations of the sites for which subsurface data were available[1].

These reports along with available water well records, City of Bay City water line maps, 1998 aerial photographs, and Dow well and boring records from the Dow Bay City Sites were reviewed in preparing this assessment.

The Site consists of low-lying, essentially flat, terrain along the Saginaw River and is surrounded by water on all sides (Figure 3). The elevation of the site ranges from 580 - 586 ft relative to the USGS datum. Several wetland areas currently exist at the Site and are projected to remain in the future. The subsurface materials consist primarily of fine silty sand and silt up to 12 ft thick overlying dense glacial till. The surface soils also contain various amounts of clay, peat, gravel, and industrial fill. The glacial till consists primarily of silty clay and extends to approximately 80 to 90 feet below ground surface (bgs) where it overlies bedrock of the Saginaw Formation. Figures 3 and 4 in the April 2001 Hydrogeologic Assessment are geologic cross sections constructed at the Site showing these relationships.

Ground water at the Site is encountered at a depth of 1 to 5 ft bgs under unconfined conditions. A limited amount of information is available on ground water levels at the Site; however available data indicate that ground water flow is generally to the east ultimately discharging to the Saginaw River. It is likely the flow directions and gradients fluctuate seasonally and are affected by long-term trends in the water levels of the Great Lakes (average water levels in the Saginaw River at the Site are essentially the same as in Lake Huron). Due to the proximity of the Site to the Saginaw River, it is likely that shallow ground water is in hydraulic communication with the river and that ground water levels will fluctuate along with the river levels. It is expected that the shallow ground water is recharged by the river and service water ditches during periods of rising water levels and dewaters to some degree during periods of falling water levels. Although Site specific data are not available demonstrating this relationship, Dow has conducted detailed hydrogeologic studies at the nearby Dow Bay City Terminal and former ITI sites (Figure 2) located on the Saginaw River and observed these relationships between the river and shallow ground water system.

The geometric mean hydraulic conductivity of the saturated zone has been calculated to be 9.4×10^{-4} feet per minute (ft/min) from aquifer slug tests conducted at the Site (see Table 2, in April 2001 Hydrogeologic

[1] These represent the sites with readily available subsurface data. There may be other sites in MDEQ files that also have available data. The possible existence of additional data is not anticipated to affect interpretations of conditions at the Thorad site.

Assessment). Variable hydraulic gradients ranging from 0.00032 to 0.0072 ft/ft of have been measured at the site resulting in estimated ground water flow velocities ranging from 0.022 to 0.049 ft per day.

1.3 Evaluation

The following sections provide Site-specific information on:

- Ground water quality;
- Ground water quantity;
- Availability of drinking water; and
- Restrictions on ground water use.

Ground Water Quality
Shallow ground water is generally discouraged for use as a drinking water source by public health officials due to generally poor water quality and the potential to be impacted by various types of contamination. General water quality parameters that are routinely considered by the State of Michigan relative to the suitability of ground water as a drinking water source include:

- Nitrate and nitrites;
- Total dissolved solids (TDS);
- Bacteriological contaminants; and
- Other sources of contamination.

Monitoring wells at the site have not been sampled for nitrate, nitrite, or bacteriological contaminants; however, samples have been analyzed for TDS. Samples were collected and analyzed for TDS from 10 onsite wells and 2 background wells in May 2002. Concentrations ranged from 590 to 7,100 milligrams per liter (mg/L) with an average of 2,800 mg/L with onsite and offsite wells at similar concentrations (Table 1). These concentrations all exceed the MDEQ generic drinking water criteria of 500 mg/L (an aesthetic standard).

Although long-term hydrogeologic data are not available for the Site, it is likely that the shallow ground water is primarily recharged by precipitation. Under certain climactic conditions the ground water is also likely to be recharged from surface water as noted previously in the section Background Information. The Site is surrounded by surface water, including service water ditches located along the southern and western edges of the Site and the Saginaw River located along the remainder of the Site boundary. The Saginaw River contains elevated concentrations of nitrate (USGS water quality data for Saginaw River) and is it possible that this would negatively impact ground water at the Site during periods of recharge from the surrounding surface water (the service water ditches primarily obtain water from the Saginaw River).

Ground Water Quantity
Ground water must be present in sufficient quantity to make installation of a water well practical. No ground water supply wells exist at the Site and no wells have been installed to test the production rate of shallow ground water. There are also no permitted or other wells known to have been installed to produce or test shallow ground water in similar hydrogeological conditions within a 3 mile radius of the site.

The saturated thickness of shallow ground water is variable across the site and is typically on the order of 2 to 5 ft. In-situ aquifer slug tests were conducted in 10 monitoring wells and indicated that hydraulic conductivity ranged between 5×10^{-3} and 1×10^{-4} ft/min with a geometric mean of 9.4×10^{-4} ft/min. Ground water sampling records at the Site indicate that most of the monitoring wells can be produced at a low rate (0.007 to 0.07 gallons per

minute (gpm)) without dewatering for the purpose of collecting ground water samples. The quantity of water that could be produced from a shallow water supply well at the Site is likely to be limited due to the relatively thin saturated thickness within an unconfined aquifer. The heterogeneous nature of the deposits suggests that ground water may be isolated and that sustained production from a well may not be possible.

Availability of Drinking Water
Due to its relatively poor quality and the estimated marginal yield to a well, it is realistic to expect that shallow ground water at the Site would only be considered for drinking water use if other higher quality and more reliable sources were not available. Other sources of drinking water are available at the Site now, and will be available in the future. These include:

1. Bay City Municipal Water Supply system; and
2. Deeper aquifers at the Site.

Municipal Water Supplies
Potable water is provided to the Site area by Bay City from intakes in Lake Huron. Water mains currently run along Wilder Road approximately 2,900 ft south of the Site and along Shady Shores Road approximately 3,800 ft north of the Site. The SC Johnson manufacturing facilities located approximately 1,500 ft west of the Site are also supplied with potable water by Bay City as well as the other businesses and industrial users in the area. Water lines were extended in 2002 to the new Port Fisher/Bay Aggregate development located approximately 1 mile south of the Site (Figure 2).

Deeper Aquifers
Ground water has been demonstrated to be present in the Saginaw Formation in the area at a depth of approximately 90 ft bgs. One water supply well was installed in this formation approximately 4,000 feet southwest of the Site and registered to the Straits Corporation for irrigation (see Figure 4 in April 2001 Hydrogeological Assessment[2]). The depth to the Saginaw Formation at the Site is estimated to be 80 to 90 ft. Saginaw Formation aquifers are isolated from the shallow ground water by approximately 70 ft of glacial till.

Water is also occasionally obtained from till sands found within the glacial till. One registered well was located in the area that was completed in a till sand. The well was completed at a depth of 32 ft bgs and was located across the Saginaw River approximately 6,500 ft northeast of the Site (see Figure 4 in April 2001 Hydrogeological Assessment). If a till sand aquifer is present at the Site, it would likely provide higher quantity and better quality water than the shallow ground water. The presence of till sands is hard to predict and it is uncertain whether or not any till sands are present beneath the Site because no borings have been drilled that fully penetrate the glacial till. As part of other activities in the area, Dow drilled 7 exploratory borings through the glacial till to the underlying Saginaw Formation at the Bay City Terminal located approximately 4,400 ft south of the Site. Of these, only 1 boring encountered a till sand at a depth of 68 bgs. The till sand was approximately 9 ft thick and appeared to be hydraulically isolated from the shallow ground water.

Restrictions on Ground Water Use
The State of Michigan regulates the permitting and use of ground water through the Well Construction Code Administrative Rules (R 325). These rules are implemented and water wells are permitted through the local health departments. The Bay County Department of Public Health has jurisdiction over the Dow Thorium Site. Rules pertaining to shallow ground water at the site include the following:

[2] Note that well #2 shown on Figure 4 is shown in error. The well record indicates it is located in another township than shown on the Figure 4.

- **R325.1621(3)(b):** This rule requires that wells be constructed to exclude known sources of contamination from the well.

- **R325.1622(1):** This rule specifies that a water well for any beneficial use shall be located where it is not subject to contamination.

- **R325.1632(3):** This rule requires that well casings extend not less than 25 ft bgs. Exceptions to the rule must be obtained in writing from the health officer pursuant to the provisions of R325.1613.

- **R325.1613(2)(d) & (e):** These rules discuss allowable deviations from the requirement that well casings extend greater that 25 ft bgs. An exception is allowed under subpart (d) if the well water is not used for human consumption and certain other conditions are met. An exception is allowed under subpart (e) if it is shown that potable water does not exist at depths of greater the 25 ft and if the distance between the well and contamination is increased or a confining layer is present above the aquifer.

These rules clearly prohibit the installation of a water well at the Dow Thorium Site because shallow ground water occurs at a depth of no more than approximately 12 ft bgs. Exceptions under R325.1613 do not apply to the Site because potable water in suitable quantities has been shown to exist in the area from aquifers at depths ranging from approximately 80 to 90 feet bgs.

1.4 Restrictive Covenants (Deed Restrictions) for the Bay City Site

To further restrict use of ground water at the site, TDCC will be placing a deed restriction on the Site as a part of the ongoing RCRA corrective action for Bay City sites. The deed restriction will be transferred to all future owners of the Site.

Region 5 of the U.S. Environmental Protection Agency (EPA) has identified The Dow Chemical Company Bay City Sites as a RCRA site that will require corrective action (EPA identification number MID 005 380 258). The Bay City sites include the Thorium Site as well as other significant facilities, including: the former Petrochemical Facility, former West Tank Farm, former Bay Refinery, and the Bay City Terminal. Seventeen (17) Solid Waste Management Units (SWMUs) and 13 Areas of Concern (AOCs) were identified by EPA in 1993. The Thorium Site was identified as SWMU #2, "Thorium Slag Pile". In 1996, the Michigan Department of Environmental Quality (MDEQ) identified a portion of the Bay City Sites as a facility subject to corrective actions. In 2002, EPA proposed the implementation of a Voluntary Agreement between EPA, MDEQ and Dow to address the implementation of corrective actions at the Bay City Sites. As proposed, the Voluntary Agreement would allow corrective actions to be implemented following MDEQ regulations and guidance documents.

Over the years Dow has initiated numerous corrective actions at the Bay City Sites and is presently working with the MDEQ under Part 201 of the Natural Resources and Environmental Protection Act 451 on the development of a Remedial Action Plan (RAP) for the Bay City Terminal. A key component of the RAP will be the implementation of land and resource use restrictions on all the affected and potentially affected properties that are part of the Bay City Sites. Under part 20120b of Part 201, it is permissible to rely upon land or resource use restrictions as long as the restrictions meet the requirements defined in the Act. The restrictive covenant must be recorded with the registrar of deeds for the county in which the property is located. The restrictions shall run with the land and be binding on the owner's successor, assigns, and lessees and shall include provisions to accomplish, among other things, the following:

- Restrict activities that may interfere with remedial action, operation and maintenance, monitoring, or other activities necessary to assure the effectiveness of the remedy;
- Restrict activities that may result in exposures above levels in the RAP;
- Require notice to the MDEQ to convey any interest in the facility;
- Grant the MDEQ the right to enter the property; and
- Allow the state to enforce the restriction by legal action.

Restrictive covenants have been recorded with Bay County for 17-acre and 32-acre portions of the Bay City Sites (see Figure 4). These restrictive covenants meet the strict provisions of 20120b and were approved by MDEQ. Both restrictions prohibit the use of ground water. Restrictive covenants will be prepared prohibiting ground water use on the remainder of the Bay City Sites as part of Dow's plan for meeting its Part 201 obligations and preparing a RAP for approval by the MDEQ.

2.0 BASES FOR SELECTION OF RECREATIONAL SCENARIO FOR FUTURE LAND USE AT THE TDCC BAY CITY SITE

2.1 Land Use History

The general area around the Thorium Site has a long history of industrial development due to its location along a major transportation corridor near the mouth of the Saginaw River. The following paragraphs briefly describe some of the significant industrial operations in the area. The locations of significant facilities discussed below are shown on Figure 5.

Some of the earliest industrial development in the site area occurred by 1919[3] with the construction of a marine terminal on the Saginaw River with railroad access. The marine terminal, located approximately ½ mile south of the Thorium Site, later became a terminal and petroleum tank farm operated by the Standard Oil Company (currently Bay Aggregate). In 1937, the Bay Refining Company opened a petroleum refinery on the banks of the Saginaw River approximately 1 ½ miles south of the Site. By 1950, other industrial concerns were present in the area including the current Marathon Ashland Petroleum LLC terminal (formerly Unocal) located on the corner of Wilder and Tiernan roads[4]. The late 1950's saw significant industrial expansion in the area with the purchase of the Bay Refining Company by The Dow Chemical Company (Dow). Beginning in about 1957, Dow began construction of the Petrochemical, Polyethylene, and Handiwrap plants. In the early 1970's the Polyethylene plant was closed and a Ziplock plant was constructed on the same site. The Straits Wood Treating facility was constructed on Wilder Road south of the Dow plants in the early 1980's. Other significant facilities constructed in the area include the coal-fired electric power plant operated by Consumers Energy across the river from the site and the West Bay County Wastewater Treatment Plant located approximately 1-mile southwest of the site.

Recent industrial development includes the construction of an asphalt terminal in 2002, by Bit-Mat Corporation on a previously undeveloped portion of the Dow Bay City Terminal. In 2002, the Bay Aggregate Company also began moving its operations from downtown Bay City to the former Standard Oil Company terminal site. Proposed additional development in the area also includes construction of a preformed concrete facility on former Dow property on Wilder and Tiernan roads.

Although there have been many changes in the industries located in the area over the past 50 years, the developed properties have remained industrial. The following facilities noted above are still in operation:

[3] USGS Bay City Quadrangle, 1919 Edition.
[4] 1950 aerial photograph

- Handiwrap Plant, current owner SC Johnson;
- Ziplock Plant, current owner SC Johnson;
- Straits Wood Treating Plant, current owner Straits Corporation; and
- Marathon Ashland Petroleum LLC.

The following properties have changed operations, but remain industrial:

- Bay Refinery, current owner Dow, part of Bay City Terminal, refinery has been demolished, operations currently include calcium chloride and liquid fertilizer storage and shipment; and
- Standard Oil Company Terminal, current owner Port Fisher, for Bay Aggregate Company operations for shipment and storage of aggregate.

It is expected that future development of the general area will remain industrial in nature for a number of reasons. The location near the mouth of the Saginaw River ensures that the area will be of interest to industries that rely on the transfer of goods by water. Both Bangor Township and Bay City have zoned the Thorium Site as well as all adjacent parcels General Industrial to encourage additional industrial development in this area. In addition, the presence of industry in the area is a deterrent to residential and commercial development because of heavy truck traffic, noise, emissions, and aesthetics. Figure 6 shows the location of Industrial Zoning in the site area. However, there are impediments to the development of the wetlands area that is subject to NRC license. These are discussed below.

2.2 Impediments to Future Development of Site

Site Physical Limitations

Based on an aerial topography, the Site elevations were determined to range from 580 to 586. This data is consistent with the United States Geological Survey (USGS) Topographic Map (1973), which indicates the site elevation ranges from 580 to 585 ft (USGS datum).

The FEMA flood zone map indicates that the Site is located in Zone AE (100 yr floodplain). The 100-yr floodplain elevation for the Site is 586. In addition to flooding, the elevation of Lake Huron and the Saginaw River naturally fluctuate from 582 to 576 (data from NOAA Great Lakes Environmental Laboratory for period 1918 to 2000). When short term fluctuations of 1 to 2 ft (due primarily to storm conditions over hours or several days) are superimposed on the long-term levels, the maximum lake elevation can be as high as 584. These data indicate that, in addition to flood conditions, the site is periodically inundated as water levels in Lake Huron and the Saginaw River naturally fluctuate.

Based on the evaluations of the site, the Saginaw River, and the 100-yr floodplain, large volumes of fill material, ranging from one to six feet, would be needed to prevent the site from periodic flooding. For each acre of fill, one (1) foot deep the cost of the material, grading and compaction would be approximately $32,000.

Restriction on Wetland Development

Any alteration of a wetlands area will require a Wetlands Permit including dredging, filling crossing, and draining surface water. Wetlands mitigation is a requirement of most Wetlands Permits. This is accomplished by creating new wetlands onsite from an upland area, creating new wetlands at an offsite location or through the purchase of property currently available in "Wetlands Mitigation Banking." Wetlands mitigation is done at one and a half times the area of wetlands disturbed. The cost of wetlands mitigation to replace floodplain volume lost due to filling would be approximately $48,000 per acre.

Poor Soil Quality

According to the United States Soil Conservation Service (USCS) Soil Survey, the Site soils are composed of sandy and loamy aquents. Aquents are described as highly variable borrow/fill/altered. The Soil Survey indicates that "major hazards or management problems" may need to be overcome to utilize areas comprised of this soil type for either development or agriculture. Groundwater is seasonally variable and is historically encountered between six inches (6") to two feet (2') below ground surface.

2.3 Future Land Use

The most probable future land use for the site is the **Recreational Intruder**. It is most likely that any future industrial development in the general area would occur at other locations that do not pose the engineering and wetlands challenges of the Site. It is reasonable to assume that this land would be maintained in a natural state. The recreational intruder is an individual that enters the site for hunting and or fishing. In the past, this type of activity has been observed at the site. The dose pathways for the Recreational Intruder would include direct exposure, particulate inhalation, meat ingestion, aquatic food ingestion, and direct ingestion.

It is possible, although less likely, that the future land use would be Industrial. The Industrial scenario would not include the use of the shallow groundwater for drinking water or any other purpose for the reasons described above. The physical limitations of the site result in significant cost and engineering impediments and challenges to the implementation of the industrial scenario. For example, the filling and mitigation of a five acre site (assuming 6 feet of fill) could cost as much as $2.4M. This is before consideration of any other site permitting or engineering issues such as the presence of loamy aquents soils. These challenges limit the types and scope of future land use that could reasonably be envisioned to occur at the Site

It is also possible based on a review of past development records in other wetlands areas in Michigan that a wetlands site could be developed for a marina (with no use of the shallow groundwater). Because of the long history of industrial use in the area and the impediments to successful development, the Marina scenario has a lower probability of occurrence than the Industrial scenario. The economic and engineering impediments for a marina development would be similar to that described above for industrial development.

A Resident Farmer scenario is the least likely scenario with an exceedingly low probability of ever occurring at the site due to physical limitations, wetlands, unsuitability of shallow groundwater for use as drinking water or irrigation, soil type, cost, environmental liability, deed restrictions, zoning, and past land use. The resident farmer scenario does not meet the definition of prudently conservative and does not apply to the Bay City Site.

NRC Comment #17.B

TDCC needs to provide a plan showing how ground water measured above the 5 pCi/L total radium limit will be remediated. This plan should identify the remediation technology that will be used, its anticipated effectiveness, and the time period over which it will be used.

TDCC Response To Comment #17.B

In comment #17.a, NRC staff indicate that compliance with the 5 pCi/l radium criteria must be met "...everywhere (i.e., at each well location at the site)." Using this logic, in Comment #17.b, the staff suggests that groundwater at isolated well locations containing radium concentrations that exceed the MCL's should be remediated; notwithstanding the fact that 1) the average groundwater concentration on the Site is below the MCL's (3.1 pCi/l total radium) , 2) the concentrations in the few Site wells exceeding the MCL are only slightly elevated (8.5 pCi/l maximium), and 3) there are also background wells with concentrations exceeding the MCL's (7.66 pCi/l maximum). Requiring compliance at each well location does not appear to be consistent with SDMP Action Plan commitment to ALARA or to represent a risk-informed approach.

Requiring that the 5 pCi/l radium criteria be met at each well location at the Site is not appropriate for two reasons:

1. The affected groundwater is not likely to be a source of drinking water. As discussed in the response to Comment #2, the shallow ground water at the site would not be used as a potable or domestic source of water. Michigan state regulations prohibit the installation of water wells in shallow groundwater. The groundwater at the site is of poor quality. Alternative higher quality sources of drinking water are available. And finally, deed restrictions will prohibit ground water use over the entire TDCC Bay city site, including the Thorad site.

2. Compliance with this requirement would not be consistent with a risk-informed, ALARA approach. The National Primary Drinking Water Standards (NPDWS) do not address measurements in groundwater since the regulations only pertain to existing drinking water sources for communities of 25 persons or greater. Therefore, the ALARA provision of the SDMP Action Plan appears to be the criteria for determining whether the maximum individual groundwater concentration or the average Site concentration should be used as the compliance measure for unrestricted use. It is our understanding that this would involve the consideration of a prudently conservative, not worst case, dose scenario.

   It is not credible to assume that an individual will place a well in the worst case location on the Site and that the maximum concentration identified in an individual well will be maintained over the 30 year exposure period used in NRC risk assessment. This would represent the maximally exposed individual, which NRC specifically discounted with the introduction of the average member of the critical group concept. Remediation to such a criterion would not result in a significant dose reduction to an actual future site occupant. In fact, the dose from the residual NRC licensed material in groundwater, after adjustment for background effects, could be as low as zero, under any exposure scenario. Because the dose reduction would be low, the corresponding cost per person-rem would be exorbitant and certainly far exceeding the $2,000/person-rem NRC guidance.

Alternatively, adoption of a groundwater averaging concept would be an appropriate approach for determining compliance with SDMP requirements at the site.

1. Consideration of an averaging concentration concept is consistent with the NRC concept of the average member of the critical group. The average member is defined in NUREG-1549 as "an individual who is assumed to represent the most likely exposure situation based on prudently conservative exposure assumptions." The average of the wells represents the most likely exposure concentration from the Site groundwater.

2. NUREG-1727 "NMSS Decommissioning SRP" recommends the use of the peak of the mean when probabilistic modeling is used. If the distribution of Site groundwater concentrations is used as the parameter distribution function and groundwater ingestion were the only pathway, the peak of the mean dose would correspond closely to that calculated with the average concentration. Also, the average concentration is used for compliance with every other contaminated media. Using the average concentration is consistent with NRC risk assessment guidance.

3. The site has high background levels of radium in groundwater, and there is considerable overlap of the background and Site concentration distributions. In fact, 25% of the background results from the last round of groundwater samples were in excess of the 5 pCi/L total radium limit (29% of the Site results exceeded the MCL). Thus, there is relatively low confidence that any given well concentration actually exceeds background which would justify averaging the data over a broader geographical area.

4. There appear to be seasonal fluctuations in concentration levels that are likely due to seasonal changes in hydogeologic conditions. Trying to develop a compliance plan tied to the peak seasonal high concentration, at the peak location, would require, at a minimum, extensive groundwater modeling and may not be technically feasible at all.

Table 2 provides a summary of groundwater concentration data from the last round of samples (Fall 2002). This was the most comprehensive sampling campaign and included the largest number of background samples from areas approved by NRC staff. The average total radium concentrations for the Site and background are 3.1 and 3.3 pCi/l, respectively. The average Ra-228 concentrations for the Site and background are 2.7 and 2.5 pCi/l, respectively.

TDCC proposes to use the average of the total radium concentration in the groundwater, at the 95% confidence level, to demonstrate compliance with the SDMP Action Plan NPDWS reference standard.

Table 1 – Total Dissolved Solids Concentrations in Thorad Site Shallow Groundwater

Well ID	Sample Date	Temperature (deg. C)	Specific Conductivity (mS/cm)	pH	Redox Potential (mV)	Total Dissolved Solids Field Results (ppm)	Total Dissolved Solids Laboratory (mg/L)
C5-2	5/14/2002	10.91	1,249	7.61	100	NR	590
D5-2	5/15/2002	12.40	2,524	10.12	-144	1,233	1,500
D6-1	5/15/2002	15.15	3,577	9.97	-182	1,529	2,000
F5-4	5/14/2002	13.06	2,138	8.39	-105	NR	1,200
F5-5	5/14/2002	12.68	4,945	9.96	-113	NR	3,300
F5-6	5/14/2002	11.78	6,609	9.87	-136	NR	4,000
F7-3	5/15/2002	10.25	8,486	9.65	-105	>1,999	7,100
F7-4	5/15/2002	12.43	4,027	7.19	-55	1,800	2,500
F7-7	5/15/2002	11.06	4,992	9.32	-60	>1,999	3,200
BKG-N1	5/14/2002	9.35	1,367	6.62	210	NR	860
MW-5847-A1	5/14/2002	8.48	7,498	6.65	212	NR	5,700
G5-8	5/14/2002	11.74	3,422	8.58	78	NR	2,100

Table 2 – Groundwater Monitoring Results From Fall 2002 Sampling Campaign

Station	Ra-226 pCi/L	Ra-228 pCi/L	Ra-226 + Ra-228 pCi/L
B5-3B	0.156	0.91	1.066
C5-2D	-0.191	2.63	2.439
D4-7	0.383	2.65	3.033
D6-8A	0.128	1.39	1.518
E10-7A	0.096	1.82	1.916
E4-1	-0.007	1.22	1.213
E6-1	0.251	1.11	1.361
F4-2	0.144	1.23	1.374
F4-4A	0.55	4.61	5.16
F5-5D	0.24	1.99	2.23
F5-6D	0.027	1.52	1.547
F7-3A	0.024	0.568	0.592
F7-4A	0.227	1.64	1.867
G5-8	1.5	4.88	6.38
G6-9A	1.86	6.64	8.5
I5-5C	1.31	4.98	6.29
I6-8C	0.618	5.58	6.198
Background 4921	0.232	1.6	1.832
Background 5847	3.71	3.95	7.66
Background 5849	0.249	1.9	2.149
Background 5851	1.12	2.82	3.94
Background 5852	-0.144	1.16	1.016
Background 5855	0.291	4.73	5.021
Background 5858	0.285	1.12	1.405
Background 5860	0.431	3.14	3.571

Legend

Rivers & Lakes

Cities

Essexville

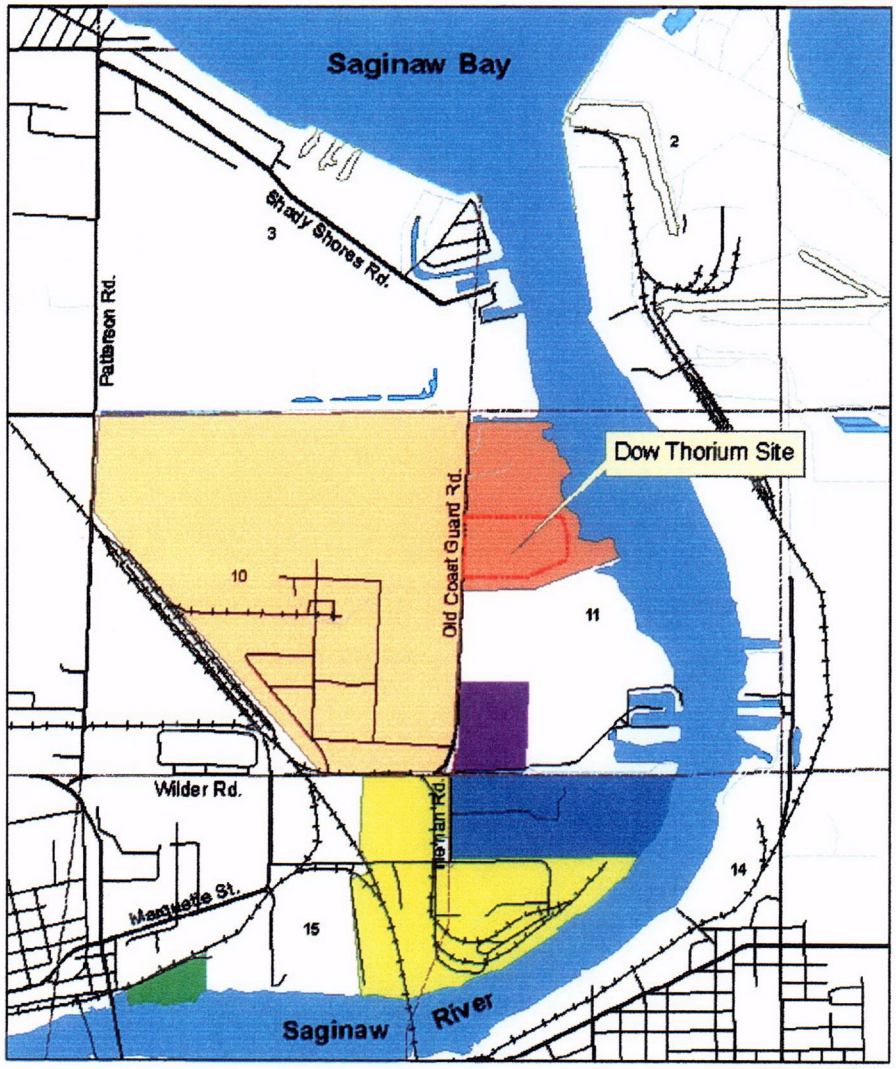
Bay City

0 1,000 2,000 4,000 6,000 8,000 Feet

N

Figure 1
Thorium Site Location

C01



Legend

Sites

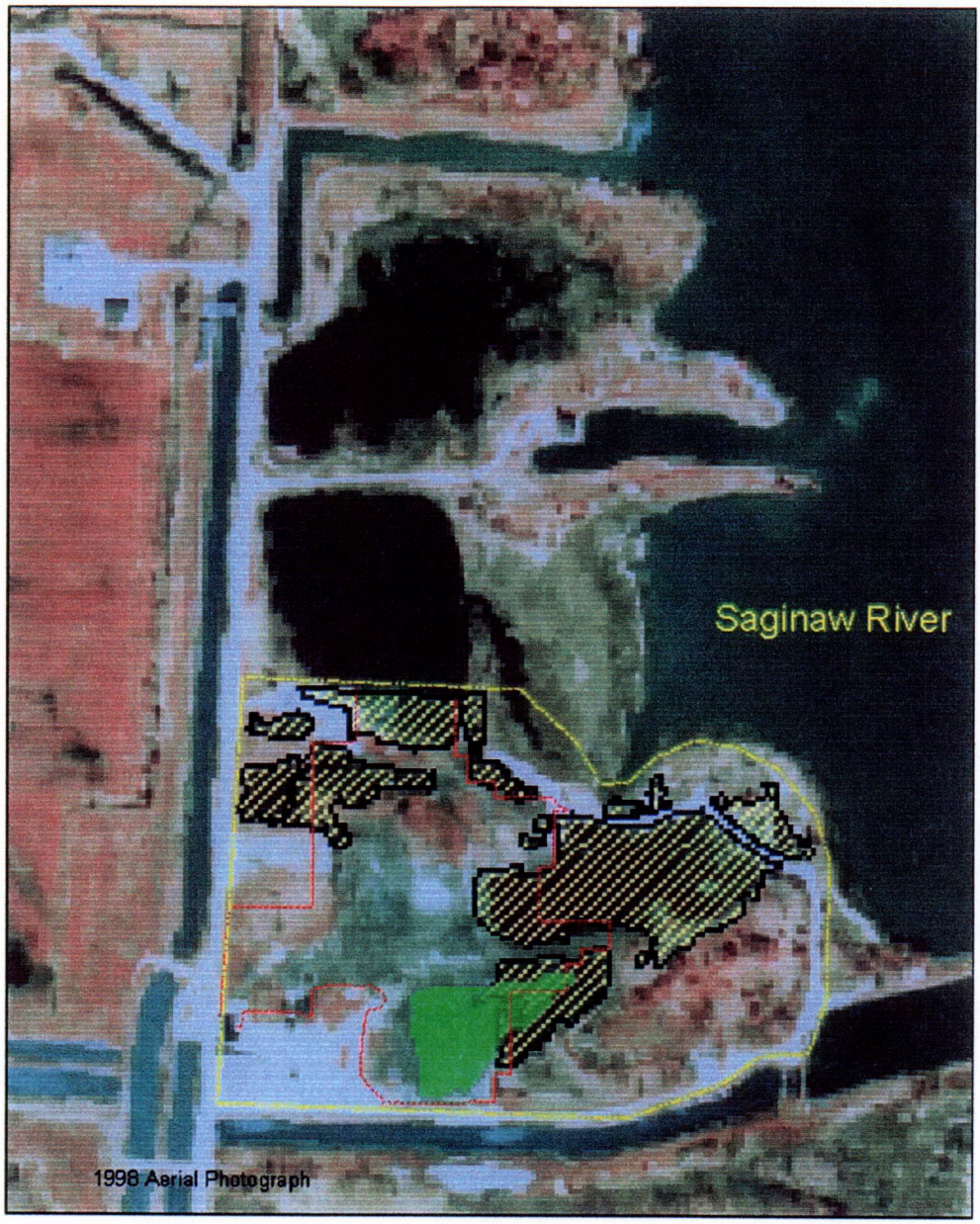
- Dow Former ITI
- Dow Bay City Terminal
- Port Fisher/Bay Aggregate
- Marathon Ashland/Unocal
- Dow Throrium
- Dow Petrochemical

Figure 2
Sites with Subsurface Data

N

0 750 1,500 3,000 4,500 6,000 Feet

C01A



Legend

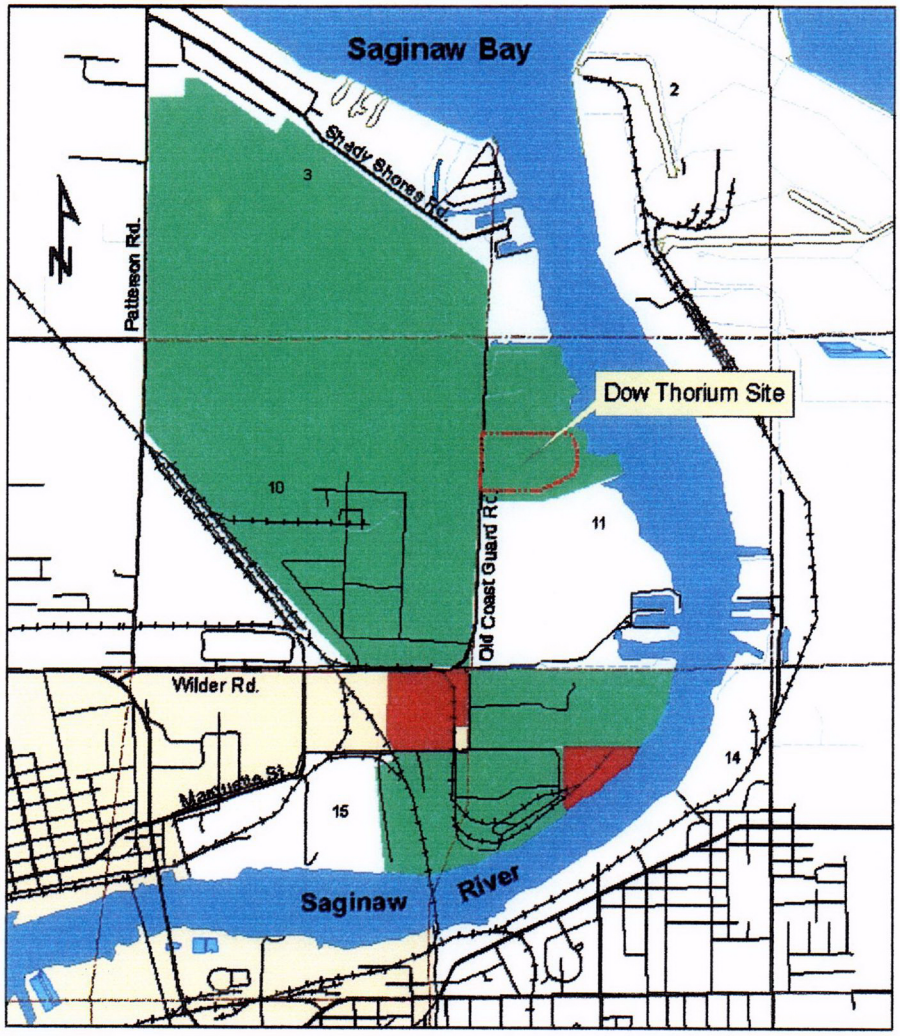
- Fenceline--July 2000
- Former Thorium Slag Pile
- Excavated Areas

N

Figure 3
Thorium Site Features

0 100 200 400 600 800 Feet

C02



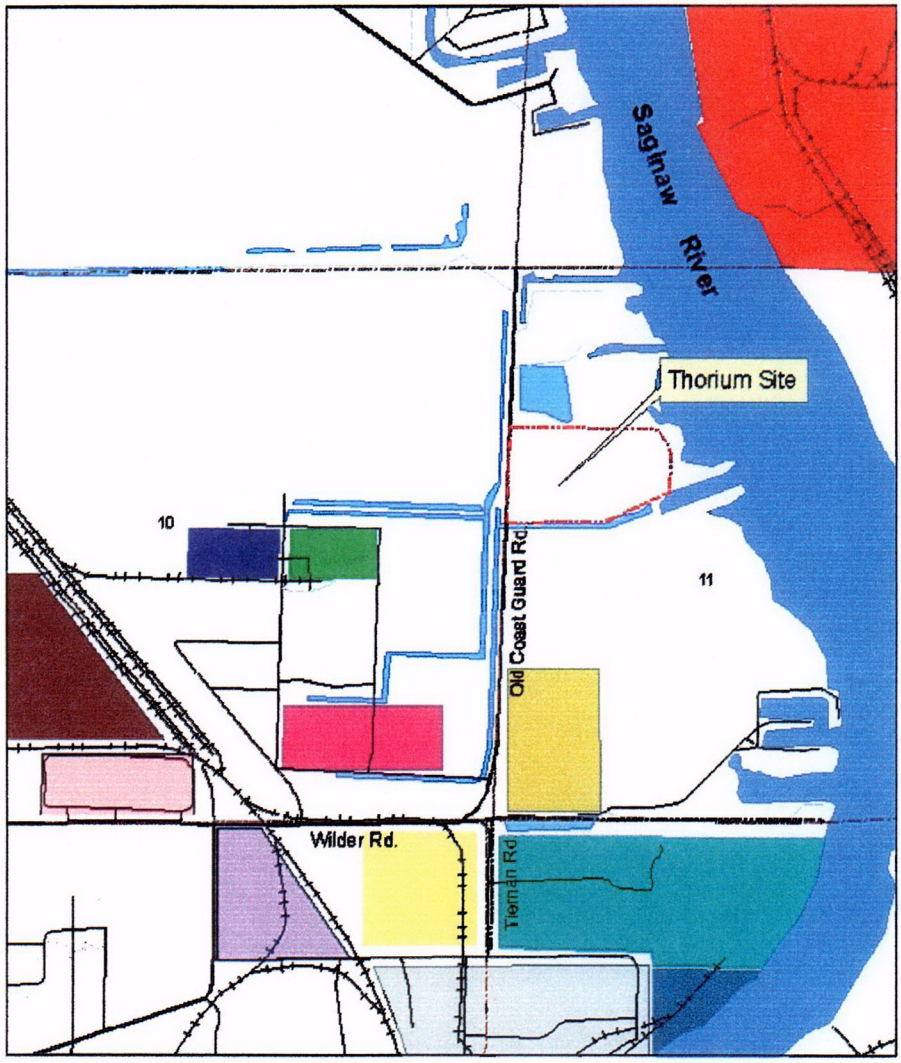
Legend

- Bay City GW Ordinance
- Future GW Restrictive Covenant
- Current Restrictive Covenant

Figure 4
Ground Water Restrictive Covenants

0 950 1,900 3,800 5,700 7,600 Feet

C03



Legend

Site Identification

- Wastewater Treatment Plant
- Crane Plastic Lined Pipe Plant
- SCJ Handiwrap Plant
- SCJ Ziplock Plant
- Former Petrochemical Plant
- Stalls Wood Treating
- Proposed Preformed Concrete
- Marathon Ashland Terminal
- Port Fisher/Bay Aggregate
- Bit Mat Asphalt
- Dow Bay City Terminal
- Consumers Energy Power Plant

Figure 5
Significant Industrial Sites

N

0 750 1,500 3,000 Feet

C04

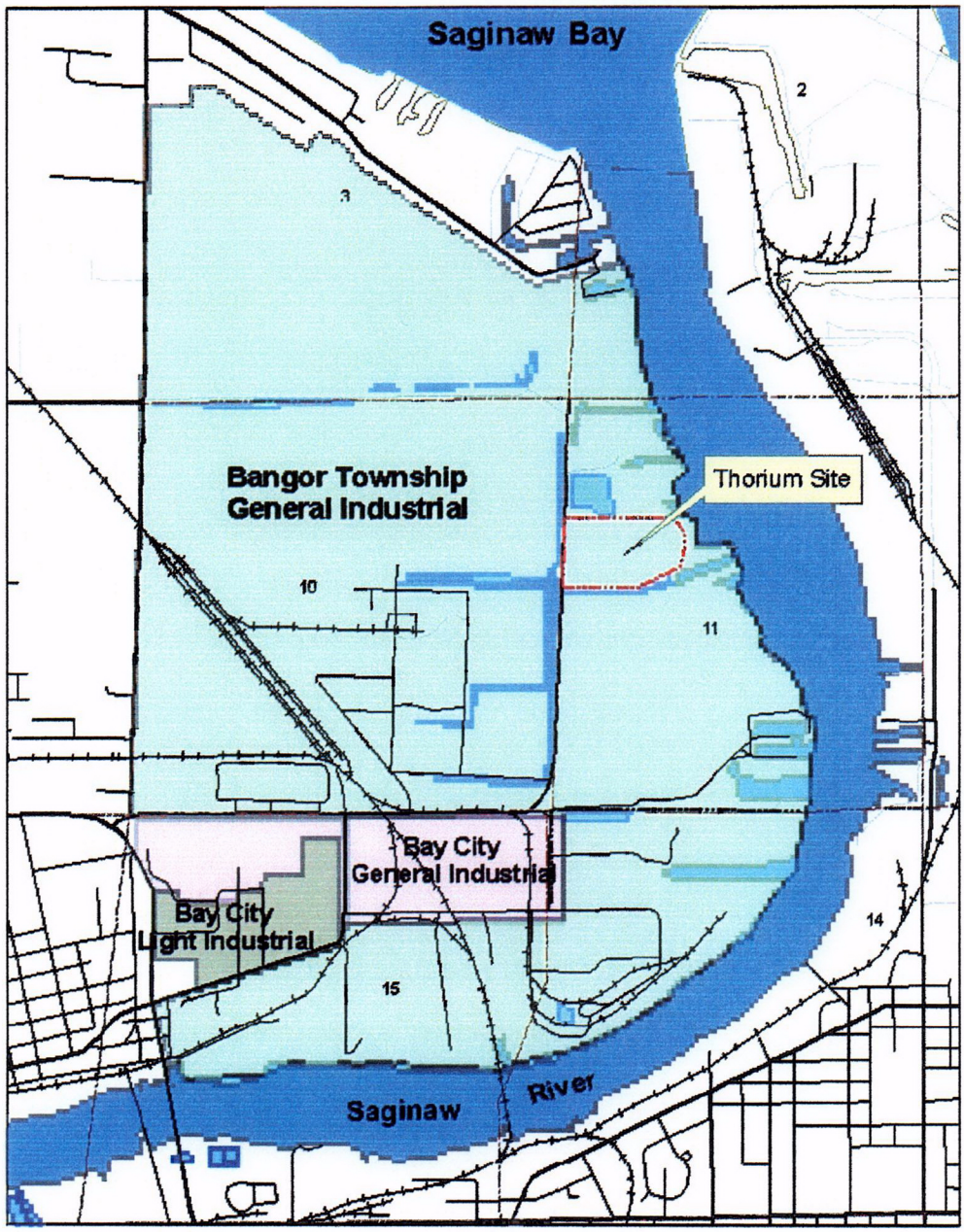


Figure 6
Industrial Zoning

N

0 750 1,500 3,000 4,500 6,000
Feet

C05

URS

HYDROGEOLOGICAL ASSESSMENT

Dow Thorium Site
Bay City, MI

Prepared By:

URS Construction Services
1111 Washington St.
Midland, Michigan 48640

April 2001

The Dow Chemical Company
Midland, Michigan 48674

Ashman Center
May 13, 2002

Mr. Sam Nalluswami
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

RE: HYDROGEOLOGIC ASSESSMENT
NRC LICENSE STB-527

As requested enclosed are three copies of the Hydrogelogic Assessment done for the Bay Thorium site by URS dated April 2001.

Please let me know if you have questions regarding this information.

Ben Baker
Project Manager
The Dow Chemical Company
Ashman Center
4520 E. Ashman
Midland, MI 48674
(517) 636-0787

Enclosures (3)

HYDROGEOLOGICAL ASSESSMENT

Dow Thorium Site
Bay City, MI

Prepared for:

The Dow Chemical Company
Midland, Michigan

Prepared by:

URS Corporation
1111 Washington St.
Midland, Michigan 48640

April, 2001

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2 Soil Borehole Locations
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Appendix D: Slug Test Data

1.0 Introduction

The Dow Chemical Company requested URS Corporation (URS) to perform an evaluation of the hydrogeologic conditions at the Thorium Contamination Site (Thorad) in Bay City, Michigan. Background information on the site geology and hydrogeology is contained in the September 5, 2000 memorandum "Hydrogeologic Assessment of The Dow Chemical Company Thorium Contamination Site in Bay City, Michigan" (Appendix A).

The Thorad site is located north of Bay City, Michigan near the mouth of the Saginaw River and consists of a low lying area adjacent to the river that was formerly utilized by The Dow Chemical Company for the storage of thorium contaminated slag material (Figure 1). A large percentage of the site has been successfully remediated and "cleared" by the Nuclear Regulatory Commission (NRC). However, approximately 9 acres of the site have not yet been cleared.

The purpose of this investigation was to provide an evaluation of the site geology and hydrogeology for the remaining contaminated area. Previous reports have indicated that groundwater is typically encountered 3-5 feet below grade throughout the area and is essentially continuous with the surface water in the Saginaw River. Groundwater flow velocity most likely varies seasonally based on the rise and fall of the Saginaw River. Additional field-work was performed to further characterize the site soils and to estimate groundwater velocity and flow directions.

2.0 Field Activities

URS collected over 100 continuous soil cores from the surface down to the glacial till clay from across the site. A URS geologist examined 41 representative soil cores (Figure 2) and prepared detailed soil descriptions and borehole logs (Appendix B).

Upon review of the soil cores, 10 locations were selected for the installation of groundwater monitoring wells (Figure 2). Each monitoring well was installed through hollow-stem augers by McDowell & Associates on Decmeber 20-21, 2000. Each well

consists of a 2-inch diameter, 5-foot long 0.01-inch slotted PVC screen and riser. The monitoring well screens were installed just above the till clay and in many cases are screened across the water table because of the limited saturated thickness. Copies of the well completion diagrams prepared for each well are provided as Appendix C.

URS measured static water levels in each new monitoring well and in 5 previously installed piezometers on January 17, 2001 using a clean electronic water level meter. Groundwater elevations were then calculated and are presented as Table 1.

Aquifer slug tests were conducted in each new monitoring well on January 15-16 to determine the hydraulic conductivity of the saturated layer at each location. A solid PVC slug was utilized to instantaneously displace a known volume of water from each well. Water levels were then recorded using a downhole pressure transducer connected to an electronic data logger until the water level reequilibrated. Because the monitoring wells are screened across the water table, falling head or "slug in" tests were not typically performed since water cascading through the dry filter pack above the water table can produce erroneous results. The saturated thickness was insufficient to conduct a rising head or "slug out" test in wells E10-7 and F4-2. At these locations a falling head test was performed by rapidly draining 1 gallon of deionized water into the well casing. Slug test data were analyzed using the method of Bouwer and Rice (1976). Plots of the slug test calculations are provided in Appendix D.

3.0 Site Geology

The river sediments and fill layers overlying the glacial till clay have previously been identified as the only layer having a significant potential for the migration of thorium (URS, 2000). The sediments encountered in the soil cores collected within the study area consist predominantly of fine silty sand and silt. Lenses of clay, peat and gravel are also present to a lesser extent. Within the study area, layers of thorium contaminated soil and fill material up to 9 feet thick is also present. This material is often bluish-gray and has a soft rubbery, highly plastic consistency.

Geologic cross sections were prepared to illustrate the relationships between the soils encountered above the till clay (Figure 3 and Figure 4). The surface topography at the site is relatively flat with an average grade elevation of approximately 585 feet relative to the USGS datum. Much of the variation in the surface topography is in fact due to excavating and various remedial activities. The depth of the till clay varies from 1 to 10 feet below grade, but is typically encountered 7 feet (578 ft.) below grade within the study area. Native soils including silt and peat layers are often found directly overlying the clay. Overlying the silt and peat layers is a highly variable sequence of sand, clay, and fill materials including thick layers of thorium contaminated slag material. Although some of the area may have previously been excavated, most of the fill was probably placed directly into low-lying areas. In all likelihood, these low-lying areas were wetlands, ponds, or inlets from the Saginaw River.

4.0 Site Hydrogeology

The Thorad site is surrounded by surface water with the Saginaw River located to the east and several service water ditches located to the north, west and south. Several shallow ponds are also present within the study area. The large excavated area located in the northeast corner of the site as well as the shallow pond located near the former slag pile is actively dewatered during remedial operations (Figure 5). The extraction pumps used to dewater the site are operated seasonally and were shut down for the winter in October 2000.

Groundwater is encountered 1-5 feet below grade across the site. Figure 5 depicts the groundwater elevation contours and flow directions for the site determined for January 17, 2001. A relative high point in the groundwater surface is located near the center of the site and groundwater flow occurs radialy outward or away from the groundwater mound. The gradient varies from 0.00032 ft./ft. toward the east to 0.0072 ft./ft. toward the northeast. Historical data from previously installed monitoring wells indicate that groundwater typically flows toward the east and a shallow gradient of 0.0045 ft./ft. has been calculated for the principal flow direction.

Groundwater flow and the gradient most likely fluctuate seasonally. In addition, the long-term rise and fall of water levels in the Great Lakes may affect flow patterns. (The water level in the Saginaw River is essentially the same as Lake Huron at this location.) Historical river level data indicate that the elevation of the Saginaw River has fluctuated by as much as 8 feet over the past 23 years with an average elevation of 579.4 feet.

Slug test results indicate an average (geometric mean) hydraulic conductivity of 9.44×10^{-4} feet/minute for the shallow saturated layer (Table 2). This result is consistent with the hydraulic conductivity typically reported for silty sands and silt. Using this value for the hydraulic conductivity along with the gradient calculated above, the groundwater velocity can be calculated using the following formula:

$$V_{gw} = \frac{k \cdot \frac{\Delta H}{\Delta X}}{n_{ef}}$$

Where :

V_{gw}= Groundwater Flow velocity
k= Hydraulic Conductivity
$\Delta H/\Delta X$= Gradient
n_{ef}= Effective Porosity (estimated as 0.2)

Using the formula above, a groundwater velocity of 11 ft/yr has been calculated for the groundwater in the shallow saturated layer beneath the study area.

5.0 Conclusions and Recommendations

The groundwater velocity calculations presented above should be regarded as an estimate and are only applicable to the conditions in January 2001. It is possible that the flow direction and gradient may vary seasonally as well as with long-term fluctuations in Lake Huron levels.

Table 1. Groundwater Elevation Measurements (1/17/01)

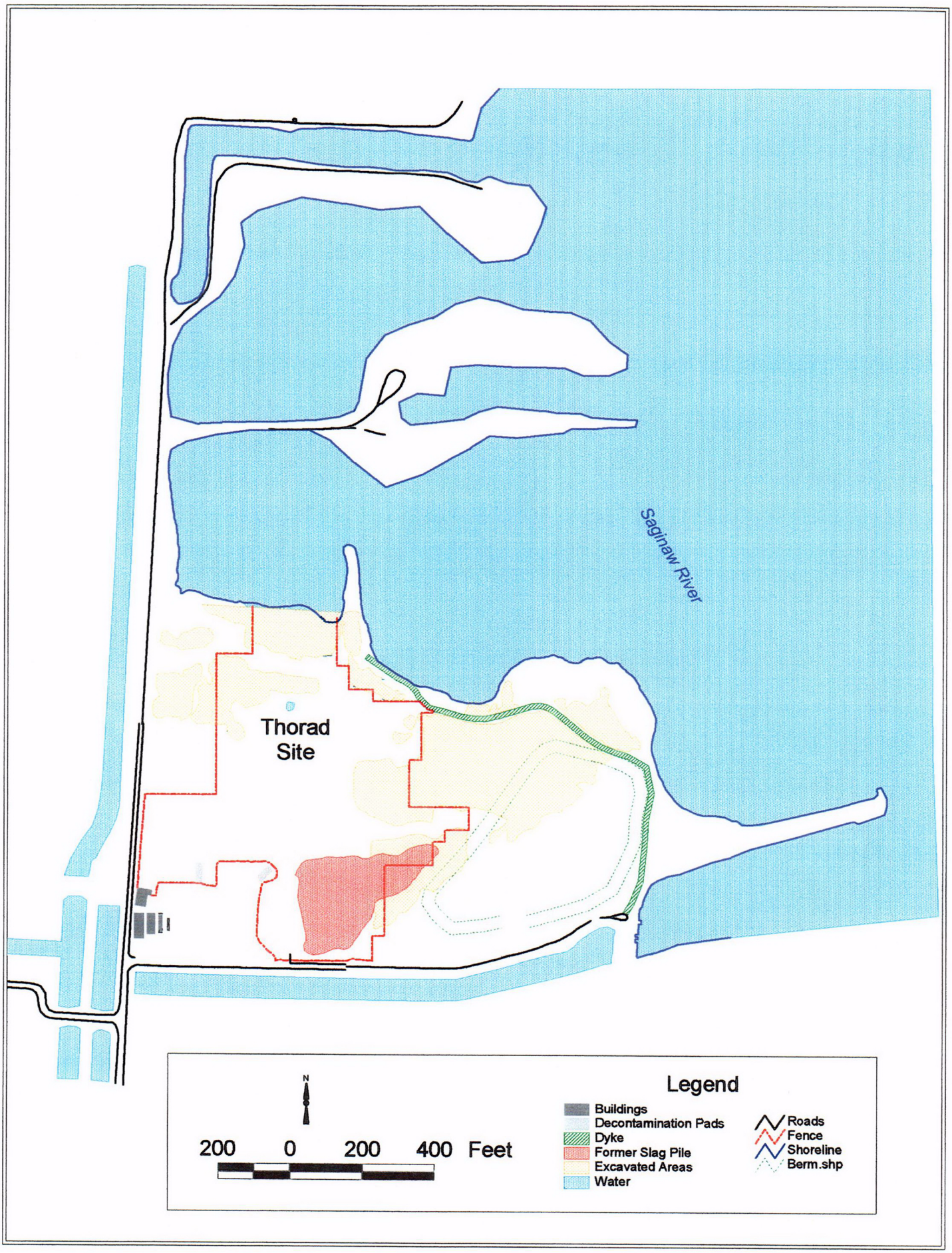
Well/Piezometer I.D.	Top of Casing Elevation (feet)	Depth to Water	Groundwater Elevation (feet)
B5-3	587.69	4.94	582.75
D4-7	587.55	4.49	583.06
D6-8	587.13	4.14	582.99
E10-7	587.30	7.05	580.25
E4-1	588.76	5.74	583.02
E6-1	587.70	4.89	582.81
F4-2	587.47	4.62	582.85
G5	588.52	6.19	582.33
G5-8	586.93	3.56	583.37
G6-9	587.83	5.06	582.77
G-1	586.30	4.65	581.65
G-2	586.52	4.82	581.70
G-3	587.80	6.22	581.58
G-4	587.61	4.89	582.72

Table 2. Thorad Site Slug Test Hydraulic Conductivity Data

Well ID	Test Type	k (ft/min)
B5-3	Slug Out	2.22E-04
D4-7	Slug Out	3.73E-03
D6-8	Slug Out	1.00E-03
E10-7	Slug In	5.20E-04
E4-1	Slug Out	6.55E-04
E6-1	Slug Out	8.83E-04
F4-2	Slug In	3.33E-03
G-5	Slug Out	5.24E-03
G5 -8	Slug Out	9.85E-04
G6-9	Slug Out	1.31E-04

Arithmetic Mean =	1.67E-03
Geometric Mean =	9.44E-04

Figures


Saginaw River
Thorad Site
N
200 0 200 400 Feet
Legend
Buildings
Decontamination Pads
Dyke
Former Slag Pile
Excavated Areas
Water
Roads
Fence
Shoreline
Berm.shp

C06

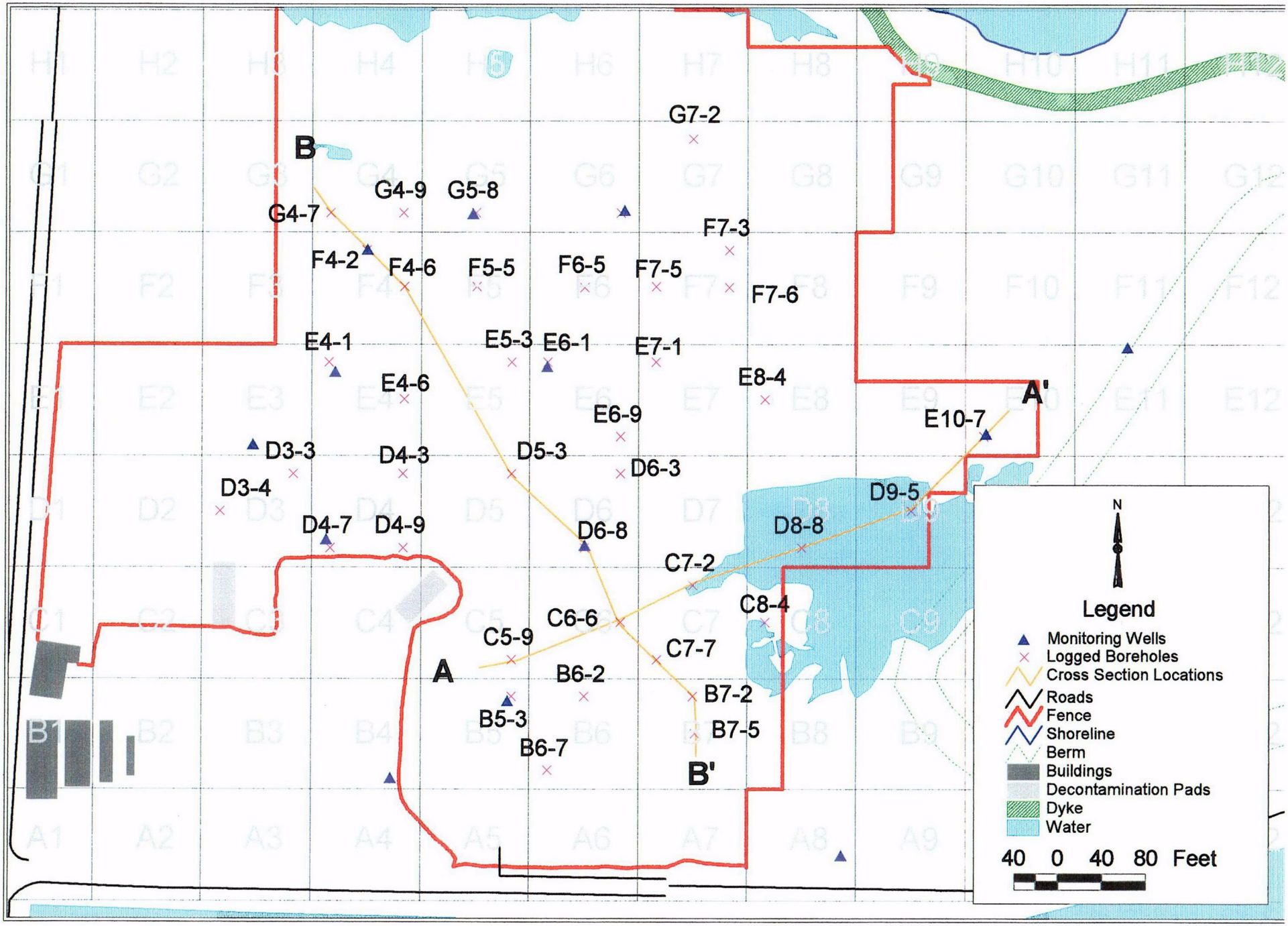
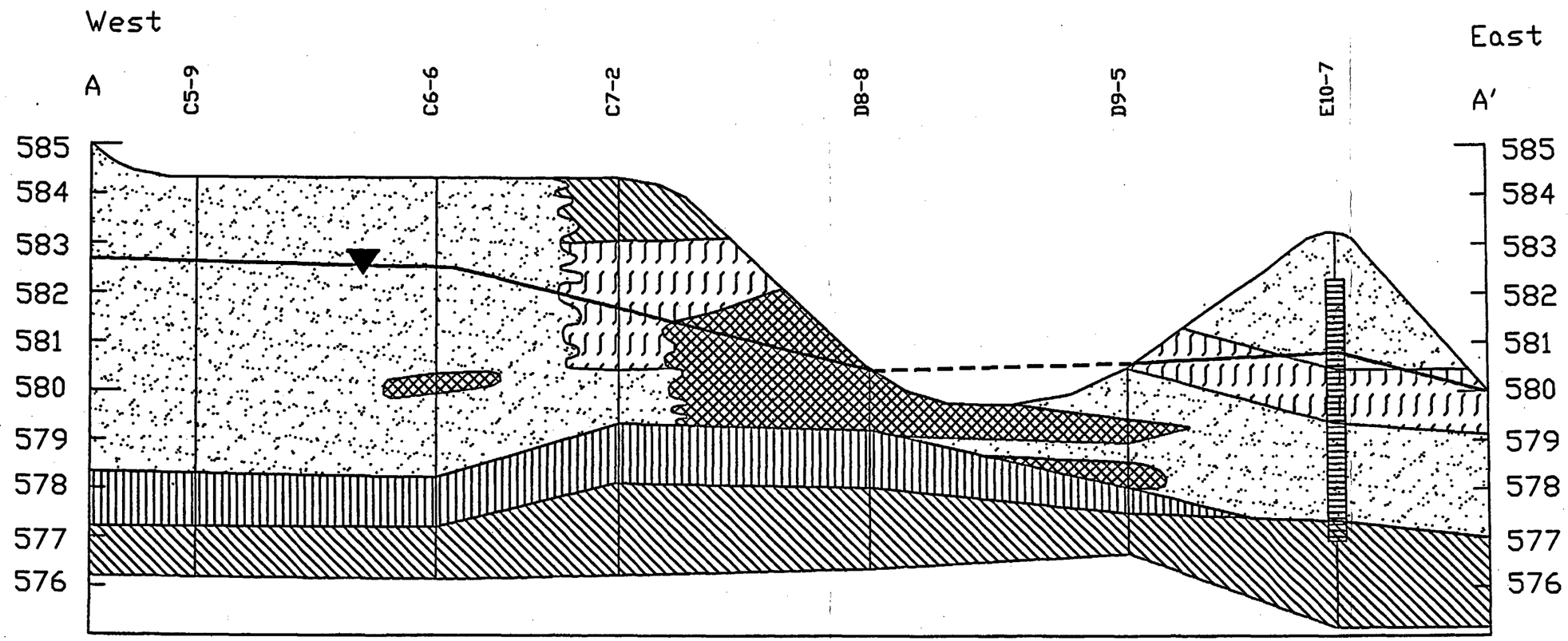


Figure 2. Borehole and Cross Section Locations.

C07



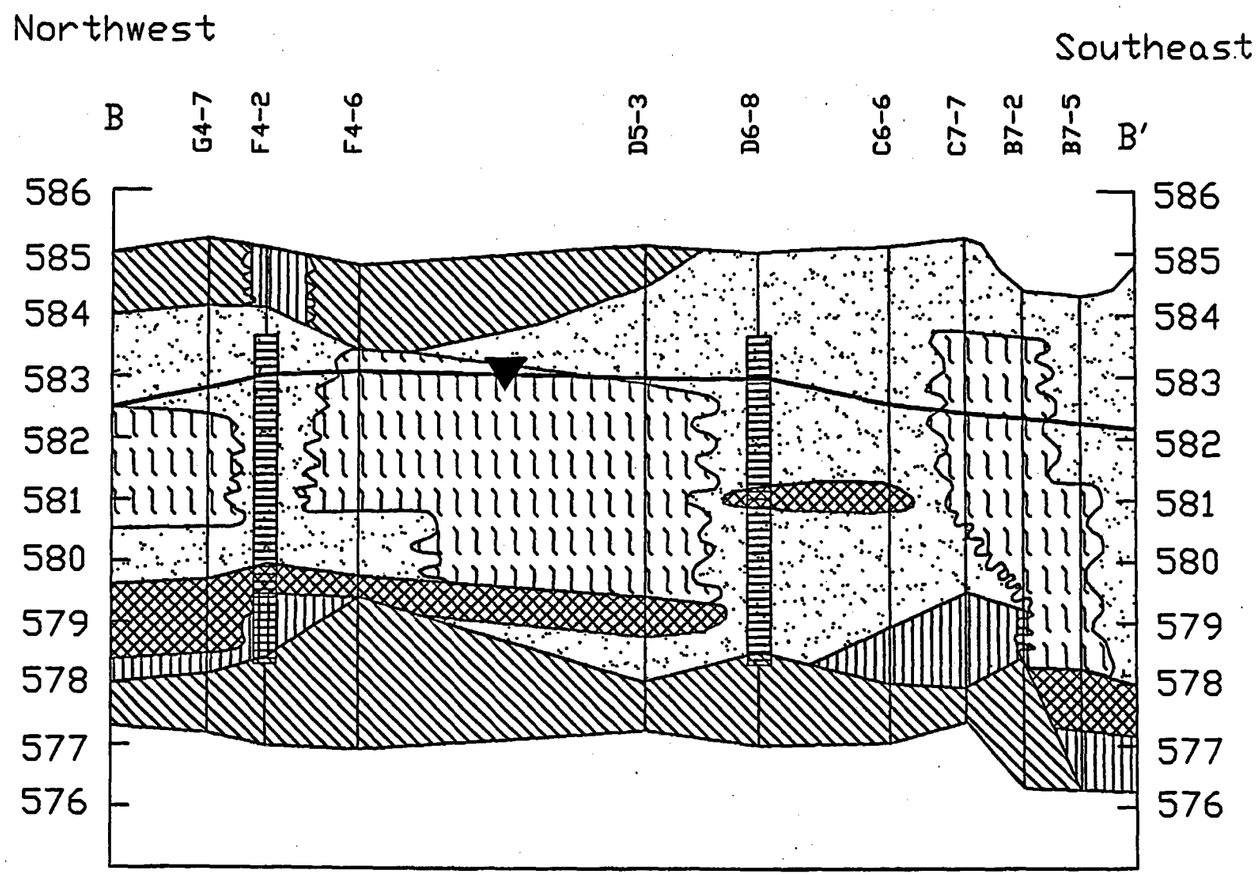
Clay
Silt
Peat
Sand
Slag
Water Table

Scale
Vertical 1" = 2.5'
Horizontal 1" = 50'

Vertical Exaggeration: 20'

Figure 3
Cross Section A-A'
Dow Thorium Site
Bay City, MI

PROJ# M3-00004306.00



Clay
Silt
Peat
Sand
Slag
Water Table

Scale
Vertical 1" = 2.5'
Horizontal 1" = 50'

Vertical Exaggeration: 20'

Figure 4
Cross Section B-B'
Dow Thorium Site
Bay City, MI

PROJ# M3-00004306.00

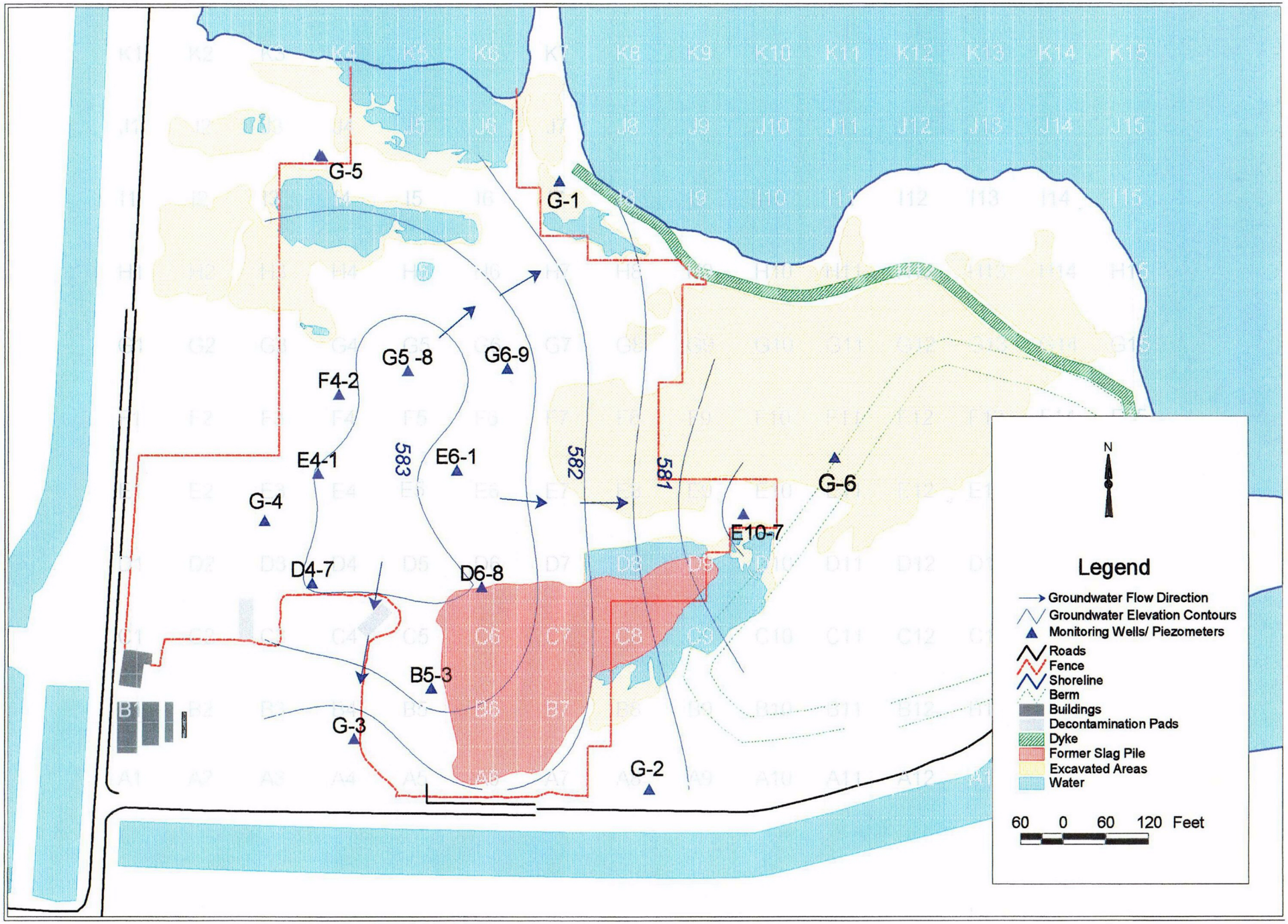


Figure 5. Groundwater Elevation Contours - 1/17/01

C08

Appendix A

URS Memorandum – September 5, 2000

URS

Memorandum

Date: 5 September 2000

To: Ben Baker, The Dow Chemical Company

From: Michael Hall

Subject: **Hydrogeologic Assessment of The Dow Chemical Company Thorium Contamination Site in Bay City, Michigan.**

URS Corporation (URS) was requested by the Dow Chemical Company to perform a hydrogeologic assessment of The Thorium Contamination (Thorad) Site in Bay City, Michigan. This assessment is in support of an effort to model the leaching potential of the radioactive thorium found in the soil at this site. The objectives of this hydrogeologic assessment were to delineate the hydrogeologic conditions at the site, and to evaluate groundwater use in the surrounding area. To this extent, URS reviewed available site data, performed a limited field investigation, and located and evaluated well records within a mile radius of the site. This memorandum summarizes the results of this hydrogeologic assessment.

DATA REVIEW

URS reviewed documents provided by the Dow Chemical Company. These files yielded four documents that pertained to the hydrogeologic conditions at the Thorad Site. These documents are listed in Table 1.

Table 1: Documents Describing the Hydrogeologic Conditions at the Thorad Site.

Document Title	Date	Summary
Evaluation of a Storage Site At The Bay City Plant Site of the Dow Chemical Company for Magnesium/Thorium Sludge	4/27/71	Soil investigation performed to evaluate leaching potential of thorium.
Groundwater Elevation and Flow Study Industrial Waste Site Perimeter , Dow Chemical USA—Bay City Location East of "C" Avenue and North of Water Inlet Ditch, 23,500 E-W on 26,000 N-S.	12/9/77	Groundwater Investigation performed to determine gradient and flow direction for Thorad Site.
ThoriumSlag Piles in Midland and Bay City: Letter from S.W. Maxey, Health Physiscist for the Dow Chemical Company.	8/10/87	Description of groundwater gradient and flow direction as well as radiation levels in groundwater.
Letter fromDinkar P. Kharkar: Nuclear Projects Manager for Thermo Anlaytical Inc.	8/31/92	Radiation level measurements for groundwater collected from the Thorad Site.

Figure 1 indicates the approximate location (survey data could not be located) of the boreholes and wells installed during the investigations described in Table 1. Attachment 1 contains selected information from the reports listed in Table 1.

SITE HYDROGEOLOGIC CONDITIONS

Based on review of the site data, six piezometers were installed at the Thorad Site. The locations for these piezometers are identified in Figure 2. Piezometers were installed with a Geoprobe, and continuous soil samples were collected from the surface to the total depth of each borehole. Each borehole was extended to the top of the glacial till. Borehole logs are contained in Attachment 2. Piezometers consisting of 1-inch diameter slotted schedule 40 were installed in the open boreholes and backfilled with sand. Once completed the location and elevation of each piezometer was determined by survey.

The geology at the site is simple, and consists of 6-12 feet of river sediment and fill overlying a hard, dense till clay. The river sediments consist predominantly of sand, silty sand, and clayey sand with occasional lenses of clay and silt. Organic material is common throughout the river sediment, and occasional lenses of peat are also present.

Some areas of the Thorad Site contain up to 6 feet of fill. This fill consists of rubble, soil, and magnesium/thorium sludge. It is unlikely that the area was excavated, and fill was probably placed directly into low-lying areas. In all likelihood, these low areas were wetlands, ponds, or inlets from the Saginaw River.

The glacial till consists of very hard, very dense gray silty clay with a trace of gravel. Information from other sites in the area also indicates that sand lenses are sometimes present within the glacial till, although these bodies tend to be widely dispersed and often discontinuous.

No boreholes were extended through the till clay at the Thorad Site, however, information from surrounding sites indicates that bedrock is encountered at between 80 and 90 feet below ground level in this area. Bedrock consists of sandstone and shale of the Saginaw Formation.

Groundwater is found within the river sediments, glacial till sands, if present, and Saginaw Formation. Groundwater in the river sediment is found between 3 and 5 feet below ground level at the Thorad Site, and is essentially continuous with the surface water in the Saginaw River. This is evident from the photographs presented as Figure 3. Table 2 lists water level measurements and elevations for the piezometers installed at the Thorad Site.

Figure 2 depicts the groundwater elevation contours and flow direction for the site based on the elevations calculated in Table 2. These measurements indicates a very shallow east-northeast gradient (0.004 ft/ft) toward the Saginaw River. This gradient likeley remains very low throughout the years and it is possible that there are occasional fluctuations in the flow direction based on the rise and fall of the Saginaw River.

Table 2: Groundwater Measurements and Elevations at the Thorad Site.

Piezometer ID	Top of Casing Elevation (feet MSL)	Depth to Water Measurement (8/28/00)	Groundwater Elevation (feet MSL)
G-1	586.30	5.91	580.39
G-2	586.52	5.73	580.79
G-3	587.80	5.76	582.04
G-4	587.61	4.75	582.86
G-5	587.39	5.74	581.65
G-6	584.80	4.43	580.37

Groundwater is also present under confining conditions in the Saginaw Formation and till sands, where they are present. No information on the groundwater elevation and flow direction for the Saginaw Formation or till sands was available for the Thorad Site.

LOCAL WATER WELLS

Five water well records within a mile of the Thorad Site were obtained from the Department of Health. The general location of each well is indicated on Figure 4. Department of Health Water Well Records are contained in Attachment 3.

Three of the wells within a mile of the site were water supply wells, four (contained on one water well record,) were monitoring wells, and one was a cathodic protection well. Water supply well #1 appears to be screened in a glacial till sand, and is located across the Saginaw River to the east of the Thorad Site. Water supply wells 2 and 3 appear to be screened in the Saginaw Formation, and are located to the northwest and southwest of the Thorad Site, respectively.

Based on these logs, and evaluation of the local groundwater use for other sites in the area, it appears that the Saginaw Formation is the most significant source of groundwater in the area. Till sands may periodically be tapped for groundwater when present, but widespread use is unlikely given their sporadic and wide dispersal. It is unlikely that anything other than monitoring or cathodic protection wells are screened in the river sediment. Investigations at other sites in the area indicate that the river sediments thin significantly away from the Saginaw River, and may contain groundwater only on a sporadic, or seasonal basis. Only those sediments adjacent to the Saginaw River provide a reliable groundwater source and the installation of wells in this area is unlikely, as it would be easier to pump directly from the river.

CONCLUSIONS

Based on this investigation, it appears that the primary pathway for the migration of thorium would be the groundwater in the river sediment, and ultimately the surface water to which this groundwater discharges. Because the groundwater in the surface sediment is not used as a water source, the primary human contact risks for this pathway would be through direct contact by workers digging excavations below the groundwater, and those collecting groundwater samples

from the surface sediment. Surface water provides additional human contact risks, the most significant being contact with the water during recreational activities, and consumption of fish harvested from the area.

Because of the low hydraulic conductivity, migration of thorium through the till clay would be extremely slow, and migration of the thorium into the bedrock aquifer would be extremely slow. If an upward groundwater gradient is present between the bedrock aquifer and river sediment, the this migration would be virtually non-existant. If a till sand were present, and in hydraulic communication with the river sediment, migration of thorium from the groundwater in the river sediment to the bedrock aquifer might be more rapid, unless there was an upward hydraulic gradient, in which case the downward migration of the thorium would be virtually non-existant. At present, there is no evidence of a till sand in contact with the river sediment at the Thorad Site, and this potential is unlikely.

If you have any questions regarding this report, or require any additional information, please contact me.

cc: Jerry Sgro, URS Corporation
File 007133

FIGURES

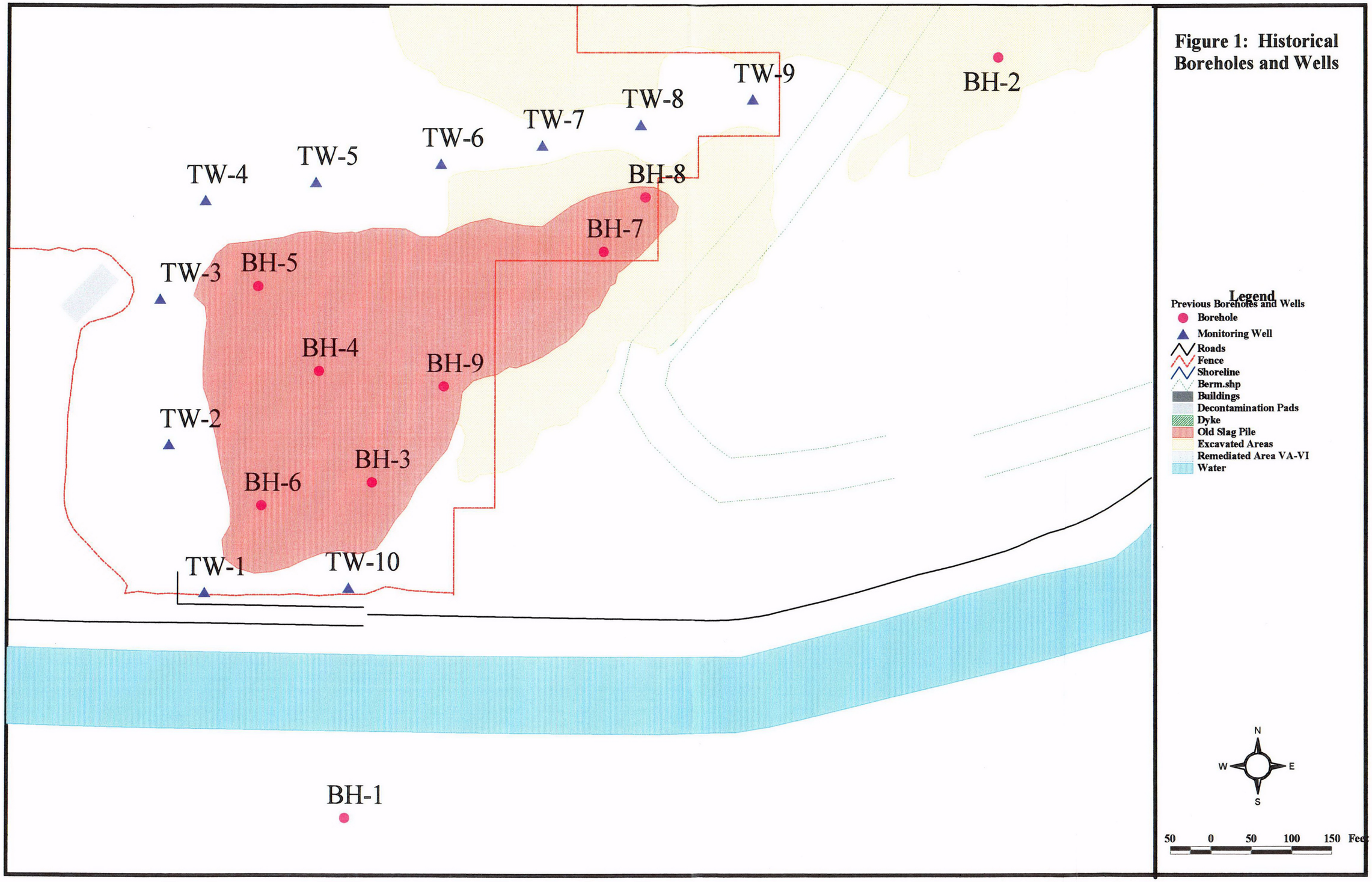


Figure 1: Historical Boreholes and Wells

C09

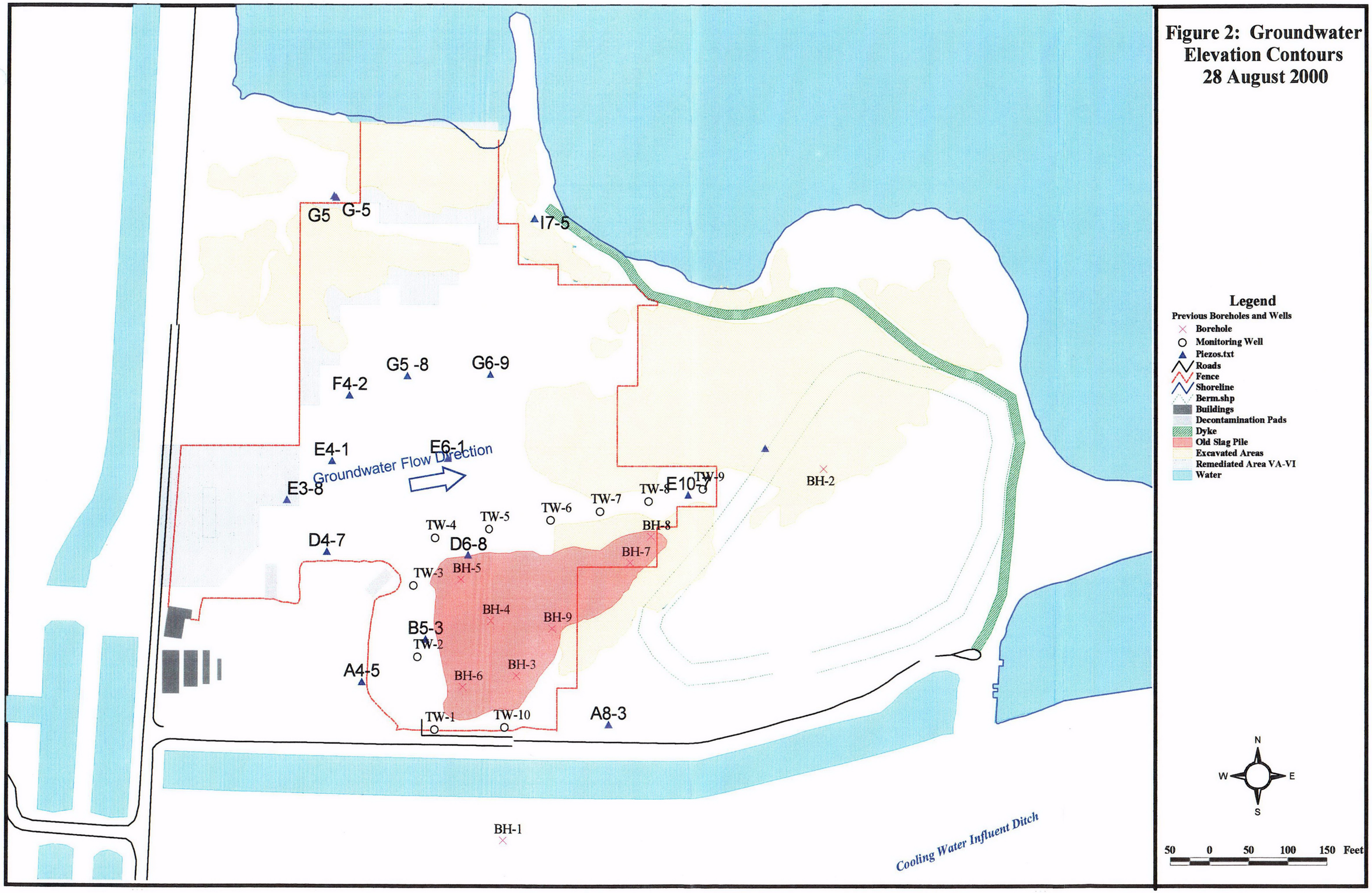
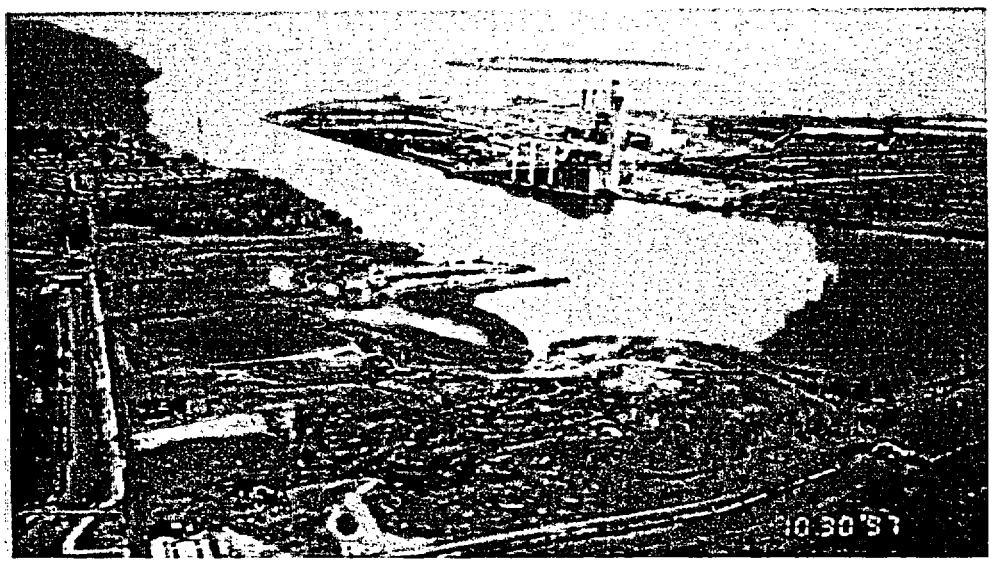


Figure 2: Groundwater Elevation Contours 28 August 2000
Legend
Previous Boreholes and Wells
Borehole
Monitoring Well
Piezos.txt
Roads
Fence
Shoreline
Berm.shp
Buildings
Decontamination Pads
Dyke
Old Slag Pile
Excavated Areas
Remediated Area VA-VI
Water
G5
G-5
I7-5
G5 -8
G6-9
F4-2
E4-1
E6-1
Groundwater Flow Direction
E3-8
E10-7
TW-9
TW-8
TW-7
TW-6
TW-5
TW-4
BH-2
BH-8
BH-7
D4-7
D6-8
TW-3
BH-5
BH-4
BH-9
B5-3
TW-2
BH-3
A4-5
BH-6
TW-1
TW-10
A8-3
BH-1
Cooling Water Influent Ditch
N
W
E
S
50 0 50 100 150 Feet

C10

East



Northeast

Figure 3: Views of Thorad Site Showing Ponding.

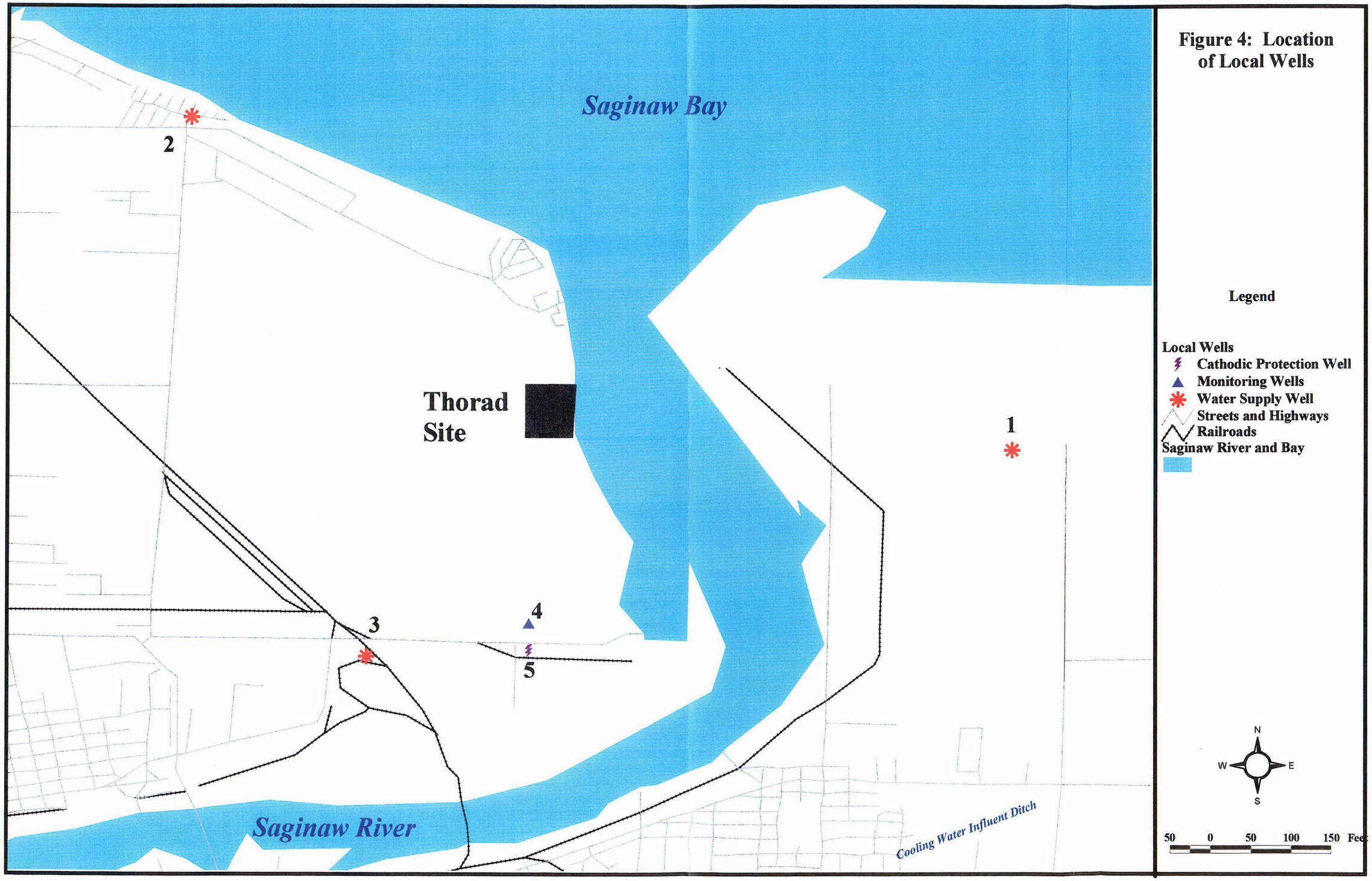


Figure 4: Location of Local Wells

C11

ATTACHMENT 1: SITE DOCUMENTS

Ground Water Elevation and Flow Study
Industrial Waste Site Perimeter
Dow Chemical USA - Bay City Location
East of "C" Avenue and North of Water Inlet Ditch
23,500 E-W on 26,000 N-S

For

Dow Chemical USA
Bay City Location

By

SAMTEST, Inc.
Midland, Michigan 48640

December 9, 1977

B1207

SAMTEST INC - DIVERSIFIED TESTING SERVICES P.O. BOX 1666 - MIDLAND MICH - (517) 636-3610

Introduction

We have completed the water level investigation for the industrial waste site - 23,500 E-W at 26,000 N-S Dow Chemical USA - Bay City. Ten (10) shallow nine foot (9 ft.) wells were drilled on the southwest and north side of the site and the equilibrium water levels measured. Test well locations appear on the Location Diagram in this report.

The purpose of this investigation is to evaluate the ground water levels and the direction of flow from the hydraulic gradients.

Test Well Preparation Procedure

Test wells were drilled to approximately nine feet (9 ft.) using a six inch (6 in.) auger where silty weathered brown clay was encountered. A ten foot (10 ft.) section of four inch (4 in.) diameter schedule 30 PVC pipe was used to case each hole to approximately seven feet (7 ft.) The bottom of the pipe was capped and the pipe perforated with one eighth inch (1/8 in.) holes to a height of 3 1/2 ft. Equilibration with ground water level was considered complete after seven (7) days when the water levels were recorded.

Granular permeable soil was encountered in all cases to a depth of seven and one half (7 1/2 ft.) feet except Test Well No. 1 which was extended through about seven and one half (7 1/2 ft.) feet of clay fill. This is underlain by brown medium fine sand.

Discussion

A study of the ground water elevations presented in the Location Diagram indicate the hydraulic gradient and the water flow is perpendicular to the constant elevation lines. From the results presented here water flow appears to be around the waste site toward the process water inlet ditch on one side and the Bay side on the other although a more comprehensive study would be required to completely define the flow net.

General Remarks

The above discussion is based on those soil borings performed on only one side of the site and do not reflect variations that might be encountered on the southeast side of the site. Extension of the test well program to include the southeast side of the site would help clarify what appears to be somewhat of an anomoly with Test Well No. 1.

The Test Wells are installed with the idea of continually sampling and monitoring the water levels. It should, however, be kept in mind that changes in ground water composition might require some time to equilibrate with the water present in each test well. For this reason, any water sampling program should be extended over a sufficient time period to allow for this equilibration.

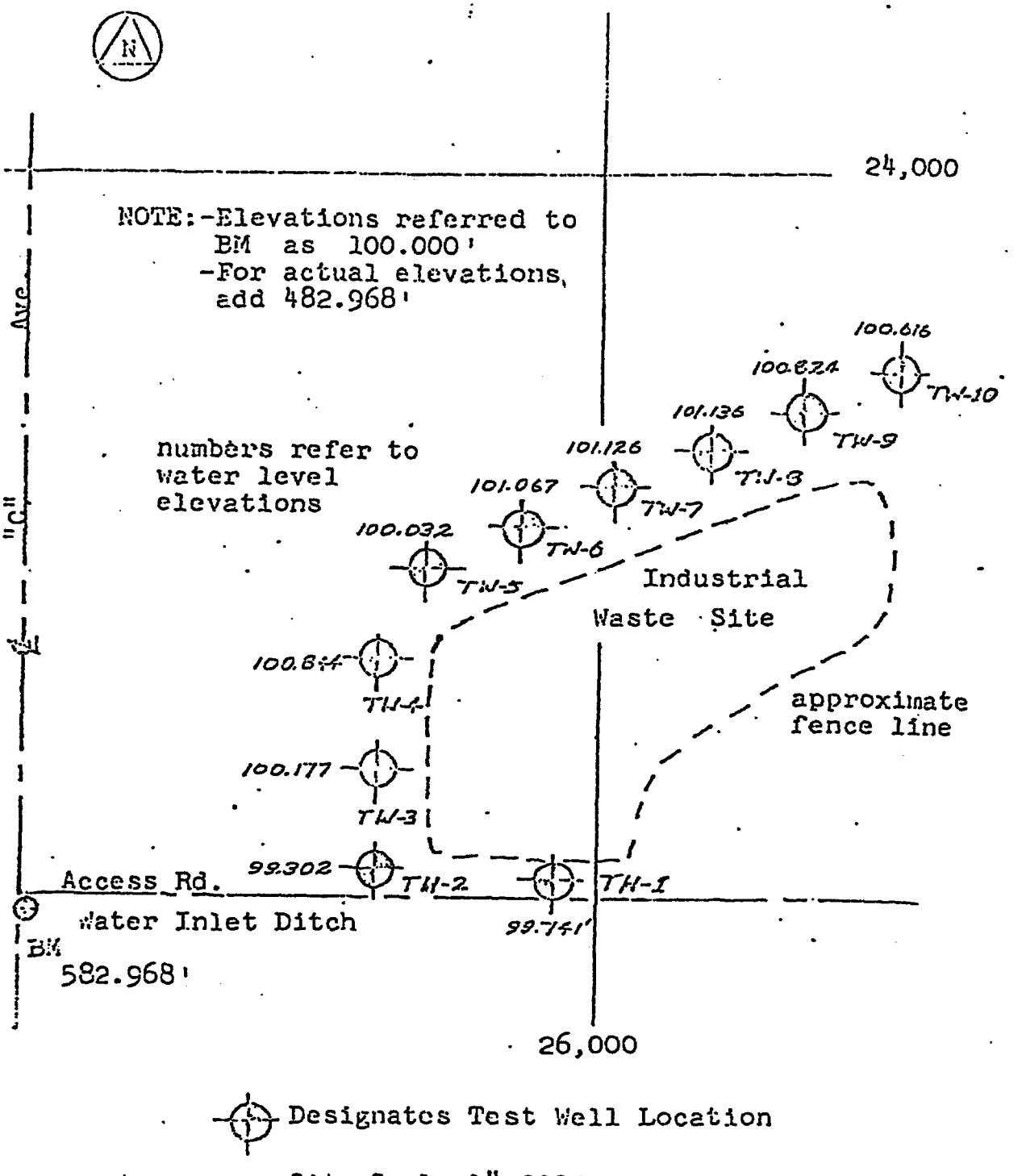
The water level in each test well was measured from the arrow marked on the upper edge of each casing. The arrow, in turn has been

referred to the bench mark elevation noted on drawing No. 50-A-A-16 Revision 19 Dow Chemical USA - Bay City Location. This bench mark is noted as 582.968 ft. - square "D" chiseled on top of cast headwall on north side of intake ditch. The top of each casing elevation appears in the table presenting the various water level values.

Please call if there are any questions about the test procedures or results presented herein.

TEST WELL LOCATION DIAGRAM B1207

Ground Water Study -
Dow Chemical USA- Bay City



Designates Test Well Location

Site Scale 1"=200'

Dow Chemical USA - Bay City
Hydraulic Gradient Study
B1207

Test Well Water Elevation Results

Test Well Number	Elevation* Top of Casing	Water Level
#1	105.199 ft.	99.741 ft.
#2	106.729	99.302
#3	105.781	100.177
#4	105.375	100.844
#5	105.761	101.032
#6	105.386	101.167
#7	104.334	101.126
#8	104.803	101.136
#9	104.855	100.824
#10	105.199	100.616

*Elevation of Bench Mark as 100.000'

Note: For actual elevation add 482.968 ft.

MICHIGAN DRILLING COMPANY

LOG OF SOIL BORING

DATE [illegible] BORING No. 299-[illegible]

B No. [illegible] PROJECT [illegible]

LOCATION [illegible] Bay City, Michigan

SURFACE ELEV. [illegible]

GROUND WATER TABLE [illegible]

G. W. VOLUME

SAMPLE NUMBER	DEPTH	LEGEND	SOIL DESCRIPTION	FOREIGN	GRAVEL	C. SAND	M. SAND	F. SAND	SILT	CLAY	BLOWS PER 12" PENETRATION	CONSISTENCY	MOISTURE %	RING SHEAR LB/SQ. FT.	COMPRESSION
	2		Compact to slightly compact moist foundry sand and black silt								[illegible]				
299 A	4										[illegible]		9		
		SILL	Stiff moist peat												
	6		Stiff moist swamp bottom material												
299 B											[illegible]		10		
	8														
299 C	10		Extremely stiff moist variegated clay, sand and pebbles, traces of vegetation								30	.4	11	0.725	[illegible]
	12														
	14														
299 D			Extremely stiff moist variegated clay and pebbles, traces of vegetation								[illegible]	.4	[illegible]	[illegible]	[illegible]
	16														
	18		Extremely stiff moist slightly oxidized blue clay, sand and pebbles												
299 E	20		Very stiff moist blue clay, sand and pebbles								20	[illegible]	13	[illegible]	[illegible]
	22														
	24														
299 F	26		Very stiff moist blue clay, sand and pebbles								18	.65	11	0.750	[illegible]
	28														
299 G	30		Very stiff moist blue clay, sand and pebbles								[illegible]		11	[illegible]	[illegible]
	32														
	34														
	36														
	38														

MICHIGAN DRILLING COMPANY

LOG OF SOIL BORING

DATE [illegible] | BORING No. 302-[illegible]

3 No. [illegible] PROJECT [illegible]

LOCATION [illegible] Bay City, Michigan

SURFACE ELEV. [illegible]

GROUND WATER TABLE [illegible]

G. W. VOLUME [illegible]

2nd GW 18'6" Heavy

SAMPLE NUMBER		DEPTH	LEGEND	SOIL DESCRIPTION	FOREIGN	GRAVEL	C. SAND	M. SAND	F. SAND	SILT	CLAY	BLOWS PER 12" PENETRATION	CONSISTENCY	MOISTURE %	RING SHEAR LB/SQ. FT.	COMPRESSION
		2		Medium compact moist foundry sand, cores, slag and brick fill												
		4										7				
302		6		Firm moist black peat												
				Compact moist discolored fine sand												
		8		Stiff moist blue clay, sand and pebbles, traces of vegetation								6				
302	B	12										26	.5	14	3975	126
302	C	16		Extremely stiff moist highly oxidized blue clay, sand & pebbles								26	.55	11	6450	77
302	D	20		Very stiff moist blue clay, sand and pebbles, streaks of sand								19	.65	12	3070	24
302	E	25										17	.65	12	3200	34
302	F	30		Stiff moist blue clay, sand & pebbles								16	.8	13	3330	[illegible]
302	[illegible]	35		Very stiff moist blue clay, sand and pebbles								19	.75	14	2325	34
302	[illegible]	40		Stiff moist blue clay, sand & pebbles								16	.8	16	2475	26
302	[illegible]	45		Stiff moist blue clay, sand & pebbles								[illegible]	.8	15	2475	[illegible]
302	[illegible]	50		Stiff moist blue clay, sand & pebbles								11	1.5	14	1100	21
302	[illegible]	55		Stiff moist blue clay, sand & pebbles								9	[illegible]	16	[illegible]	[illegible]
302	[illegible]	60		Stiff moist blue clay, sand & pebbles								11	.9	[illegible]	[illegible]	[illegible]
302	A	65		Stiff moist blue clay, sand & pebbles								11	.9	16	[illegible]	[illegible]
[illegible]	[illegible]	70										9	.75	[illegible]	[illegible]	[illegible]
302	[illegible]	75		Firm moist blue clay, sand & pebbles rouge markings								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
302	[illegible]	[illegible]		Extremely stiff moist blue clay, medium refusal								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		--														

MICHIGAN DRILLING COMPANY

LOG OF SOIL BORING

DATE 7-7-1[illegible]

BORING No. [illegible]-303-[illegible]

SURFACE ELEV. 321.5

GROUND WATER TABLE [illegible]

G. W. VOLUME Heavy

I No. [illegible] PROJECT The Dow Chemical Company

LOCATION Site "[illegible]"
Bay City, Michigan

SAMPLE NUMBER		DEPTH	LEGEND	SOIL DESCRIPTION	FOREIGN	GRAVEL	C. SAND	M. SAND	F. SAND	SILT	CLAY	BLOWS PER 12" PENETRATION	CONSISTENCY	MOISTURE %	RING SHEAR LB/SQ. FT.	COMPRESSION SHEAR
		2	FILL	Compact moist foundry sand, cores, slag and brick fill								15 12 10				
303	A	4	P	Medium compact wet black peat								[illegible]				
		6		Medium compact wet fine discolored sand												
303	[illegible]			Firm moist swamp [illegible] from material								5		14		
		8		Firm moist blue clay, sand pebbles traces of vegetation, lenses of silt								6				
303	[illegible]	10		Stiff moist blue clay, sand & pebbles traces of vegetation, lenses of silt								13	.9	15	1600	[illegible]
		12		Extremely stiff moist highly oxidized blue clay, sand pebbles, traces of vegetation lenses of silt												
		14														
303	[illegible]	16		Extremely stiff moist highly oxidized blue clay, sand pebbles								36	.95	14	[illegible]	[illegible]
		18														
303	[illegible]	20		Very stiff moist blue clay, sand and pebbles								22		[illegible]	[illegible]	
		22														
		24														
303	F	26		Very stiff moist blue clay, sand and pebbles								26	.70	13	[illegible]	[illegible]
		28														
303	[illegible]	30		Very stiff moist blue clay, sand and pebbles								[illegible]	.71	19	[illegible]	[illegible]
		32														
		34														
		36														
		38														

Test Well Water Elevation Results

Test Well Number	Elevation* Top of Casing	Elevation* Water Level
#1	105.199 ft.	99.741 ft.
#2	106.729	99.302
#3	105.781	100.177
#4	105.375	100.844
#5	105.761	101.032
#6	105.386	101.167
#7	104.334	101.126
#8	104.803	101.136
#9	104.855	100.824
#10	105.199	100.616

*Elevation of Bench Mark as 100.000'

Note: For actual elevation add 482.968 ft.

OFFICE COPY

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN 48674

August 10, 1987

THORIUM SLAG PILES IN MIDLAND AND BAY CITY

The enclosed information was presented to the NRC and the State of Michigan DRH on July 7, 1987, and then presented to the EPA and the State of Michigan DNR on July 21, 1987.

The information enclosed covers background information of both sites and summarizes the character of each site. The extent of the presentations were to give a basic overview of each site and discuss the possibility of disposal of the thorium in the Salzburg Landfill.

An overview of the landfill is included with the disposition options for this Low Level Thorium Slag.

S. W. Maxey
Health Physicist
Industrial Hygiene Laboratory
1803 Building
517/636-1536

dld

Enclosures

RESTRICTED FOR USE WITHIN THE DOW CHEMICAL COMPANY

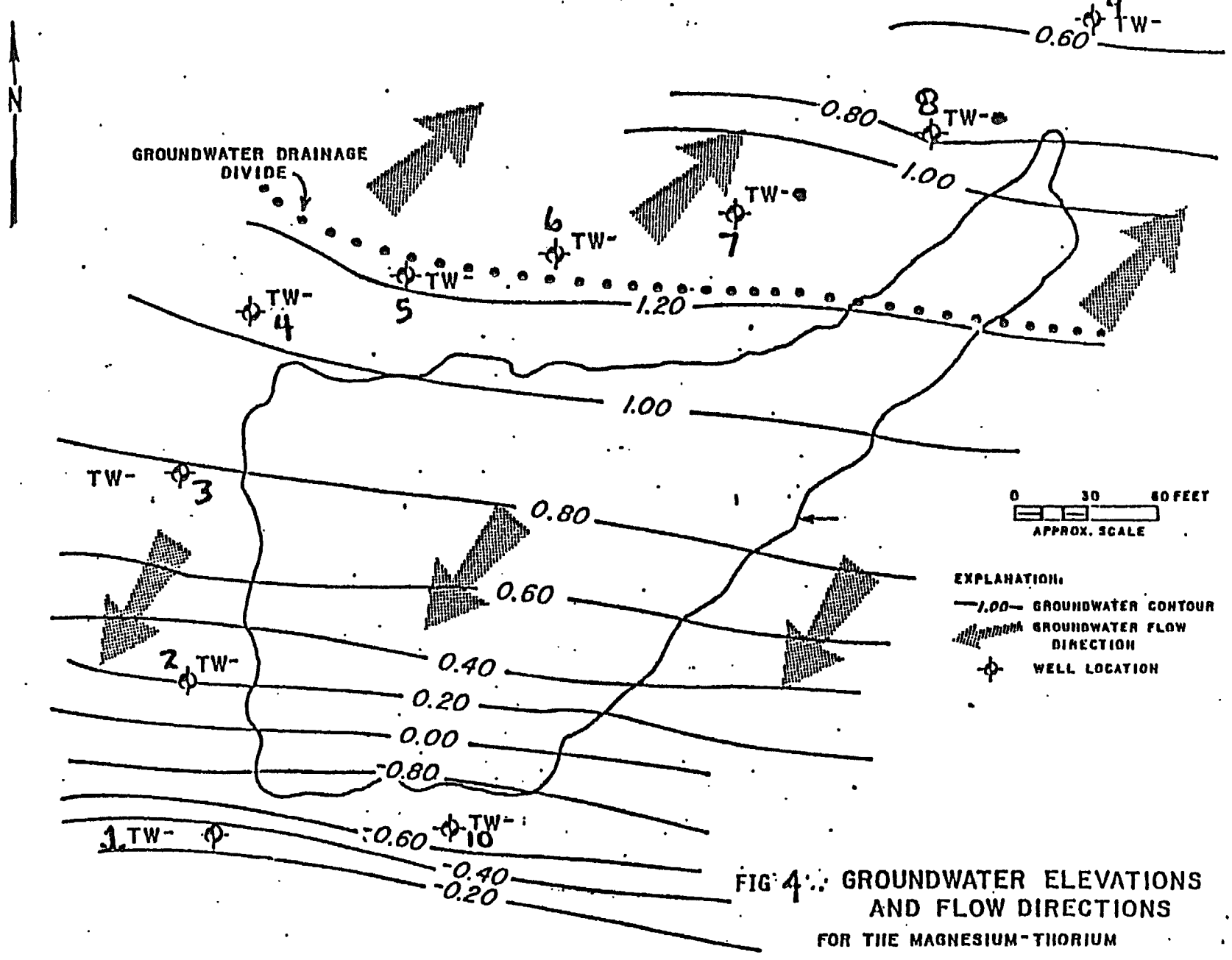


FIG 4: GROUNDWATER ELEVATIONS AND FLOW DIRECTIONS FOR THE MAGNESIUM-THORIUM

BAY CITY THORIUM STORAGE SITE TECHNICAL DATA

WATER DATA

DATE	DESCRIPTION	RESULTS	
1/70	WATER SAMPLE FROM POND NEAR PILE	<0.1 PCI/G	
4/71	WATER SAMPLE FOR TH FROM INLET CANAL DOW/STATE	<0.6 PCI/G	
4/71	ICE SAMPLE FROM POND NEAR PILE	<0.4 PCI/G	
8/77	8 WATER/SEDIMENT SAMPLES BY DOW	<1 PCI/G	
12/77	10 TEST WELLS DRILLED TO DETERMINE WATER FLOW AND ELEVATION	FLOW TOWARD INLET CANAL AND BAY	
2/78	WATER LEACHING OF THORIUM FROM SLUDGE AT PH 2, 7, 10 BY DOW	<0.5 G TH	
2/78	DOW LEACHING STUDY OF THORIUM AND DAUGHTERS FROM SLUDGE AT	INITIAL	10 DAYS STEADY STATE
	PH 2	36 PCI/G	10 PCI/G
	PH 7	18 PCI/G	5 PCI/G
	PH 10	18 PCI/G	5 PCI/G
9/79	NRC SAMPLES OF WELL, CANAL AND POND WASTE - 6 SAMPLES	<2 PCI/L - 4.0 PCI/L	

BAY CITY THORIUM STORAGE SITE TECHNICAL DATA

SOIL DATA

DATE	DESCRIPTION	RESULTS
7/56	3 SOIL BORINGS TO DETERMINE COMPOSITION OF SOIL	CLAY 6-16 FT
1/57	3 SOIL BORINGS TO DETERMINE COMPOSITION OF SOIL	CLAY 6-16 FT
4/69	3 SOIL BORINGS TO DETERMINE COMPOSITION OF SOIL	CLAY 6-16 FT
1/70	4 SOIL SAMPLES PERIPHERY OF PILE	0.1 - 0.6 PCI/G
4/71	26 SOIL SAMPLES TAKEN 1' BELOW SURFACE AT 5', 50' AND 100' NE, NW, N, W POND	<0.7 PCI/G
	6 SAMPLES WERE SLIGHTLY ABOVE BACKGROUND	0.9 - 2.0 PCI/G
4/71	5 SOIL SAMPLES (DOW AND STATE) TAKEN OUTSIDE THE PILE	1.6 - 5.5 PCI/G
	1 SOIL SAMPLE (DOW AND STATE) INSIDE PILE AREA	34 PCI/G
	1 MUCK SAMPLE FROM POND	2.5 PCI/G

TMA
Thermo Analytical Inc.

TMA/Norcal
2030 Wright Avenue
P. O. Box 4040
Richmond, CA 94804-0040
(510) 235-2633 Fax No. (510) 235-0438

August 31, 1992

Ref: P.O. No. M90007-02
TMA/Norcal N2-07-011-8249

Mr. G. R. Miller
Dow Chemical USA
Michigan Division, Bldg. 1266
Midland, MI 48667

Dear Mr. Miller:

The results of the nine water samples we received on 2 July 1992 for analysis have been completed and are shown on Attachment 1. The QA/QC results are given in Attachment 2. The samples were filtered through 0.45 μ filter paper prior to analysis.

The samples contain large amounts of dissolved salts. The errors on gross alpha measurements are high due to small aliquots taken for alpha measurements. Due to absorption of alphas the sample weight on 2" planchets for gross alpha measurement is not more than 250 mg.

We appreciate this opportunity to be of service.

Very truly yours,

D. P. Kharkar

Dinkar P. Kharkar, Ph.D.
Manager, Nuclear Projects

DPK/ss

Enclosures: Attachments 1 and 2

ENVIRONMENTAL ANALYSIS RESEARCH LABORATORY
CHAIN OF CUSTODY (General Purpose)

Facility or Location Sampled: Bay City T wells

Group of Analytes or Parameters to be Measured: Gross α & β, Ra226, Ra228, Th232 — Should be Filtered 0.45μ millipore

EL Number:
Field Log Book: WCN-137
Field Log Pages: 190
Account No.:
AL Number:
(if applicable)

# of Bottles	Sample Identification	Sample Date	pH	Conductivity	Other Tests	Was Sample Filtered?	Preservative Added	Number of Bottles Consumed	Discarded	Analyst's Initials
1	#2	6-30-92								
1	#3									
1	#4									
1	#5									
1	#6									
1	#7									
1	#8									
1	#9									
1	#10									

Field Observations: Wells ~~Tanks~~ RW were dry.

Signature(s) of Sampler(s): Glen Webby Richard W. White — 6-30-92 (date)

I have received 9 (number) bottles in good condition from the sampler(s). Gloria Cottley (signature) — 7-1-92 (date)

Observations:

I have received 9 (number) bottles in good condition from the preceding person. Jamie Moore (signature) — 7-1-92 (date)

Observations:

I have received 9 (number) bottles in good condition from the preceding person. Yamamoto (signature) — 7/2/92 (date)

Observations: Samples were received in good condition

FROM: DR. DINKAR P. KHARKAR

TO: MR. G.R. Miller

DATE: 9/14/92

I do not have the COC for the Samples reported on April 3, 1992. Enclosed is the Chain-of-Custody for the Samples reported on Aug 31, 1992.

D.P. Kharkar
9/14/92

NMENTAL ANALYSIS RESEARCH LABORATORY
AIN OF CUSTODY (General Purpose)

Group of Analytes or Parameters to be Measured:
Gross α & β
Ra226
Ra228
Th232
should be Filtered 0.45μ millipore

EL Number:
Field Log Book: WCN-137
Field Log Pages: 190
Account No.:
AL Number:
(if applicable)

ple te	pH	Conductivity	Other Tests	Was Sample Filtered?	Preservative Added	Number of Bottles Consumed	Discarded	Analyst's Initials
-92								

Field Observations: Wells I ~~and~~ were dry.

Signature(s) of Sampler(s): Glen Webby Richard W. White — 6-30-92 (date)

I have received 9 (number) bottles in good condition from the sampler(s). Gloria Cottley (signature) — 7-1-92 (date)

Observations:

I have received 9 (number) bottles in good condition from the preceding person. Gavin Morris (signature) — 7-1-92 (date)

Observations: Gavin Morris

I have received 9 (number) bottles in good condition from the preceding person. Yamamoto (signature) — 7/2/92 (date)

Observations: Samples were received in good condition

This final (whi y) a mal h th les tf

ATTACHMENT 2 QUALITY CONTROL SAMPLE RESULTS, SPIKES AND BLANKS

SPIKES:

TMA/Norcal Group No.	Nuclide	Added	Found	Found / Added Ratio ± 2 σ
8249-10	Gross Alpha	0	0.09 ± 0.4	Satisfactory
QC-8218	Gross Beta	0	-0.03 ± 0.4	Satisfactory
8249-10				
QC-8221	^{228}Th	0	0 ± 0.07	Satisfactory
	^{230}Th	0	0 ± 0.02	Satisfactory
	^{232}Th	0	0 ± 0.02	Satisfactory
8249-10				
QC-8220	^{228}Ra	0	0 ± 1	Satisfactory
790-60	^{226}Ra	12.65	12.51	0.99 ± 0.16
790-61	^{226}Ra	10.54	9.62	0.91 ± 0.15

ATTACHMENT 1 RESULTS (cont'd, page two 2)

Customer ID No.	TMA/Norcal Group No. 8249	Collection Date	Analysis	Results pCi/L ± 2 σ
#8	7	6/30/92	Gross Alpha	0 ± 37
			Gross Beta	690 ± 46
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 3
			^{228}Th	0 ± 0.2
			^{230}Th	0 ± 0.02
			^{232}Th	0 ± 0.02
#9	8	6/30/92	Gross Alpha	0 ± 17
			Gross Beta	235 ± 18
			^{226}Ra	0 ± 1
			^{228}Ra	9 ± 2
			^{228}Th	0.4 ± 0.1
			^{230}Th	0 ± 0.04
			^{232}Th	0 ± 0.04
#10	9	6/30/92	Gross Alpha	0 ± 25
			Gross Beta	775 ± 37
			^{226}Ra	0 ± 1
			^{228}Ra	4 ± 2
			^{228}Th	0.2 ± 0.1
			^{230}Th	0 ± 0.06
			^{232}Th	0 ± 0.04

ATTACHMENT 1 RESULTS

Customer ID No.	TMA/Norcal Group No. 8249	Collection Date	Analysis	Results pCi/L ± 2 σ
#2	1	6/30/92	Gross Alpha	2 ± 11
			Gross Beta	143 ± 11
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 1
			^{228}Th	0 ± 0.1
			^{230}Th	0 ± 0.05
			^{232}Th	0 ± 0.02
#3	2	6/30/92	Gross Alpha	0 ± 8
			Gross Beta	115 ± 9
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 1
			^{228}Th	0 ± 0.1
			^{230}Th	0 ± 0.2
			^{232}Th	0 ± 0.02
#4	3	6/30/92	Gross Alpha	11 ± 19
			Gross Beta	134 ± 18
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 1
			^{228}Th	0 ± 0.08
			^{230}Th	0 ± 0.06
			^{232}Th	0 ± 0.03
#5	4	6/30/92	Gross Alpha	0 ± 35
			Gross Beta	693 ± 30
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 2
			^{228}Th	0 ± 0.07
			^{230}Th	0 ± 0.09
			^{232}Th	0 ± 0.02
#6	5	6/30/92	Gross Alpha	0 ± 23
			Gross Beta	420 ± 27
			^{226}Ra	0 ± 1
			^{228}Ra	0 ± 1
			^{228}Th	0 ± 0.1
			^{230}Th	0 ± 0.09
			^{232}Th	0 ± 0.02
#7	6	6/30/92	Gross Alpha	0 ± 45
			Gross Beta	737 ± 44
			^{226}Ra	0 ± 1
			^{228}Ra	5 ± 2
			^{228}Th	0.6 ± 0.3
			^{230}Th	0 ± 0.2
			^{232}Th	0 ± 0.2

Chemical Biology Research

The Dow Chemical Company

EVALUATION OF A STORAGE SITE AT THE BAY CITY PLANT SITE OF THE DOW CHEMICAL COMPANY FOR MAGNESIUM/THORIUM SLUDGE

PROBLEM

At the Bay City Plant site of The Dow Chemical Company is located a pile of magnesium/thorium sludge which was accumulated from 1955 to 1970. This evaluation was carried out to determine if this material was, and is, innocuous to the environment surrounding the pile or if the material is drifting in the wind or leaching into the sub-surface by the action of rain.

DISCUSSION

During the casting of magnesium and magnesium alloys, a sludge material is produced which sinks to the bottom of the melt crucible. After the metal or alloy has been pumped or poured from the crucible, the sludge material remains at the bottom of the vessel and must then be dumped and discarded.

DOW CONFIDENTIAL

The metal we are talking specifically about in this evaluation is an alloy of magnesium with 3% thorium. The thorium is used to improve the high temperature properties of the magnesium so the alloy may be used for applications such as aircraft engines, aircraft structural parts and missile parts. However, thorium is radioactive and is listed as a source material by the United States Atomic Energy Commission. Since it is a source material, its use is licensed and supervised by the Atomic Energy Commission. Thorium is relatively low in radioactivity and the sludge which is produced and has been stored at the Bay City Plant is less radioactive than most grades of naturally occurring thorium ores. Thorium is naturally occurring and exists in the earth's crust at an average of about 13 ppm which is 3 times that of uranium. It is more abundant than tin and the precious metals.

The magnesium/thorium sludge pile is located in the northeast corner of the Dow plant site, about 800-900 feet from the Saginaw River. The sludge pile is directly north of the inlet canal which brings cooling water to the Dow plant site. The location is immediately adjacent to a pond

DOW CONFIDENTIAL

and about 450 feet east of a road going toward a United States Coast Guard Station (see Figure 1).

The pile is actually made up of approximately 400 mounds covering a total of approximately 1 acre of land. Each mound is the result of a truck load of sludge being dumped on the area. The sludge pile is not uniformly radioactive since the magnesium/thorium alloy and magnesium metal were being cast simultaneously at the foundry. The sludge from both processes was not segregated and was dumped in the same area, resulting in some spots in the pile actually being nonradioactive.

Assuming that each pile is about 6 feet high and has a total volume of approximately 226 cubic feet, it is estimated that the total pounds of sludge on the pile amounts to about 4,640,000. The average radioactivity known from previous testing is about 1.7×10^{-3} μCi/gram.* Thus, the total activity of the sludge pile is about 3.4 Ci. It is known that 1 Ci of thorium is 19,850 pounds of thorium metal. Therefore, about 67,000 pounds of thorium exist in the pile.

*μCi (microcurie) = 1×10^{-6} curie; 1 curie = amount of material which produces 3.7×10^{10} disintegrations per second.

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Using a Victoreen 440 ionization chamber survey meter and measuring the radiation on the pile at a height of about 2 feet, the readings (57 taken) ranged from 0.5 mr/hr to 8.4 mr/hr, for an average of 3.1 mr/hr. However, when the survey meter was used outside the perimeter of the fence (which surrounds the pile) at a distance of about 5-15 feet, no levels of radioactivity above background could be obtained; that is, the values were less than 0.5 mr/hr. The levels on the pile require that the area be marked as a "Radiation Area" and as "Radioactive Material." Since the material is located on Dow property, access to the area is limited since access to the entire plant is restricted.

The first series of samples taken and analyzed were samples of the sludge itself. The sample points are shown in Figure 2 and the values are shown in Table I. The values range from 7×10^{-3} μCi/gram to 1×10^{-6} μCi/gram, with an average of 1.7×10^{-3} μCi/gram. The samples were analyzed by the activation analysis section of Radiochemistry Research, The Dow Chemical Company, using gamma spectrum counting. All samples in this report were analyzed in this manner by this group.

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The second series of samples were taken at the surface of the soil and 1 foot below the surface of the soil. These samples were taken at distances of 5 feet, 50 feet and 100 feet from the pile at directions northeast, northwest, north and west of the pond. Samples were taken approximately 5 feet from the pile of "muck" from the bottom of the pond and ice from the top of the pond (see Figure 3).

The results show 6 samples out of 26 total samples which had values above the background radiation level in the analytical laboratory. These 6 values are shown in Table II. It is evident from the values obtained that essentially no drifting or blowing of the sludge occurs or has occurred during the time that the sludge has been in the present location.

A third series of 10 samples was taken by the Michigan State Department of Public Health and duplicated by The Dow Chemical Company. The location of the samples is shown in Figure 4. Sample 1 was a sample of water taken from the inlet canal. Sample 2 was a sample of topsoil taken directly from below the pile. The sludge had been pushed to one side and the sample of topsoil was taken at the interface between the pile and the soil. Sample 3 was a sample of the

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magnesium/thorium sludge itself. Samples 4-7 and 10 were samples of topsoil taken from around the pile. Sample 6 was taken 250 feet from the pile, and the others 6 feet from the pile. Sample 8 was a sample of ice from just below the surface of the center of the pond and Sample 9 was a sample of the "muck" from below the same spot.

The solid samples were dried in a laboratory oven at 110-120°C for two hours. These samples were then analyzed and the values shown in Table III were obtained. Again, with the exception of Samples 2 and 3, which were expected to be relatively high, the samples are very low in radioactivity showing that the material is not drifting on the surface of the surrounding soil nor contaminating the water nearby. The radioactivity of the sample of the sludge corresponds quite well to the values for the sludge obtained previously (see Figure 2 and Table I).

The fourth series of samples taken were to determine whether or not rainfall was leaching radioactive materials from the pile into the subsurface. To do this, core drilling samples were taken in seven different spots below the pile.

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Six of these spots were chosen because the levels of radioactivity are relatively high compared to the remainder of the pile area. Because thorium is a naturally occurring material at an average concentration of about 13 ppm, it was desired to have numbers which would indicate the naturally occurring radioactivity in the area of the pile. In order to obtain these background samples, two holes about 200 feet from the pile were drilled. Hole #1 was across the inlet canal to the south of the pile in a fill area and Hole #2 was northeast of the pile along the assumed drainage route toward the Saginaw River. Hole #1, south of the pile, was drilled to a depth of 23 feet. Clay was reached about 10 feet 6 inches down and the subsurface was clay from there to the 23 feet level. In Hole #2, northeast of the pile, clay was found at 8 feet 3 inches and extended to the bottom of the hole which was at 24 feet. The remainder of the holes directly below the pile were drilled to depths of 12-16 feet only, because clay was hit in all instances at about 6-10 feet and it was assumed that no water leaching would penetrate the relatively impervious clay layer (see Figure 5 for the sampling locations).

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In all instances, after the auger had been pulled from the hole and water seeped back into the hole fast enough so that it did not freeze before a sample could be taken, water samples from individual holes were taken. These were obtained from Holes #2, #4, #6, #7, #8 and #9. A hollow auger drilling rig was used to decrease the possibility of contamination of the core samples from higher strata of the subsoil. Samples of the subsurface cores were taken at depths which would show different types of strata below the holes.

Again, all solid samples were dried for two hours at 110-120°C in a laboratory oven before analysis. The results of these analyses are shown in Table IV. During the analysis of the core samples, eight background radiation levels in the laboratory were run. These were averaged to obtain a value from which to calculate the amount of radioactivity present in the samples. As can be seen in Table IV, all values are very low. The analyst reported all reported values as being within the 1-2% variation of the background count from the average value which was used for calculation purposes. The analyst also reported that the values for thorium daughters given also in Table IV have an error of ±100% due to the very low values which were obtained.

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During preparations for the core sampling it was necessary to level the pile so that the drilling rig could be driven onto the pile. This was done using a bulldozer which stirred the pile. The breathing zone of the bulldozer operator was monitored using both a radiation film badge and a small portable pump connected to a membrane filter to sample any dust to which the operator might be exposed. The radiation film badge showed no exposure and the membrane filter showed no radiation detectable above the sensitivity of the test. These results, again, give the indication that the material on the sludge pile is not susceptible to becoming dust, even with quite vigorous agitation.

RESULTS

The results of the analyses shown in Tables I-IV show that the magnesium/thorium sludge does not leach into the ground and contaminate underground water or subsurface materials. They also indicate that the material does not readily drift with the wind. Therefore, it appears that the magnesium/thorium sludge which is stored on the Bay City

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Plant site is innocuous to the surrounding environment and may be left in that area safely for the present with no danger to the surroundings.

Richard D. Olson

R. D. Olson
Industrial Hygiene Section
Chemical Biology Research

April 27, 1971

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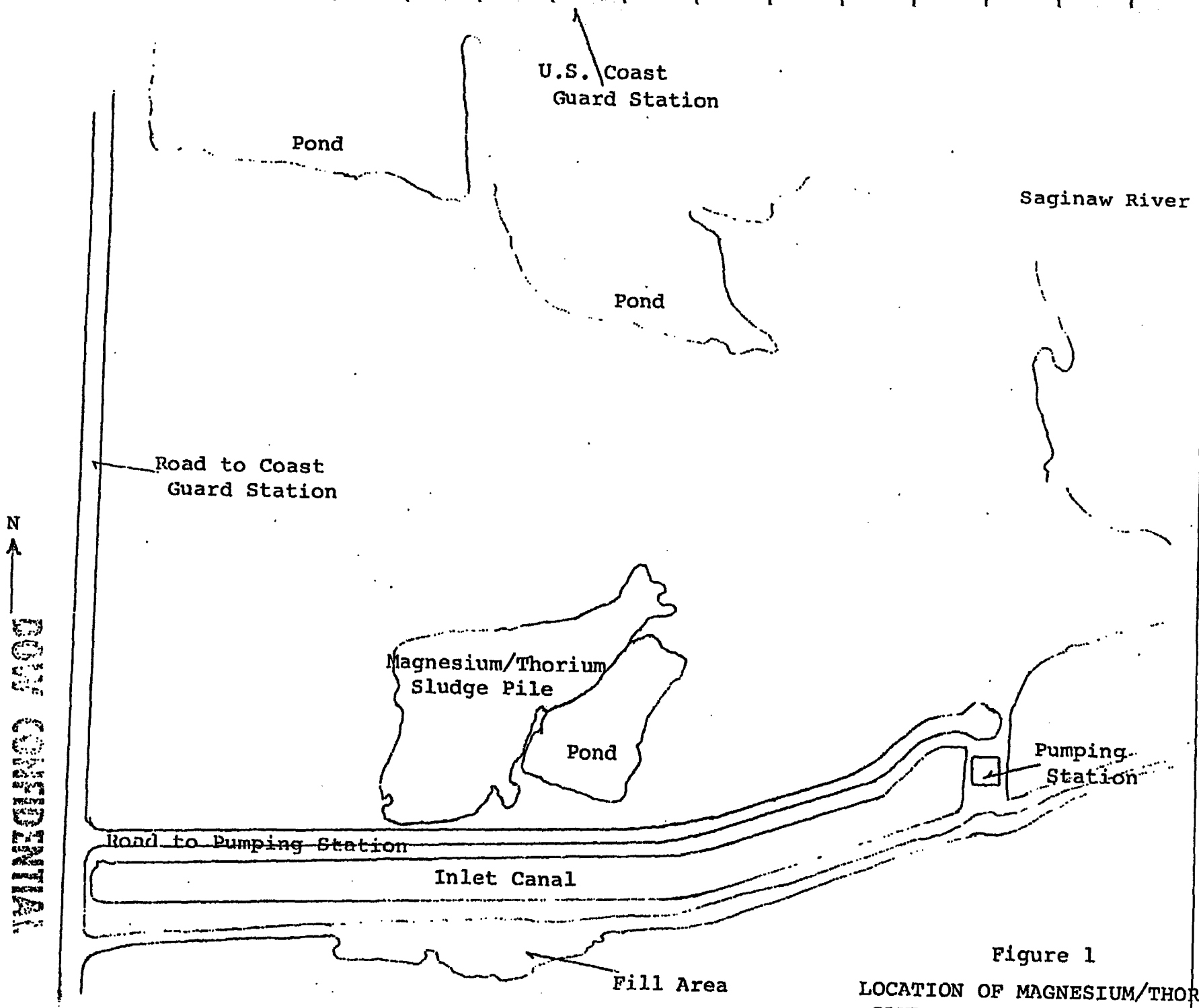

Figure 1

LOCATION OF MAGNESIUM/THORIUM SLUDGE PILE

Figure 2.

MAGNESIUM/THORIUM SLUDGE PILE LEVELS OF RADIATION

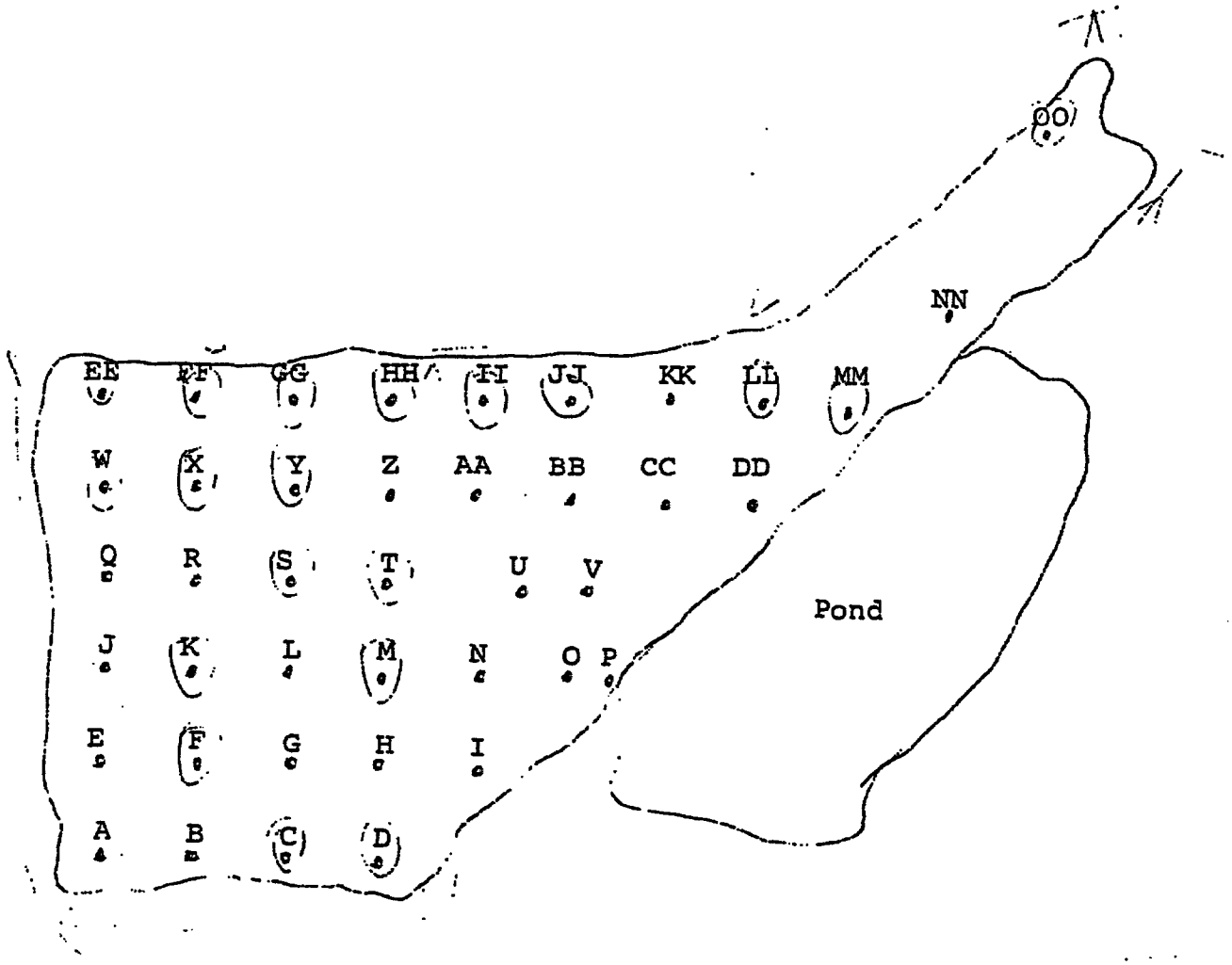

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Table I. Values for Figure 2. Magnesium/Thorium Sludge Analyses. Values are in microcuries per gram.

Sample	Analysis		Sample	Analysis
A	1×10^{-5}	1.0	AA	2×10^{-4}
B	1×10^{-6}	0.1	BB	1×10^{-4}
C	2×10^{-3}	20.0	CC	2×10^{-5}
D	1×10^{-3}	10.0	DD	5×10^{-4}
E	7×10^{-6}	0.7	EE	2×10^{-3}
F	2×10^{-3}		FF	7×10^{-3}
G	7×10^{-6}		GG	5×10^{-3}
H	9×10^{-4}		HH	1×10^{-3}
I	3×10^{-6}		II	6×10^{-3}
J	5×10^{-5}		JJ	1×10^{-3}
K	1×10^{-3}		KK	3×10^{-5}
L	2×10^{-6}		LL	6×10^{-3}
M	6×10^{-3}		MM	4×10^{-3}
N	2×10^{-6}		NN	8×10^{-6}
O	4×10^{-6}		OO	2×10^{-3}
P	3×10^{-6}			
Q	2×10^{-5}			
R	2×10^{-6}			
S	6×10^{-3}			
T	6×10^{-3}			
U	6×10^{-6}			
V	2×10^{-5}			
W	4×10^{-3}			
X	1×10^{-3}			
Y	4×10^{-3}			
Z	3×10^{-4}			

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Figure 3.

SURFACE SAMPLE LOCATIONS. Samples taken on the surface and one foot below the surface at five feet, fifty feet and one hundred feet from the pile.

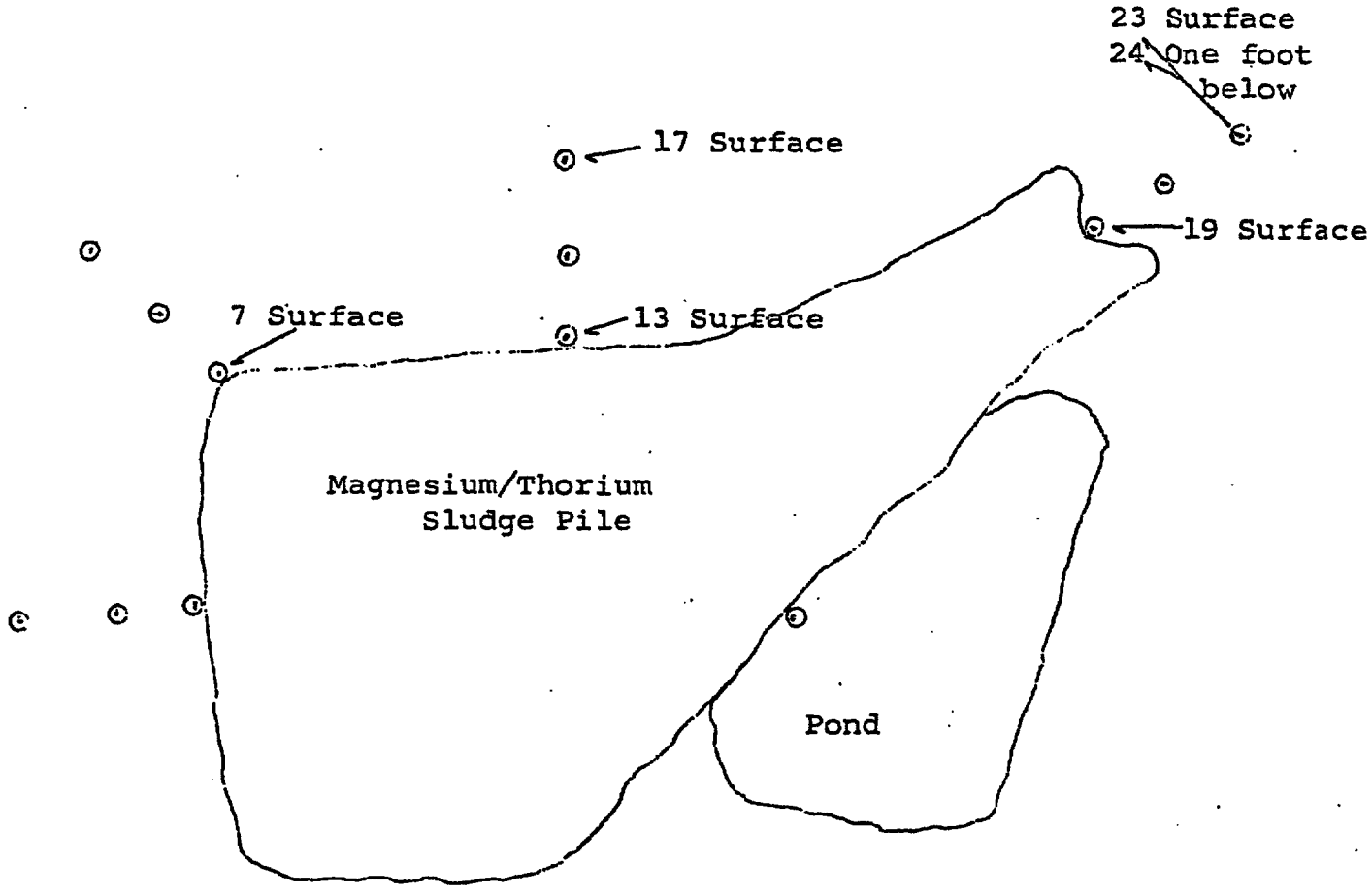

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Table II. Values for Surface Samples, Figure 3.

Sample Location	Analysis (picocuries/gram)
Surface 5 feet northwest of pile.	0.9 ± 0.2
Surface 5 feet north of pile.	2.0 ± 0.4
Surface 100 feet north of pile.	0.9 ± 0.2
Surface 5 feet northeast of pile.	1.0 ± 0.2
Surface 100 feet northeast of pile.	1.3 ± 0.3
Below surface 1 foot, 100 feet northeast of pile.	1.2 ± 0.3
All other samples.	<0.7

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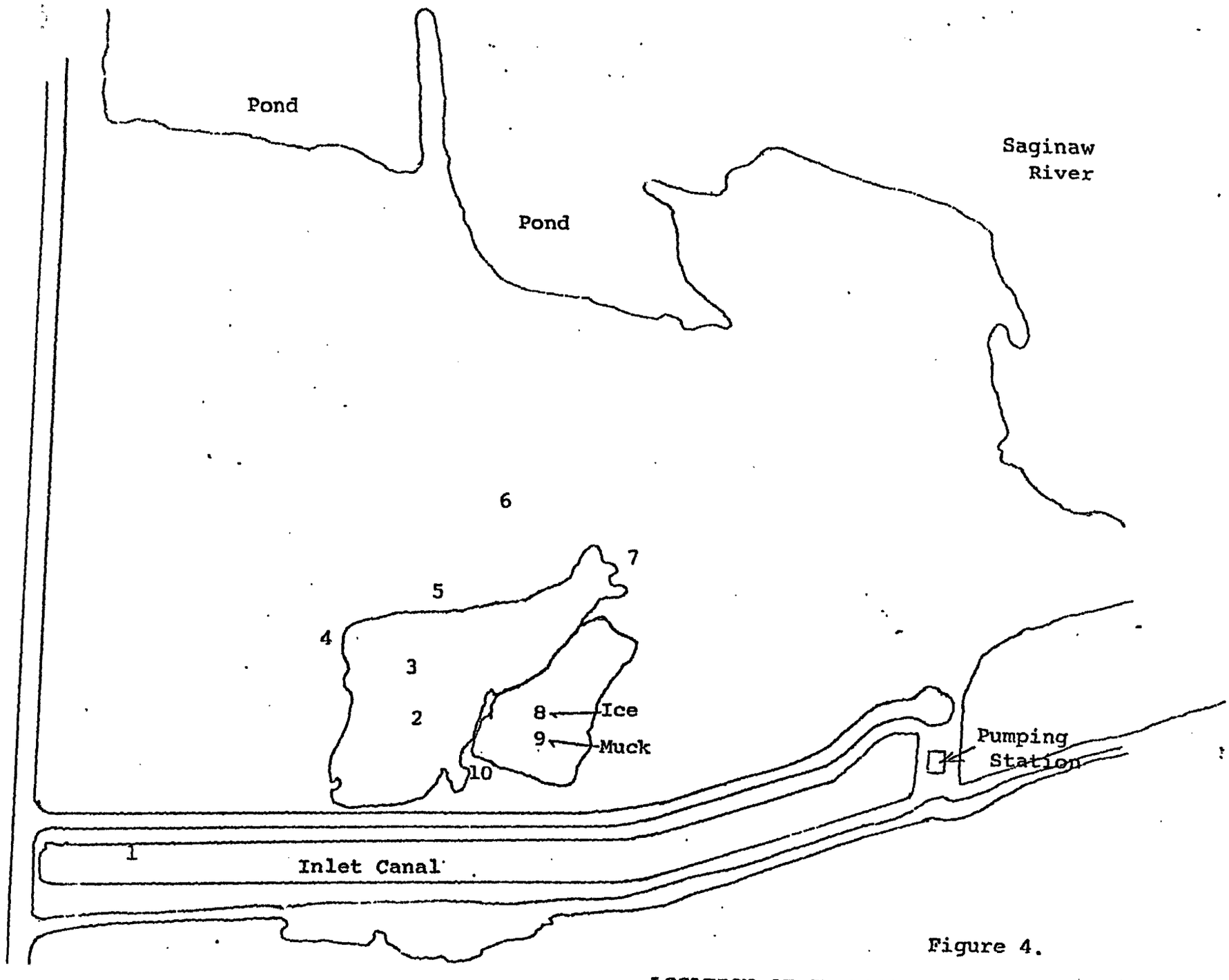

Figure 4.

LOCATION OF SAMPLES FOR THIRD SERIES

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Table III. Values for Figure 4, Samples by Department of Public Health (Michigan) and The Dow Chemical Company.

Sample Number		Values in (picocuries/gram)
1	Water	<0.6
2	Topsoil	34.2 ± 3.4
3	Pile sample	2320 ± 23
4	Soil surface	3.3 ± 0.3
5	Soil surface	3.6 ± 0.4
6	Soil surface	4.4 ± 0.4
7	Soil surface	5.5 ± 0.5
8	Ice from pond	<0.4
9	Muck from pond	2.5 ± 0.3
10	Soil surface	1.6 ± 0.2

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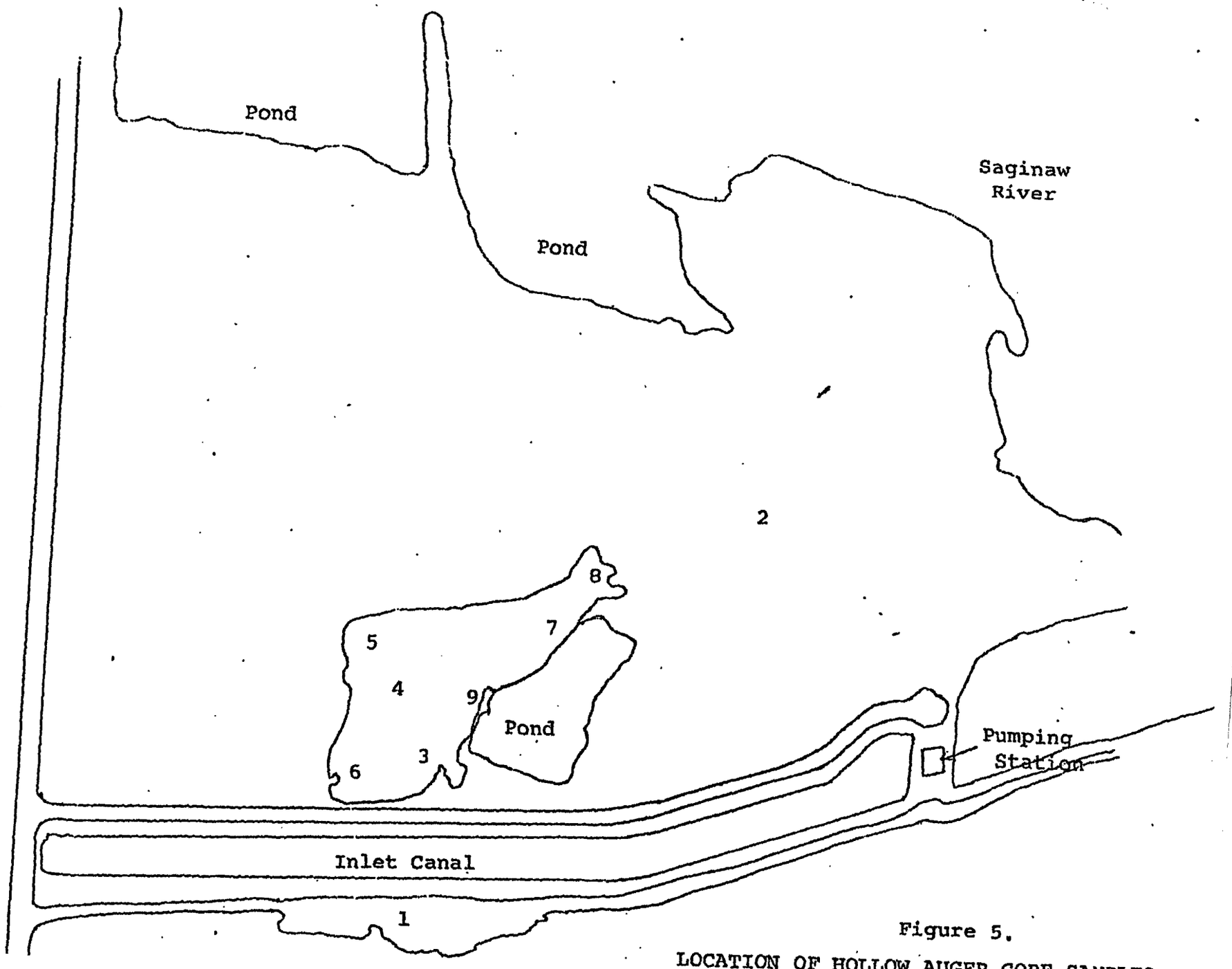

Figure 5.
LOCATION OF HOLLOW AUGER CORE SAMPLES

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Table IV. Values for Figure 5, Hollow Auger Boring Samples. Values are in picocurie/gram.

Boring Number	Depth (ft)	Sample Material	Thorium	Thorium Daughters
1	2	Fill	1.6 ± 0.8	0.9
	6	Sand	1.5 ± 0.7	1.5
	8	Sand	1.1 ± 0.5	0.6
	12	Clay	0.7 ± 0.4	0.7
	22	Clay	1.0 ± 0.4	1.1
2	2	Fill	1.4 ± 0.7	2.0
	6	Fill	<0.6	0.7
	8	Fill	<0.5	0.5
	10	Clay	1.1 ± 0.5	1.4
	12	Clay	0.9 ± 0.4	1.3
	24	Clay	0.9 ± 0.3	0.9
		Water	<0.6	<0.6
3	2	Fill	0.7 ± 0.4	0.8
	6	Fill	<0.5	<0.5
	8	Swamp bottom	0.6 ± 0.4	2.9
	10	Clay	<0.6	<0.8
	12	Clay	1.8 ± 0.8	3.9
4	2	Fill	<0.6	<0.6
	6	Swamp bottom	<0.6	<0.6
	8	Clay	<0.6	0.7
	12	Clay	0.8 ± 0.4	1.0
		Water	<0.6	<0.6

continued

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Table IV. Continued. All values in picocurie/gram.

Boring Number	Depth (ft)	Sample Material	Thorium	Thorium Daughters
5	2	Fill	2.4 ± 0.8	2.3
	6	Fill	1.3 ± 0.5	1.1
	8	Clay	<0.6	1.5
	12	Clay	0.9 ± 0.3	0.9
6	2	Fill	<0.6	<0.6
	6	Fill	0.8 ± 0.4	0.7
	8	Clay	<0.6	1.0
	12	Clay	<0.5	<0.6
		Water	<0.6	<0.6
7	2	Fill	0.8 ± 0.4	1.0
	6	Swamp bottom	0.8 ± 0.4	0.7
	8	Clay	<0.6	0.9
	12	Clay	0.7 ± 0.3	0.8
		Water	<0.6	<0.6
8	2	Fill	0.7 ± 0.4	1.4
	6	Swamp bottom	<0.6	0.6
	8	Clay	0.7 ± 0.4	0.8
	12	Clay	1.0 ± 0.3	1.1
		Water	<0.6	<0.6
9	2	Fill	<0.6	0.6
	6	Swamp bottom	<0.6	0.6
	8	Clay	<0.6	<0.6
	12	Clay	<0.5	0.7
		Water	<0.6	<0.6

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THE DOW CHEMICAL COMPANY

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LAB. CODE LETTERS AND REPORT NUMBER: NBH2.1-1-119
ACCT: 14020

MIDLAND, MICHIGAN | DEPARTMENT: Chemical Biology Research | DATE: April 23, 1971

AUTHORS: R. D. Olson R. D. Olson 4/27/71 | PROBLEM NUMBER: 9085000

TITLE: EVALUATION OF A STORAGE SITE ON THE BAY CITY PLANT SITE OF THE DOW CHEMICAL COMPANY FOR MAGNESIUM/THORIUM SLUDGE

LAB. CODE LETTERS AND REPORT NUMBER NBH2.1-1-119(1)

INFORMATIVE SUMMARY WITH CONCLUSIONS

A quantity of magnesium/thorium sludge has accumulated on a site at the Bay City Plant. This site was evaluated to determine whether the material has drifted with the wind or been leached into the subsurface below the area. Analysis of samples has shown that no contamination of the surrounding area or subsurface has been caused by the material.

REVIEWED BY L G Silverstein Jr sjl

ISSUED TO

DEPARTMENT	ATTENTION OF	DEPARTMENT	ATTENTION OF

Midland Division Administration - H. Bosscher, W. C. Timm, 47
Safety & Industrial Hygiene - L. G. Silverstein, 400
Medical - B. B. Holder, 607
Waste Control & Utilization - E. H. Shannon, 628
Bay City Petrochemicals - D. H. Smith, Bay City Plants
Hydrocarbons/Bay City Plants - K. E. Coulter, 677
Chemical Biology Research - J. B. Charm, 1701

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NUCLEAR ENGINEERING CO., INC.

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(415) 933-0770

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RADIOACTIVE SHIPMENT RECORD

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SHIPPER: _____ DATE _____ 19 ____

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INSTRUCTIONS

1. Please complete this form in triplicate on each shipment of radioactive waste to Nuclear Engineering Co., Inc. Use as many pages as necessary & distribute as follows:
   A. Mail original copy to NECO Office serving you.
   B. Give yellow copy to truck driver.
   C. Retain pink copy for your files.
2. Indicate by a check mark in column 2 whether contents are solid, liquid or gaseous.
3. All shipments must meet regulations and general packaging requirements of 49 CFR parts 170-190 and 14 CFR part 103.
4. DISCLAIMER: Title to all materials which were previously owned by the customer or supplier contained in waste furnished for burial as listed on this form or under this contract shall be deemed to be vested in Nuclear Engineering Company, Inc. upon delivery to our facilities or placed aboard our vehicle. The customer or supplier shall have no right to the recovery of any material contained in such waste nor any credit for their potential value.

ITEM NO.	PHYSICAL STATE: SOLID	LIQUID	GASEOUS	RADIATION, MR/HR: AT SURFACE	AT 3'	PRINCIPAL ISOTOPE(S)	BY-PRODUCT CURIES	SNM GRAMS	SOURCE LBS.	CUBIC FEET	TRANSPORT GROUP(S)	FISSILE CLASS	LABEL USED
			Jim: Please give me your opinion										
			on what other legal requirement Dow										
			should have with NECO on the sludge.										
						Thank you							
							Harry Schlueter				9-9-71		
							1701 Bldg						
							Phone 6-4676						
			9-15-71										
	Phone call												
			Contract field alone would serve										
			to clear Dow of further responsibility										
									9-27-71				

TRIPLICATE RETAINED FOR CUSTOMER'S FILES

ATTACHMENT 2: BOREHOLE LOGS

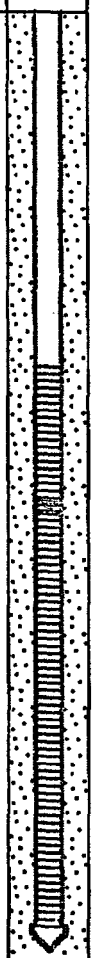
URS RADIAN **BORING NUMBER G-1**

CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 9/21/00	DATE FINISHED: 9/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 4 ft.	BOREHOLE DEPTH: 8.5 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
						Brown (10YR 5/3) silty SAND with roots and vegetation (SM), dry; loose; poorly sorted; poorly graded.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 6.75 ft. bgl. Completed at the surface with 3.25 ft. stick-up and backfilled with clean fill sand.	
1	-1					Pale brown (10YR 6/3) - black medium silty SAND (SM); moist; loose; poorly sorted; poorly graded; blotchy texture.		
2	-2							
						Very dark brown (10YR 2/2) silty-clayey SAND with some peat (SM); moist; loose; poorly sorted; poorly graded.		
3	-3							
4	-4							
5	-5							
						Gray (10YR 5/1) silty CLAY with trace gravel (CL); dry; very hard; medium-high plasticity.		
6	-6							
7	-7							
8	-8							
						End of Log		
9	-9							
10	-10							
11	-11							
12	-12							

URS RADIAN **BORING NUMBER G-2**

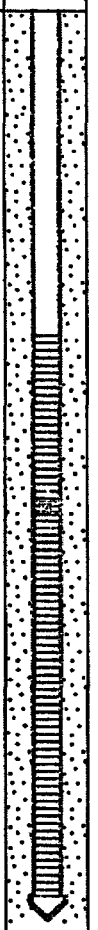
CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 9/21/00	DATE FINISHED: 9/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 4.25 ft.	BOREHOLE DEPTH: 11 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
						Brown (10YR 5/3) silty SAND with roots and vegetation (SM), dry; loose; poorly sorted; poorly graded.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 8 ft. bgl. Completed at the surface with 2 ft. stick-up and backfilled with clean fill sand.	
						Brown (10YR 5/3) sandy CLAY with gravel (CL); moist; hard; low plasticity.		
1	-1							
2	-2					Asphalt debris.		
3	-3							
4	-4							
						Dark brown (10YR3/3) to black clayey SAND with some peat (SC); wet; loose; poorly sorted; poorly graded; pungent-swampy odor.		
5	-5							
						Grayish brown (10YR 5/2) medium gravelly SAND (SW); wet; loose; poorly sorted; well graded.		
6	-6							
						Gray (10YR 5/1) to brown mottled sandy CLAY with trace gravel (CL); dry; very hard; medium plasticity.		
7	-7							
8	-8							
9	-9							
10	-10							
11	-11					End of Log		
12	-12							

URS RADIAN **BORING NUMBER G-3**

CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 9/21/00	DATE FINISHED: 9/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 4.25 ft.	BOREHOLE DEPTH: 12 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
						Dark gray (10YR 4/1) gravelly SAND (SW); dry; loose; poorly sorted; well graded.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 7.75 ft. bgl. Completed at the surface with 2.25 ft. stick-up and backfilled with clean fill sand.	
1	-1					Dark brown (10YR 3/3) fine silty SAND with iron stains and debris (SM); moist; loose; poorly sorted; poorly graded.		
2	-2					Pale bronw (10YR 6/3) fine SAND with black organic streaks (SP); moist; loose; well sorted; poorly graded.		
3	-3							
4	-4					As above but wet.		
5	-5					Black silty SAND with some peat (SM); wet; loose; poorly sorted; poorly graded; pungent-swampy odor.		
6	-6					Gray (10YR 5/1) medium SAND with trace wood debris (SP); wet; medium dense; well sorted; poorly graded.		
7	-7							
8	-8							
9	-9							
10	-10					Gray (10YR 5/1) silty CLAY with trace gravel (CL); moist; soft; medium plasticity.		
11	-11					As above but dry and very hard.		
12	-12							

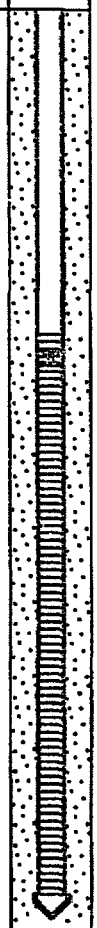


URS RADIAN JOB NUMBER: 007133

URS RADIAN **BORING NUMBER G-4**

CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 9/21/00	DATE FINISHED: 9/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 10 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X = Y =		SURFACE ELEVATION:

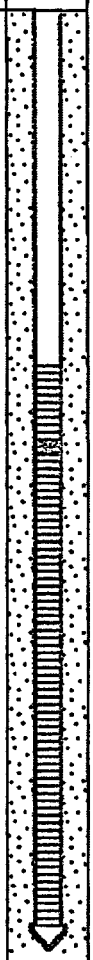
DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
1	-1					Pale-dark brown (10YR 3/3) silty SAND with iron stains (SM); dry; loose; poorly sorted; poorly graded; blotchy texture.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 7.75 ft. bgl. Completed at the surface with 2.25 ft. stick-up and backfilled with clean fill sand.	
2	-2					Gray-white silty-clayey fill material; possible brine sludge.		
3	-3					Gray (10YR 5/1) gravelly SAND with white sludge material (SW); wet; poorly sorted; well graded.		
4	-4					Black silty SAND with wood debris (SM); wet; loose; poorly sorted; poorly graded; swampy odor.		
5	-5					Very dark gray (10YR 3/1) fine silty SAND with trace gravel (SM); wet; medium dense; poorly sorted; poorly graded.		
6	-6					Gray (10YR 5/1) -brown mottled silty CLAY with trace gravel (CL); dry; very hard; medium plasticity.		
7	-7							
8	-8							
9	-9							
10	-10					End of Log		
11	-11							
12	-12							



URS RADIAN **BORING NUMBER G-5**

CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 9/21/00	DATE FINISHED: 9/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 3.75 ft.	BOREHOLE DEPTH: 10.5 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
						Brown (10YR 5/3) silty SAND with gravel and vegetation (SM); dry; loose; poorly sorted; poorly graded.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 8 ft. bgl. Completed at the surface with 2 ft. stick-up and backfilled with clean fill sand.	
						Black very coarse SAND (SP); dry; loose; well sorted; poorly graded; coal or ash.		
1	-1					Brown (10YR 5/3) sandy CLAY with gravel (CL); dry; very hard; medium plasticity.		
2	-2					Black medium-fine SAND (SP); moist; loose; well sorted; poorly graded; coal or ash; swampy odor.		
3	-3							
4	-4							
5	-5					As above but wet with strong swampy odors.		
6	-6							
						Dark grayish brown (10YR 4/2) medium-fine silty SAND with trace shells and vegetation (SM); wet; medium dense; poorly sorted; poorly graded.		
7	-7							
8	-8					Grayish brown (10YR 5/2) silty CLAY with trace gravel (CL); dry; very hard; medium plasticity.	Overpacked sample tube. Estimated contact by washing out sand and subtracting void space. Description based upon clay observed in the cutting shoe.	
9	-9							
10	-10							
						End of Log		
11	-11							
12	-12							

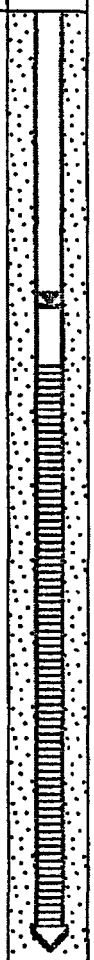


URS RADIAN JOB NUMBER: 007133

URS RADIAN **BORING NUMBER G-6**

CLIENT: The Dow Chemical Co.	PROJECT: Thorad Hydrogeological Assessment	LOCATION: Bay City, MI
DATE STARTED: 8/21/00	DATE FINISHED: 8/21/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Robb Houston	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 10 ft.
DRILL METHOD: Geoprobe		COMPLETION: Piezometer
DRILL COMPANY: URS Radian		DRILLER: Gary Waugh
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS	Well
1	-1					Grayish brown (10YR 5/2) -black medium SAND (SP); moist; loose; well sorted; poorly graded; blotchy texture.	Set 1-inch PVC piezometer with 5-foot 0.01-inch slotted screen at 8 ft. bgl. Completed at the surface with 2 ft. stick-up and backfilled with clean fill sand.	
2	-2					Grayish brown (10YR 5/2) medium SAND with trace roots (SP); wet; loose; well sorted; poorly graded; swampy odor.		
3	-3							
4	-4					Very dark grayish brown (10YR 3/2) fine silty SAND with wood debris (SM); wet; loose; poorly sorted; poorly graded.		
5	-5							
6	-6					Gray (10YR 5/1) silty CLAY with trace gravel (CL); moist-dry; very hard; medium plasticity.		
7	-7							
8	-8							
9	-9							
10	-10					End of Log		
11	-11							
12	-12							



ATTACHMENT 3: DEPARTMENT OF HEALTH WATER WELL RECORDS

GEOLOGICAL SURVEY SAMPLE NO.

WATER WELL RECORD
ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

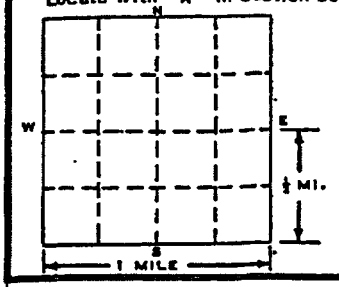
County	Township Name	Fraction	Section Number	Town Number	Range Number
Bay	Hampton	¼ ¼ ¼	7	N/S.	E/W.

Distance And Direction from Road Intersections
½ mi West of the End of Green Rd to End of Ethan Dr.

Street address & City of Well Location

Locate with "X" in section below

Sketch Map:



3 OWNER OF WELL: Randy Bernardit

Address

4 WELL DEPTH: (completed) 32 ft. Date of Completion Aug 18, 78

5 ☐ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Jetted ☒ Bored ☐ ____

6 USE: ☒ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ____

7 CASING: Threaded ☐ Welded ☐
Diam. 12" Crock
____ in. to ____ ft. Depth
____ in. to ____ ft. Depth
Height: Above/~~Below~~ Surface 1 ft.
Weight ____ lbs./ft.
Drive Shoe? Yes ☐ No ☐

8 SCREEN:
Type: ____ Dia.: ____
Slot/Gauze ____ Length ____
Set between ____ ft. and ____ ft.
Fittings:

9 STATIC WATER LEVEL
____ ft. below land surface

10 PUMPING LEVEL below land surface
____ ft. after ____ hrs. pumping ____ g.p.m.
____ ft. after ____ hrs. pumping ____ g.p.m.

11 WATER QUALITY in Parts Per Million:
Iron (Fe) ____ Chlorides (Cl) ____
Hardness ____ Other ____

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☐ Pitless Adapter ☐ 12" Above Grade

13 Well Grouted? ☐ Yes ☐ No
☐ Neat Cement ☐ Bentonite ☐ ____
Depth: From ____ ft. to ____ ft.

14 Nearest Source of possible contamination
75 feet N Direction Septic Type
Well disinfected upon completion ☒ Yes ☐ No

15 PUMP: ☒ Not Installed
Manufacturer's Name ____
Model Number ____ HP ____ Volts ____
Length of Drop Pipe ____ ft. capacity ____ G.P.M.
Type: ☐ Submersible ☐ Jet ☐ Reciprocating

2 FORMATION

FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
0 to 4 sand		
4 to 30 blue clay		
30 to 32 clay and some sand		
12' ship sent till		
10' clay fill		

USE A 2ND SHEET IF NEEDED

16 Remarks, elevation, source of data, etc.

17 WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Gale Pump — REGISTERED BUSINESS NAME
1007 — REGISTRATION NO.
Address Akron Mich
Signed Gale Pump — AUTHORIZED REPRESENTATIVE
Date Aug 18, 78

D67d 100M (Rev. 12-68)

LOCAL HEALTH DEPT. COPY

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Twp.	Fraction	Section No.	Town	Range
Bay	Bangor	¼ ¼ ¼	1	15 N/S.	R3E E/W.

Distance And Direction from Road Intersections: West of S.33 and N 245 ft

OWNER No.

N fractional ½ of NW ¼ of S-15 N R3E

Street address & City of Well Location

3 OWNER OF WELL: Bob Doak

Address: Bangor

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
top & Clay	82	82
pebbly Clay	84	2
Clay & sandy	111	27
Gravel	113	2
pebbly Clay	115	2
blue soft rock	124	9
gray sand shale	147	23
streaks sandstone		
& gray shale	172	25
hard stone	176	4
streaks black shale		
& sand stone	182	6
sand stone	195	13
[illegible]	196	

4 WELL DEPTH: (completed) 194 ft. Date of Completion 9-24-1971

5 ☐ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☑ Hollow rod ☐ Jetted ☐ Bored ☐ ___

6 USE: ☑ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ___

7 CASING: Diam. 2 in. to 135 ft. Depth; Threaded ☑ Welded ☐; ___ in. to ___ ft. Depth

Height: Above/Below surface 3 ft.; Weight 3½ lbs/ft.; Drive Shoe? Yes ☑ No ☐

8 SCREEN:

Type: ___ Dia.: ___

Slot/Gauze ___ Length ___

Set between ___ ft. and ___ ft.

Fittings:

9 STATIC WATER LEVEL 24 ft. below land surface

10 PUMPING LEVEL below land surface

___ ft. after ___ hrs. pumping ___ g.p.m.

___ ft. after ___ hrs. pumping ___ g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ___ Chlorides (Cl) ___

Hardness ___

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☑ Pitless Adapter ☐ 12" Above Grade

13 GROUTING:

Well Grouted? ☐ Yes ☐ No

Material: ☐ Neat Cement ☐ ___

Depth: From ___ ft. to ___ ft.

14 SANITARY:

Nearest Source of possible contamination

45 feet SE Direction ST Type

Well disinfected upon completion ☑ Yes ☐ No

15 PUMP:

Manufacturer's Name Layt

Model Number 5F2 HP ___

Length of Drop Pipe 84 ft. capacity ___ G.P.M.

Type: ☐ Submersible ☐ ___ ☑ Jet ☐ Reciprocating

16 Remarks, elevation, source of data, etc.

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Raymond Mach. — REGISTERED BUSINESS NAME

0320 — REGISTRATION NO.

Address 763 E Hill Rd

Signed [illegible] — AUTHORIZED REPRESENTATIVE

Date 9-24-1971

D67D 100M 6-66

GEOLOGICAL SURVEY NO. [ ]

WATER WELL AND PUMP RECORD

PART 127 ACT 368, P.A. 1978

PERMIT NUMBER [ ]

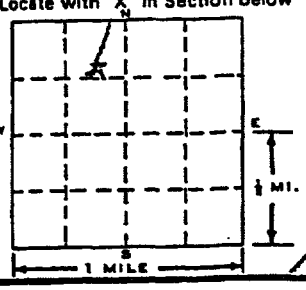
1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Bay	Bangor	¼ ¼ ¼	15	14 N/S	5 E/W

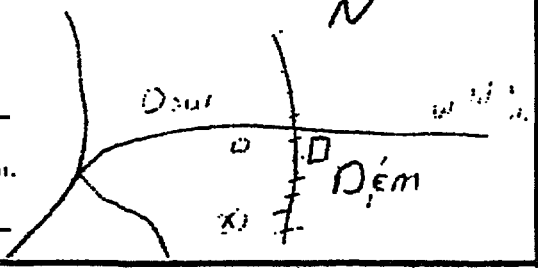
Distance And Direction From Road Intersection

Street Address & City of Well Location

Locate with "X" in Section Below



Sketch Map



3 OWNER OF WELL: Straits Corp.

Address 4774 E Wilder Rd.

Address Same As Well Location? ☒ Yes ☐ No

4 WELL DEPTH: (completed) 90 ft. | Date of Completion 7-26-84

5 ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Auger ☐ Jetted ☐ ____

6 USE: ☐ Domestic ☐ Type I Public ☐ Type III Public ☒ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☐ ____

7 CASING: Diameter ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded

6 in. to 80 ft. depth

____ in. to ____ ft. depth

Grouted Drill Hole Diameter

____ in. to ____ ft. depth

____ in. to ____ ft. depth

Height: Above/~~Below~~ Surface 1 ft.

Weight ____ lbs./ft.

Drive Shoe ☐ Yes ☐ No Boot

8 SCREEN: ☐ Not Installed

Type ✓ Diameter ____

Slot/Gauze ____ Length ____

Set between ____ ft. and ____ ft.

FITTINGS: ☐ K-Packer ☐ Lead Packer ☐ Bremer Check

☐ Blank above screen ____ ft. Other ____

9 STATIC WATER LEVEL: 2 ft. below land surface ☐ Flow

10 PUMPING LEVEL: below land surface

____ ft. after ____ hrs. pumping at 200 G.P.M.

____ ft. after ____ hrs. pumping at ____ G.P.M.

11 WELL HEAD COMPLETION: ☐ Pitless adapter ☒ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☐ Yes From ____ to ____ ft.

☐ Neat cement ☐ Bentonite ☐ Other Mud

No. of bags of cement ____ Additives ____

13 Nearest source of possible contamination

Type Septic Distance 300 ft. Direction N

Well disinfected upon completion? ☒ Yes ☐ No

14 PUMP: ☐ Not Installed ☐ Pump Installation Only

Manufacturer's name B & B

Model number 10-N-12 HP 1 Volts 230

Length of Drop Pipe 70 ft. capacity 10 G.P.M.

TYPE: ☒ Submersible ☐ Jet ____

PRESSURE TANK:

Manufacturer's name ____

Model number ____ Capacity ____ Gallons

2 FORMATION DESCRIPTION

	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand & Gravel	5	5
Clay	75	80
Sand Rock		
Course	10	90
More Below		

USE A 2ND SHEET IF NEEDED

15. Remarks, elevation, source of data, etc.

Water Little Salty

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

B & B Well Drilling 1754

REGISTERED BUSINESS NAME REGISTRATION NO.

Address Linwood MI

Signed Robert Bogie Date ____

AUTHORIZED REPRESENTATIVE

D67d (Rev. 10-80)

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

GEOLOGICAL SURVEY NO.

WATER WELL AND PUMP RECORD

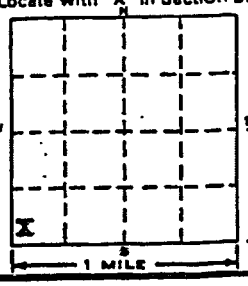
PERMIT NUMBER #4

1 LOCATION OF WELL

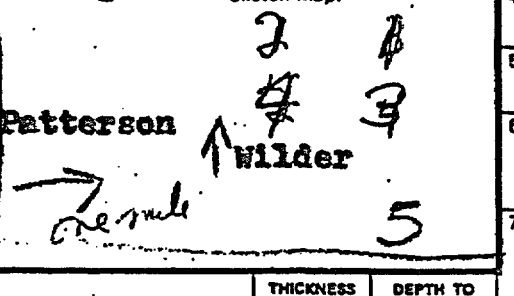
County	Township Name	Fraction	Section Number	Town Number	Range Number
Bay	Bangor	SW ¼ SW ¼ SW ¼	11	14 N/S X	5 E/W X

stance And Direction From Road Intersection
5011 Wilder Rd., one mile east of Patterson, north side
Monitoring wells
Street Address & City of Well Location

Locate with "X" in Section Below



Sketch Map:



3 OWNER OF WELL: Uno-Ven Co.
Address: 5011 Wilder Rd. Bay City, Mich.
Address Same As Well Location? ☒ Yes ☐ No

4 WELL DEPTH: 60 FT. Date Completed (MO. DAY YEAR) 8-28-91 ☒ New Well ☐ Replacement Well

5 ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Auger ☐ Jetted ☐ ____

6 USE: ☐ Domestic ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☒ ground bed

7 CASING: Diameter ☐ Steel ☐ Threaded ☒ Plastic ☒ Welded
____ in. to ____ ft. depth
____ in. to ____ ft. depth
Grouted Drill Hole Diameter
____ in. to ____ ft. depth
____ in. to ____ ft. depth
Height: Above/Below
Surface ____ ft.
Weight ____ lbs./ft.
Drive Shoe ☐ Yes ☐ No

N.T. applicable

8 SCREEN: ☒ Not Installed
Type ____ Diameter ____
Slot/Gauze ____ Length ____
Set between ____ ft. and ____ ft.
FITTINGS: ☐ K-Packer ☐ Lead Packer ☐ Bremer Check
☐ Blank above screen ____ ft. Other ____

statutes do not recognize this section as a well

9 STATIC WATER LEVEL: ____ ft. below land surface ☐ Flow

10 PUMPING LEVEL (below land surface)
____ ft. after ____ hrs. pumping at ____ G.P.M.
____ ft. after ____ hrs. pumping at ____ G.P.M.

11 WELL HEAD COMPLETION: ☐ Pitless adapter ☐ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☒ Yes From ____ to ____ ft.
☐ Neat cement ☐ Bentonite ☒ Other coke Breeze
No. of bags of cement ____ Additives ____

13 Nearest source of possible contamination NA
Type ____ Distance ____ ft. Direction ____
Well disinfected upon completion? ☐ Yes ☐ No
Was old well plugged? ☐ Yes ☐ No

14 PUMP: ☐ Not Installed ☐ Pump Installation Only
Manufacturer's name NA
Model number ____ HP ____ Volts ____
Length of Drop Pipe ____ ft. capacity ____ G.P.M.
TYPE: ☐ Submersible ☐ Jet ____
PRESSURE TANK:
Manufacturer's name ____
Model number ____ Capacity ____ Gallons

2 FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Four wells on dikes all same formations as listed below		
Fill and sand	10	10
Tan clay, stones	3	13
Tan clay, pebbles	15	28
Soft gray clay	to bottom	
One well in lower area near building		
Top soil and sand	8	8
Tan clay, stones	3	11
Tan clay	14	25
Soft gray clay	to bottom	
Well one 12 ft. casing Well 2	12 ft.	
Well 3 16 ft. casing Well 4	16 ft.	
Well 5	11 ft.	

USE A 2ND SHEET IF NEEDED

15. Remarks, elevation, source of data, etc.

RECEIVED
OCT 11 1991
Bay County Health Dept.

17. Rig Operator's Name:

16. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Everett Cragg & Sons, Inc. 73-0711
REGISTERED BUSINESS NAME REGISTRATION NO.
Address 7765 McCarty Rd. Saginaw, Mich.
Signed Jerome Cragg Date 8-24-91
AUTHORIZED REPRESENTATIVE

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

D67d 2/89

GEOLOGICAL SURVEY NO. [ ]

WATER WELL AND PUMP RECORD

PERMIT NUMBER [ ]

#5

1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Bay	Bangor	NW¼ NW¼ NW¼	14	14 N/S	5 E/W

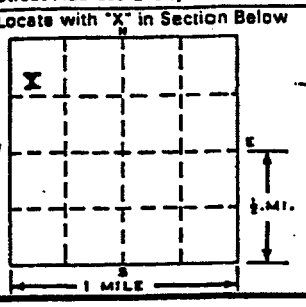
Distance And Direction From Road Intersection

411 Tiernan, South east corner of Wilder

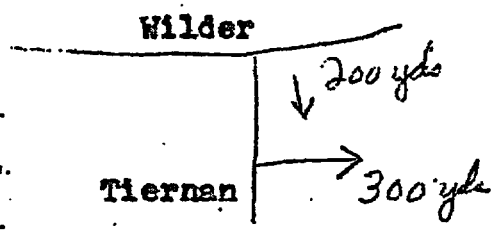
not a well

Street Address & City of Well Location

Locate with "X" in Section Below



Sketch Map:



3 OWNER OF WELL: Amaco Oil 411 Tiernan

Address: Hatzel & Buehler, Inc. 21700 Wyoming Oak Park, Mi.

Address Same As Well Location? ☐ Yes ☒ No

4 WELL DEPTH: 110 FT. Date Completed MO. 1 DAY 20 YEAR 93 ☒ New Well ☐ Replacement Well

5 ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Auger ☐ Jetted ☐

6 USE: ☐ Domestic ☐ Type I Public ☐ Type III Public ☐ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☒ ground rod

7 CASING: Diameter ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded

6 in. to 20 ft. depth

in. to ft. depth

Grouted Drill Hole Diameter

in. to ft. depth

in. to ft. depth

Height: Above/Below Surface ft.

Weight lbs./ft.

Drive Shoe ☐ Yes ☒ No

8 SCREEN: ☒ Not Installed

Type Diameter

Slot/Gauze Length

Set between ft. and ft.

FITTINGS: ☐ K-Packer ☐ Lead Packer ☐ Bremer Check ☐ Blank above screen ft. Other

9 STATIC WATER LEVEL: 10 ft. below land surface ☐ Flow

10 PUMPING LEVEL: below land surface

ft. after hrs. pumping at NA G.P.M.

ft. after hrs. pumping at G.P.M.

11 WELL HEAD COMPLETION: ☐ Pitless adapter ☐ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☒ Yes From to ft.

☐ Neat cement ☒ Bentonite ☒ Other Coke Breeze

No. of bags of cement Additives

13 Nearest source of possible contamination

Type NA Distance ft. Direction

Well disinfected upon completion? ☐ Yes ☐ No

Was old well plugged? ☐ Yes ☐ No

14 PUMP: ☒ Not Installed ☐ Pump Installation Only

Manufacturer's name

Model number HP Volts

Length of Drop Pipe ft. capacity G.P.M.

TYPE: ☐ Submersible ☐ Jet

PRESSURE TANK:

Manufacturer's name

Model number Capacity Gallons

2 FORMATION DESCRIPTION

	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Top soil	1	1
Sandy clay	2	3
Clay, stones	17	20
Soft clay	48	68
Open sandstone	3	71
Sandstone	to bottom	

RECEIVED

FEB 08 1993

Bay County Health Dept.

USE A 2ND SHEET IF NEEDED

15. Remarks, elevation, source of data, etc.

top part of sandstone took water at very good rate

17. Rig Operator's Name: Jerome Cragg

16. WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Everett Cragg & Sons, Inc. 73-0711

REGISTERED BUSINESS NAME REGISTRATION NO.

Address 7765 McCarty Rd. Saginaw, Mich.

Signed Jerome Cragg Date 1-21-93

AUTHORIZED REPRESENTATIVE

Authority: Act 368 PA 1978

Completion: Required

Penalty: Conviction of a violation of any provision is a misdemeanor.

D67d 2/89

Appendix B

Borehole Logs

URS CORPORATION

BORING NUMBER B5-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine SAND with trace silt and gravel (SP); damp.	
1	-1						
2	-2						
						Dark brown-black fine sand; wet.	
3	-3						
4	-4						
5	-5					Dark brown-black SILT with trace clay (ML); wet; soft.	
6	-6					Grayish black silty CLAY (CL); moist; soft; rooted.	
7	-7					Tan-gray silty CLAY with trace sand and gravel (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER B6-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine SAND with trace silt (SP); damp.	
1	-1						
2	-2					As above but black and wet.	
3	-3						
4	-4					2-inches organic peat; damp.	
5	-5						
6	-6					Brown organic PEAT with trace silt; moist.	
7	-7					Grayish black mottled silty CLAY (CL); moist; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER B6-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 1 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Gray fine-medium SAND with trace silt (SP); damp.	
1	-1					Bluish gray rubbery plastic material; moist; soft.	
						Gray fine SAND with trace silt (SP); wet.	
2	-2						
3	-3					Bluish gray rubbery plastic particles.	
4	-4						
5	-5					Dark brown-black organic PEAT with trace silt; moist.	
6	-6					Grayish black SILT (ML); moist; soft; rooted.	
7	-7						
						Tan-gray silty CLAY (CL); moist; soft.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER B7-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.75 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine-medium SAND with trace silt (SP); damp.	
1	-1					Bluish gray rubbery plastic material (silt to gravel sized particles); damp; soft.	
2	-2						
3	-3					As above but wet.	
4	-4						
5	-5					Dark brown PEAT with trace silt; damp.	
6	-6					Grayish black mottled silty CLAY with trace sand and gravel (CL); damp; hard.	
7	-7						
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER B7-5

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Sand and slag (SP); damp.	
2	-2						
3	-3					Grayish white rubbery plastic material; wet.	
4	-4						
5	-5						
6	-6					Dark brown PEAT; highly organic; wet.	
7	-7					Dark gray-black SILT with some sand and gravel (ML); wet.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER C5-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 4.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown silty TOPSOIL and grass; damp.	
						Tan fine-medium SAND (SP); damp-moist.	
1	-1						
2	-2					Black fine SAND (SP); moist.	
3	-3						
4	-4						
						As above but wet.	
5	-5						
6	-6					Dark gray SILT with trace sand and organic material (ML); wet.	
7	-7					Gray-black silty CLAY with trace gravel (CL); moist.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER C6-6

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine SAND with trace silt (SP); damp.	
1	-1						
2	-2					Black fine SAND with trace silt; wet.	
3	-3						
4	-4					Black organic PEAT with trace sand and silt; moist.	
						Black fine SAND with trace silt (SP); wet.	
5	-5						
6	-6					Gray SILT with trace fine sand (ML); damp; soft; rooted.	
7	-7					Gray-black silty CLAY (CL); damp; stiff; rooted.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER C7-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan CLAY with trace sand (CL); moist; soft.	
1	-1					Bluish gray rubbery plastic material (silt to gravel size particles); damp; soft.	
2	-2						
3	-3					As above but wet.	
4	-4						
						Black fine SAND (SP); wet.	
5	-5					Dark brown-black SILT with trace sand and organic material (ML); moist; soft.	
6	-6						
						Grayish black mottled silty CLAY wit trace sand (CL); hard.	
7	-7						
						Tan CLAY with tace silt (CL); damp; very hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER C7-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 1.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Dark brown fine SAND (SP); damp.	
1	-1					Bluish gray rubbery plastic material (silt to gravel size particles); damp; soft.	
2	-2					As above but wet.	
3	-3						
4	-4					Gray fine-medium SAND with some silt (SP); wet.	
5	-5						
						Dark brown SILT with some organics (ML); moist; soft.	
6	-6						
						Gray-black clayey SILT with some organic material (ML); damp; hard.	
7	-7						
						Tan-gray silty CLAY with trace sand and gravel (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER C8-4

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2 ft.	BOREHOLE DEPTH: 4 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan fine SAND with trace silt (SP); damp.	
1	-1						
2	-2					As above but black and wet.	
3	-3					Black organic PEAT; wet.	
						Grayish black mottled SILT (ML); moist; soft; rooted.	
4	-4					Grayish black mottled silty CLAY (CL); damp; hard; rooted.	
						End of Log	
5	-5						
6	-6						
7	-7						
8	-8						
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER D3-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine-medium SAND (SP); damp.	
1	-1					Bluish gray plastic rubbery material (silt to gravel size particles); damp; soft.	
2	-2						
3	-3					As above but wet.	
						Dark brown-black SILT with trace sand (ML); moist; soft.	
4	-4						
						Gray SILT with trace sand (ML); wet; soft.	
5	-5						
6	-6					As above but some fine-medium sand and gravel.	
						Tan silty CLAY (CL); moist; hard.	
7	-7						
8	-8						
						End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER D3-4

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown sandy SILT (ML); damp; soft.	
1	-1					Bluish gray rubbery plastic material (silt to gravel sized particles); damp; soft.	
2	-2					Dark brown fine SAND with trace silt (SP); damp.	
3	-3					As above but black and wet.	
4	-4						
5	-5					Black organic PEAT with trace silt; moist.	
6	-6					Gray-black SILT with trace sand (ML); wet.	
7	-7					Tan-gray silty CLAY with trace gravel (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER D4-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						4-inches Brown fine SAND and SILT (SM); damp.	
1	-1					Bluish gray rubbery plastic material (silt to gravel sized particles); damp; soft.	
2	-2						
3	-3					As above but wet.	
4	-4					Solidified plastic (massive).	
						Bluish gray rubbery plastic material; wet; soft.	
5	-5					Gray fine SAND (SP); wet.	
6	-6					As above but with trace gravel.	
7	-7					Grayish black mottled silty CLAY (CL); soft; rooted.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER D4-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown fine SAND with trace silt (SP); damp.	
1	-1						
2	-2						
						Black fine sand with trace silt; wet.	
3	-3						
4	-4						
5	-5						
6	-6						
						Gray fine-coarse sand with chunks of black plastic.	
7	-7					Grayish black mottled silty CLAY (CL); moist; soft; rooted.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER D4-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan fine SAND (SP); moist.	
1	-1						
2	-2						
						As above but black and wet.	
3	-3						
4	-4						
5	-5					Gray fine sand with trace silt; wet.	
6	-6						
						As above but with trace gravel.	
7	-7					Gray silty CLAY with trace sand (CL); moist; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER D5-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.25 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan silty CLAY with trace sand and gravel (CL); damp; soft.	
1	-1					Brown fine SAND with trace silt (SP); damp.	
2	-2					Bluish gray rubbery plastic material (silt to gravel size particles); wet; soft.	
3	-3						
4	-4						
5	-5					As above with some plastic sheeting.	
6	-6					Black organic peat with trace silt; wet.	
						Gray fine-coarse SAND with some shells (SP); wet.	
7	-7					Tan-gray silty CLAY (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER D6-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URSCorpoation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Tan sandy CLAY with trace gravel (CL); moist; medium hard.	
2	-2					Bluish gray rubbery plastic material (silt to gravel size particles); damp; soft.	
3	-3					As above but wet.	
4	-4						
5	-5						
6	-6					Dark brown-black SILT with trace organic material (ML); moist; soft.	
7	-7					Grayish black mottled silty CLAY (CL); moist; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER D6-8

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						2-inches Brown organic material and plant debris; damp.	
						Tan-brown fine SAND (SP); damp.	
1	-1						
2	-2						
						Black fine sand; wet.	
3	-3						
4	-4					Black PEAT with organic material; moist-wet.	
						Black fine SAND (SP); wet.	
5	-5						
						Grayish black fine-medium SAND with trace gravel (SP); wet.	
6	-6						
						Grayish black mottled silty CLAY (CL); damp; hard; rooted.	
7	-7						
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER D8-8

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER:	BOREHOLE DEPTH: 4 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Dark brown organic PEAT; damp.	
1	-1					Dark brown SILT with trace sand and organic material (ML); moist; soft.	
2	-2					Grayish black mottled silty CLAY (CL); damp; hard; rooted.	
3	-3					Tan silty CLAY with trace sand (CL); damp; hard.	
4	-4					End of Log	
5	-5						
6	-6						
7	-7						
8	-8						
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER D9-5

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 4 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan-brown fine-medium SAND (SP); damp.	
1	-1					Brown PEAT and some organic material; damp.	
						Gray fine SAND with trace silt (SP); damp.	
2	-2					Brown PEAT with some organics; damp; rooted.	
						Gray SILT with trace sand (ML); wet; soft.	
3	-3					Grayish black silty CLAY with trace sand (CL); hard.	
4	-4					End of Log	
5	-5						
6	-6						
7	-7						
8	-8						
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER E4-1

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Dark brown fine-medium SAND (SP); damp.	
1	-1					Blue-gray SAND and slag (SP); dry.	
2	-2						
3	-3					Black fine SAND with little silt (SP); wet; rooted.	
4	-4						
5	-5						
6	-6						
7	-7						
						Gray silty CLAY (CL); soft; rooted.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER E4-6

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Tan fine-medium SAND with little fine gravel and organic material (SP); damp.	
2	-2						
3	-3						
4	-4						
5	-5						
6	-6					Dark brown-black SILT with some peaty organic material and little fine sand (ML); wet; soft.	
						Gray fine-medium SAND (SP); wet.	
7	-7					Gray silty CLAY with little fine sand (CL); wet; stiff.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER E5-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.25 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Dark brown fine SAND (SP); damp.	
1	-1					Bluish gray rubbery plastic material (silt to gravel size particles); damp; soft.	
2	-2						
3	-3						
						Gray-black SILT with trace sand and organic material (ML); wet; soft.	
4	-4					Black fine SAND with trace silt (SP); wet.	
5	-5					Gray-black SILT with trace sand and some organic material (ML); wet; soft.	
6	-6					Gray silty CLAY with bits of plastic screening (CL); moist; soft.	
7	-7					Tan-gray silty CLAY (CL); moist; soft.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER E6-1

CLIENT: The Dow Chemical C.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown sandy SILT (ML); moist; soft.	
1	-1						
						Bluish gray rubbery plastic material (silt to gravel size particles); damp; soft.	
2	-2						
3	-3					Black fine SAND (SP); wet; loosely cemented.	
4	-4						
5	-5						
6	-6					Gray-black SILT with some organic material (ML); moist; soft.	
						Grayish black silty CLAY (CL); hard; rooted.	
7	-7						
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER E6-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 1.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan-brown fine-medium SAND with trace gravel (SP); damp.	
1	-1					As above but wet.	
2	-2						
3	-3					As above but black.	
4	-4						
5	-5					Gray-black SILT with trace sand and organic material (ML); wet.	
6	-6						
7	-7						
8	-8					Tan-gray CLAY with trace silt (CL); damp; hard.	
						End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER E7-1

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Brown fine-medium SAND with little silt (SP); damp.	
2	-2					Dark brown SAND and SILT (SM); wet; soft.	
3	-3					Gray-white slag.	
4	-4					Black fine SAND with trace silt (SP); wet.	
5	-5						
6	-6					Slag; plastic silver sheeting.	
7	-7					Dark brown SILT with some organic material (ML); soft.	
8	-8					Gray-black mottled silty CLAY (CL); stiff; rooted.	
9	-9					Tan-gray silty clay with little sand and gravel; stiff.	
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

End of Log

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER E8-4

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 0.25 ft.	BOREHOLE DEPTH: 4 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Dark brown fine-medium SAND (SP); wet.	
1	-1					Dark brown SILT with trace sand and some organic material (ML); damp; soft.	
2	-2					Tan-gray CLAY with trace silt and sand (CL); moist; soft.	
3	-3						
4	-4					End of Log	
5	-5						
6	-6						
7	-7						
8	-8						
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER E10-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.75 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation/McDowell		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Dark brown fine SAND with some organic material and plant debris (SP); damp.	
2	-2						
3	-3					Bluish gray rubbery plastic material; cohesive with sand to gravel size particles.	
4	-4					Tan fine-medium SAND with some silt and trace organics (SP); wet.	
5	-5						
6	-6					Grayish black mottled CLAY with trace silt and organic material (CL); damp; hard.	
7	-7					Tan-gray CLAY with trace silt (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER E10-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Tan fine-medium SAND with trace gravel and organic material (SP); damp.	
2	-2						
						Dark brown fine sand (SP); wet.	
3	-3						
4	-4						
5	-5						
6	-6					Dark brown-black SILT with trace sand and some peat and organic material (ML); wet; soft.	
						Gray fine-medium SAND (SP); wet.	
7	-7					Gray-tan silty CLAY with trace sand (CL); moist-wet; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER F4-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch/8.25-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown SILT with organic material (ML); damp; soft.	
1	-1					Dark brown fine SAND (SP); damp.	
2	-2					As above but wet.	
3	-3					Black fine sand with thin silvery plastic sheeting; wet.	
4	-4						
5	-5					Gray-black SILT with some organics (ML); wet; soft.	
						Gray SILT with trace sand (ML); wet.	
6	-6						
7	-7					Tan-gray silty CLAY (CL); damp-moist.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER F4-6

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan silty CLAY with little sand (CL); damp; stiff.	
1	-1						
						Gray slag and glass.	
2	-2						
3	-3						
4	-4					Black fine SAND (SP); wet.	
5	-5					Dark brown PEAT with little silt; organic.	
						Gray-black mottled CLAY (CL); moist; soft; rooted.	
6	-6						
7	-7					Tan-gray silty CLAY with plastic sheets (CL); damp; stiff.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER F5-5

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown CLAY with little sand (CL); damp; stiff.	
						White slag; dry.	
1	-1					Brown SAND with little silt (SP); damp.	
2	-2					White slag; damp.	
3	-3						
4	-4						
5	-5					Dark brown SILT with some organic material (ML); moist; soft.	
6	-6					Gray-black mottled silty CLAY with some organic material (CL); stiff.	
7	-7						
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER F6-5

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Tan fine-medium SAND with trace gravel (SP); damp.	
2	-2						
3	-3					As above but wet.	
						Tan-gray CLAY with trace sand (CL);damp; soft.	
4	-4					Chunks of gray hard plastic.	
						Dark brown-black SILT with trace sand and some organic material (ML); wet; soft.	
5	-5						
6	-6						
7	-7					Tan-gray CLAY with trace sand (CL); damp; hard.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER F7-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 4 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Dark brown TOPSOIL with trace sand and organic material; damp.	
2	-2					Brown CLAY with trace sand and gravel (CL); moist; hard.	
3	-3					Bluish gray rubbery plastic material (silt to gravel sized particles); damp.	
4	-4					As above but wet.	
5	-5					Tan-gray silty CLAY with trace sand (CL); damp; hard.	
6	-6						
7	-7					1-inch gray fine-medium sand; wet.	
8	-8					Tan-gray silty CLAY with trace sand and gravel (CL); moist; soft.	
9	-9					End of Log	
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER F7-4

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER: Ben Butler
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown silty SAND (SM); damp.	
1	-1					Brown silty CLAY with little sand and gravel (CL); damp; stiff.	
2	-2						
3	-3					Wet debris (styrofoam, silver plastic sheeting, gray plastic chunks).	
4	-4					Black fine SAND (SP); wet.	
5	-5						
6	-6					Black organic PEAT with some silt; moist.	
						Dark brown SILT with some organic material (ML); moist; soft.	
7	-7					Black SILT with little fine sand (ML); wet; soft.	
8	-8					Grayish black mottled silty CLAY (CL); moist; stiff.	
						End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER F7-6

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER:	BOREHOLE DEPTH: 4 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						1-inch Dark brown silty CLAY (CL); moist; hard.	
						Black SILT with trace sand (ML); moist; soft.	
1	-1					Tan silty CLAY with trace sand and gravel (CL); moist; hard.	
2	-2						
3	-3						
4	-4						
						End of Log	
5	-5						
6	-6						
7	-7						
8	-8						
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER G4-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3.25 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Tan-gray silty CLAY with trace sand and gravel (CL); damp; hard.	
1	-1					Dark brown fine SAND (SP); damp.	
2	-2						
3	-3					Gray-black solidified plastic (fine-medium sand sized particles); damp-wet.	
4	-4						
5	-5					Black fine SAND with trace silt (SP); wet.	
6	-6					Black organic PEAT with trace silt; moist-wet.	
7	-7					Gray SILT with some sand (ML); wet; soft.	
						Grayish black mottled silty CLAY with trace silt (CL); damp.	
8	-8					End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER G4-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 7 ft.	BOREHOLE DEPTH: 12 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Gray plastic chunks with trace sand; damp.	
2	-2					Gray solidified plastic (glassy beads and fibers); dry.	
3	-3					Plastic fibers and plastic sheets; wet.	
4	-4						
5	-5						
6	-6						
7	-7						
8	-8						
9	-9					Gray fine-medium SAND (SP); wet.	
10	-10					Tan-gray CLAY with trace sand (CL); damp; hard.	
11	-11						
12	-12					End of Log	
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER G5-8

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3.5 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Brown SILT with some sand and gravel (ML); damp; soft.	
1	-1						
2	-2					Grayish white angular limestone GRAVEL (GP); dry.	
3	-3					Debris (fabric, fine plastic screen/mesh).	
4	-4					Black fine SAND with trace silt (SP); wet.	
5	-5					Gray fine-medium SAND (SP); wet.	
6	-6						
7	-7					As above but with bits of broken glass.	
8	-8					Tan-gray CLAY with trace silt (CL); moist; hard.	
						End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION

BORING NUMBER G6-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 2.75 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe/Hollow-stem Auger		COMPLETION: Monitoring Well
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X = Y =		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
1	-1					Tan fine-medium SAND with trace gravel (SP); damp; dry.	
2	-2						
3	-3					Black fine SAND (SP); damp.	
4	-4					As above but wet.	
5	-5						
6	-6					Black SILT (ML); wet; soft; highly organic.	
7	-7						
8	-8					Black silty CLAY (CL); wet; soft.	
9	-9					End of Log	
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

URS CORPORATION

BORING NUMBER G7-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED:	DATE FINISHED:	BOREHOLE DIAMETER: 2-Inch
SUPERVISED BY: Jim Farkas	DEPTH TO WATER: 3 ft.	BOREHOLE DEPTH: 8 ft.
DRILL METHOD: Geoprobe		COMPLETION: Backfill
DRILL COMPANY: URS Corporation		DRILLER:
COORDINATES: X= Y=		SURFACE ELEVATION:

DEPTH	ELEVATION	RECOVERY	BLOW COUNT	PID	Graphic Log	GEOLOGIC DESCRIPTION	REMARKS
						Topsoil; damp.	
1	-1					Tan fine-medium SAND with trace gravel (SP); damp.	
2	-2					Brown SILT with trace sand (ML); damp; hard.	
3	-3						
4	-4						
5	-5					Dark brown-black fine SAND (SP); wet.	
6	-6						
7	-7						
8	-8					Tan-gray silty CLAY (CL); moist; soft.	
						End of Log	
9	-9						
10	-10						
11	-11						
12	-12						
13	-13						
14	-14						
15	-15						
16	-16						
17	-17						
18	-18						
19	-19						
20	-20						

URS CORPORATION JOB NUMBER: 007133

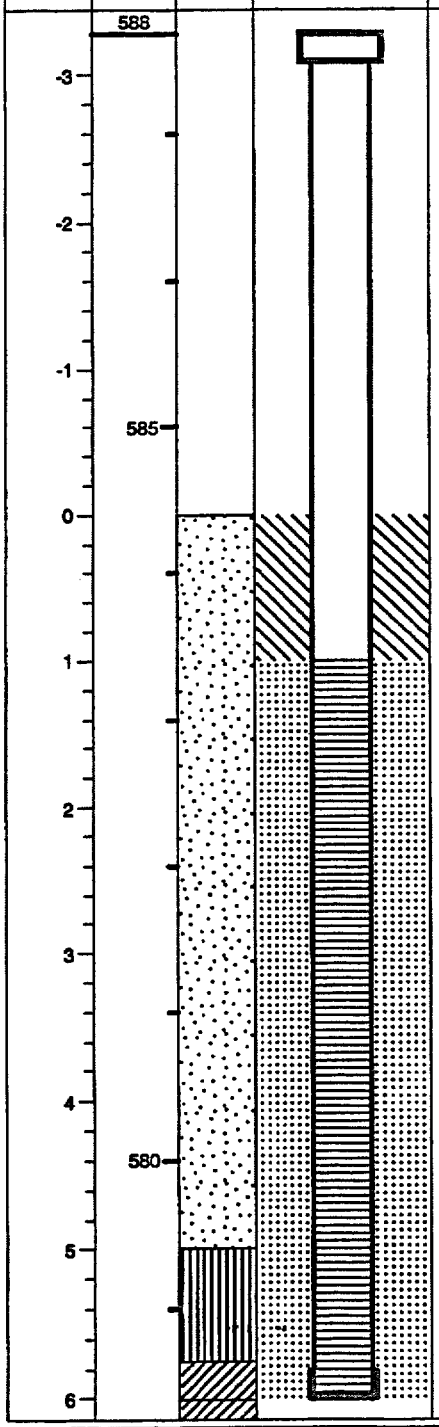
Appendix C

Well Completion Logs

URS CORPORATION

WELL NUMBER B5-3

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 8.25-Inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.75 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 479.95 ft. Y = 179.75 ft.	SURFACE ELEVATION: 584.40 ft.	TOC ELEVATION: 587.69 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 4.29 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 6 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 1 ft.
SCREEN BOTTOM: 6 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

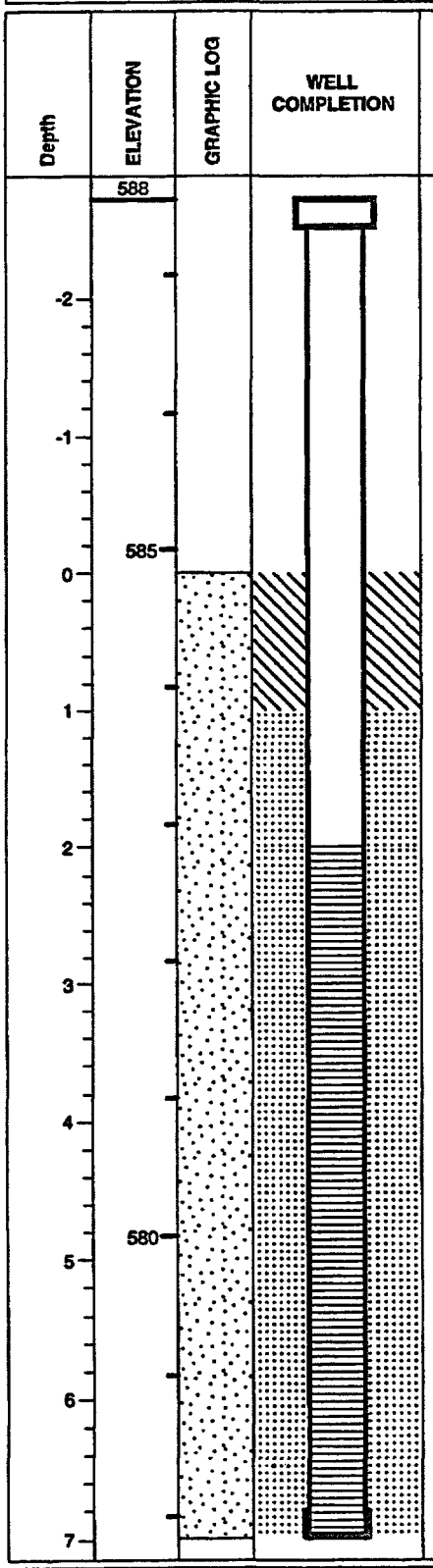
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER D4-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 583.06 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 313.37 ft. Y = 324.39 ft.	SURFACE ELEVATION: 584.83 ft.	TOC ELEVATION: 587.55 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 4.72 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 7 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 2 ft.
SCREEN BOTTOM: 7 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

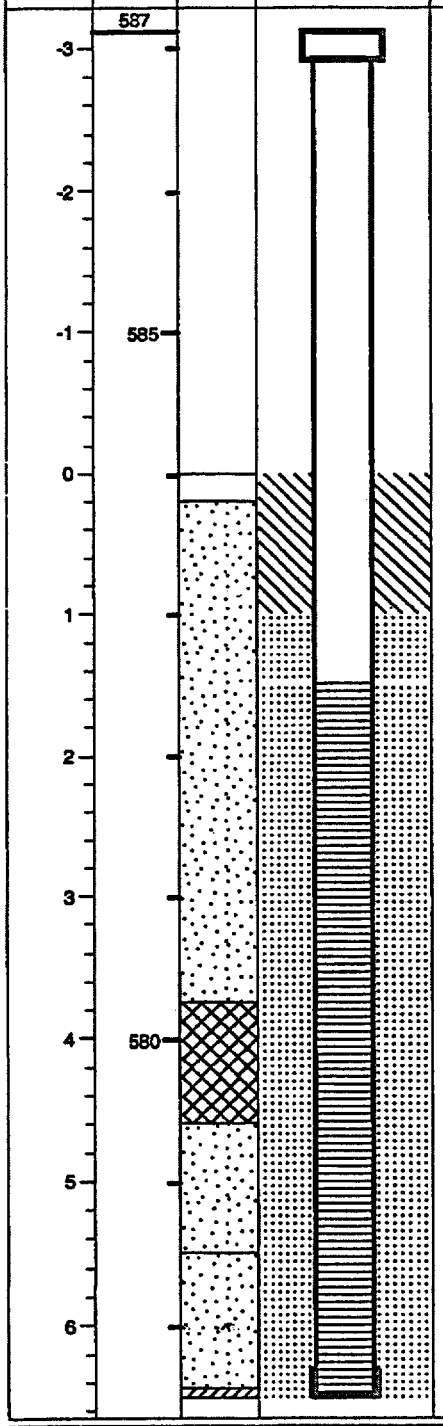
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER D6-8

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.99 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 550.56 ft. Y = 319.07 ft.	SURFACE ELEVATION: 584.01 ft.	TOC ELEVATION: 587.13 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 3.8 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 6.5 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 1.5 ft.
SCREEN BOTTOM: 6.5 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

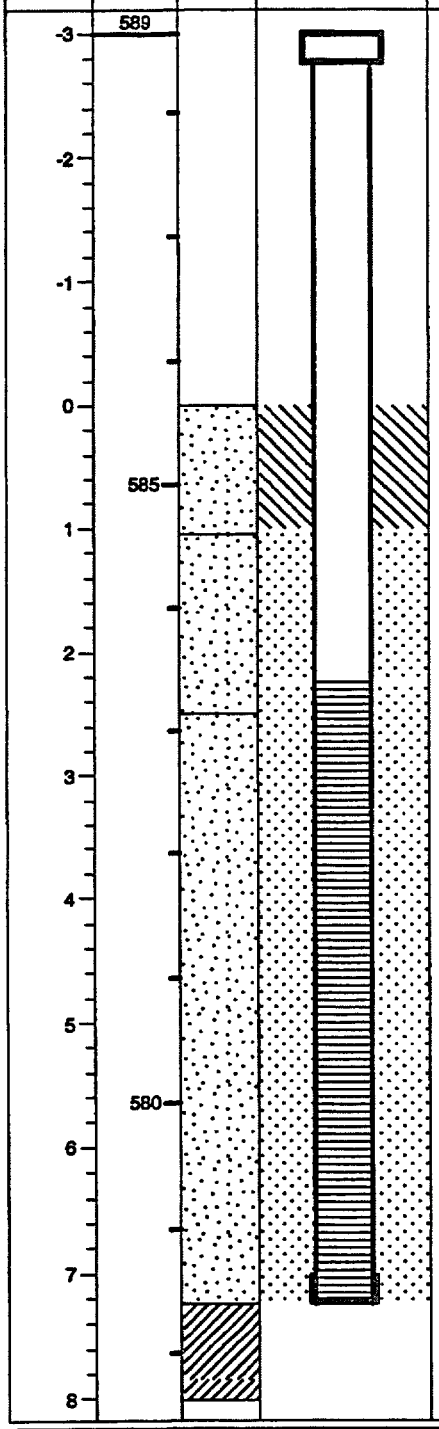
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER E4-1

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 583.02 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell & Associates		
COORDINATES: X = 321.34 Y = 474.85	SURFACE ELEVATION: 585.64 ft.	TOC ELEVATION: 588.76 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 5.37 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 7.25 ft.
FILPACK TYPE: Washed Silica Sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 2.25 ft.
SCREEN BOTTOM: 7.25 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

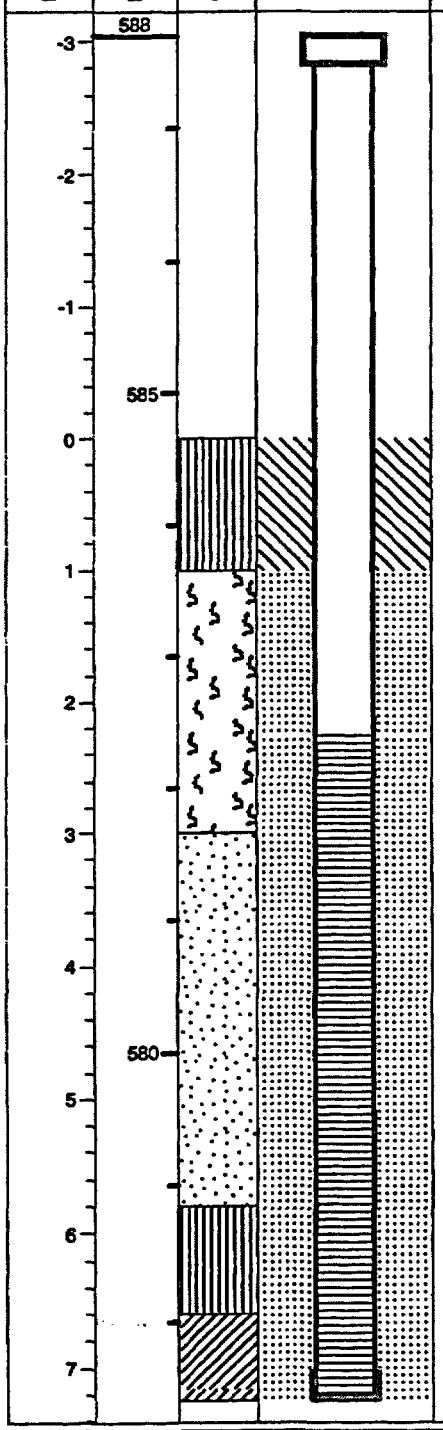
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD:

URS CORPORATION

WELL NUMBER E6-1

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/21/00	DATE FINISHED: 12/21/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.81 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 516.04 ft. Y = 479.40 ft.	SURFACE ELEVATION: 584.65 ft.	TOC ELEVATION: 587.70 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 5.3 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 7.25 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 2.25 ft.
SCREEN BOTTOM: 7.25 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

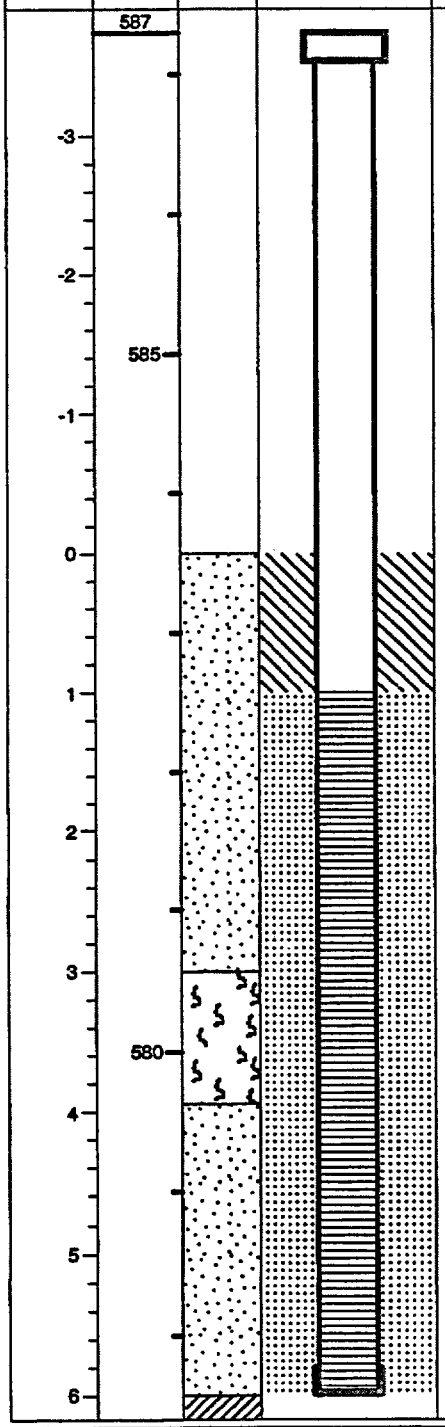
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Pump/Surge

URS CORPORATION

WELL NUMBER E10-7

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 2-inch/8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 580.25 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 918.19 ft. Y = 419.26 ft.	SURFACE ELEVATION: 583.57 ft.	TOC ELEVATION: 587.30 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 4.73 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 6 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 1 ft.
SCREEN BOTTOM: 6 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

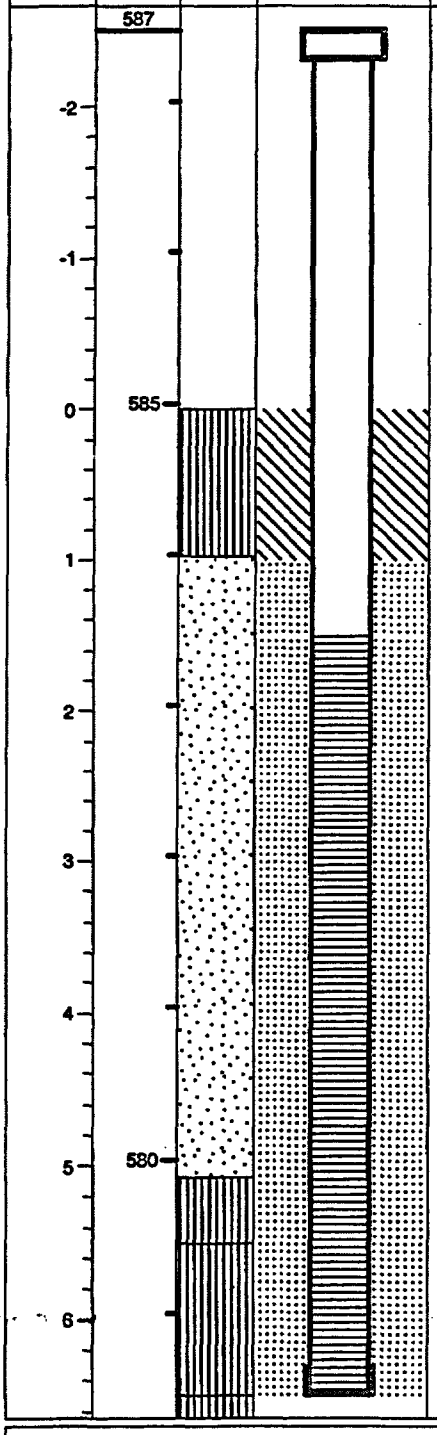
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER F4-2

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/21/00	DATE FINISHED: 12/21/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.85 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 350.57 ft. Y = 583.85 ft.	SURFACE ELEVATION: 584.96 ft.	TOC ELEVATION: 587.47 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 4.01 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 6.5 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 1.5 ft.
SCREEN BOTTOM: 6.5 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

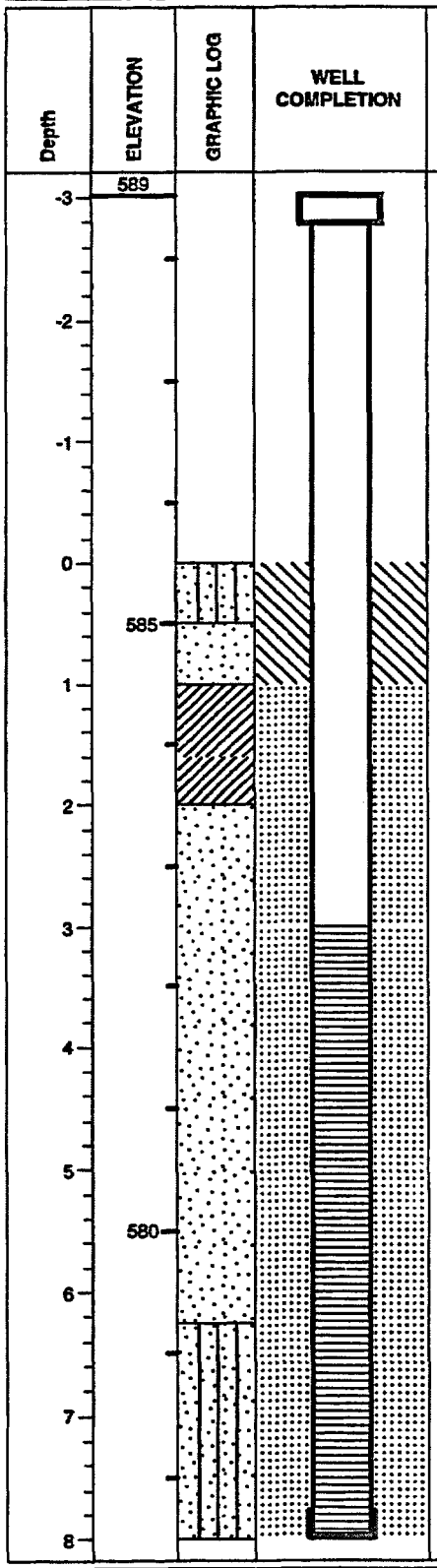
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER G-5

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/20/00	DATE FINISHED: 12/20/00	BOREHOLE DIAMETER: 2-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.27 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 327.05 ft. Y = 909.76 ft.	SURFACE ELEVATION: 585.50 ft.	TOC ELEVATION: 588.52 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 6.02 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 8 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 3 ft.
SCREEN BOTTOM: 8 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

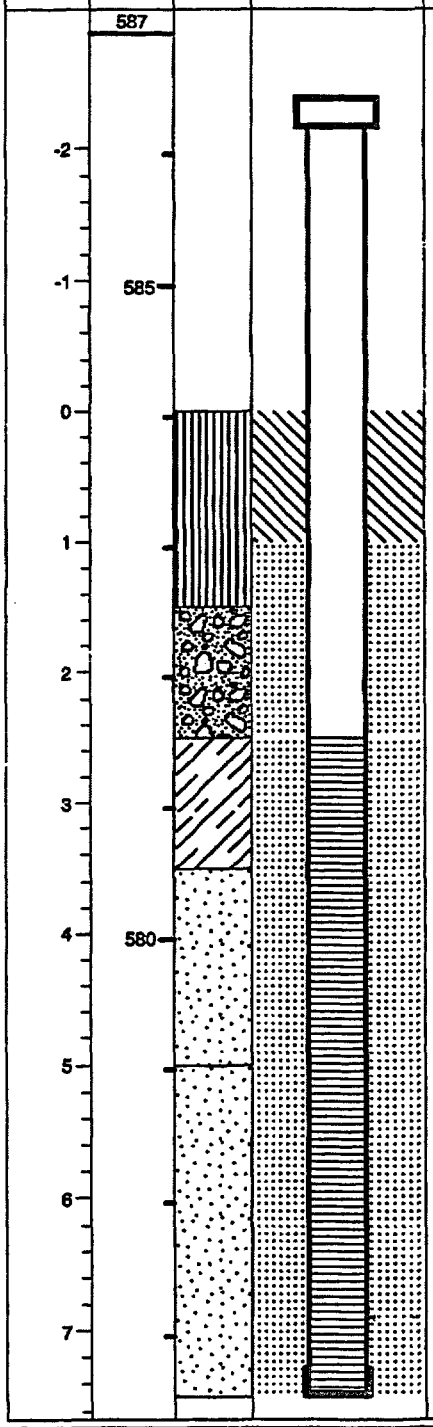
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER G5-8

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/21/00	DATE FINISHED: 12/21/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.56 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 447.29 ft. Y = 615.78 ft.	SURFACE ELEVATION: 584.04 ft.	TOC ELEVATION: 586.93 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 5.39 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: Bentonite Chips
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 7.5 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

SCREEN TOP: 2.5 ft.
SCREEN BOTTOM: 7.5 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

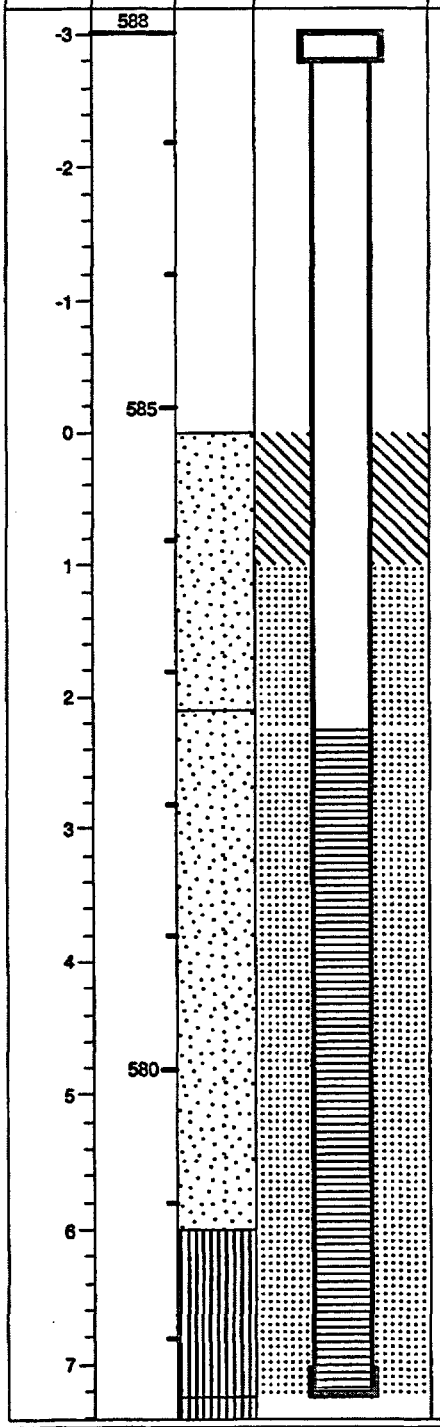
WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

URS CORPORATION

WELL NUMBER G6-9

CLIENT: The Dow Chemical Co.	PROJECT: Thorad	LOCATION: Bay City, MI
DATE STARTED: 12/21/00	DATE FINISHED: 12/21/00	BOREHOLE DIAMETER: 8.25-inch
SUPERVISED BY: Charlene Loar	DRILLER: Pete	WATER LEVEL: 582.77 ft.
DRILL METHOD: Hollow-stem Auger		
DRILL COMPANY: McDowell and Associates		
COORDINATES: X = 586.93 ft. Y = 616.87 ft.	SURFACE ELEVATION: 584.81 ft.	TOC ELEVATION: 587.83 ft.



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: Stick-Up

RISER:

RISER TYPE: PVC
RISER DIAMETER: 2-inch
RISER LENGTH: 4.27 ft.

ANNULAR SEAL:

GROUT TYPE: NA
AMOUNT OF CEMENT: NA
AMOUNT OF WATER: NA
AMOUNT OF BENTONITE: NA
SEAL TYPE: *Bentonite Chips*
AMOUNT OF SEAL: NA
DEPTH TO SEAL: 0 ft.

FILTER PACK:

FILTER PACK TOP: 1 ft.
FILTER PACK BOTTOM: 7.25 ft.
FILPACK TYPE: Washed silica sand
GRAIN SIZE: #3
AMOUNT: NA

WELL SCREEN:

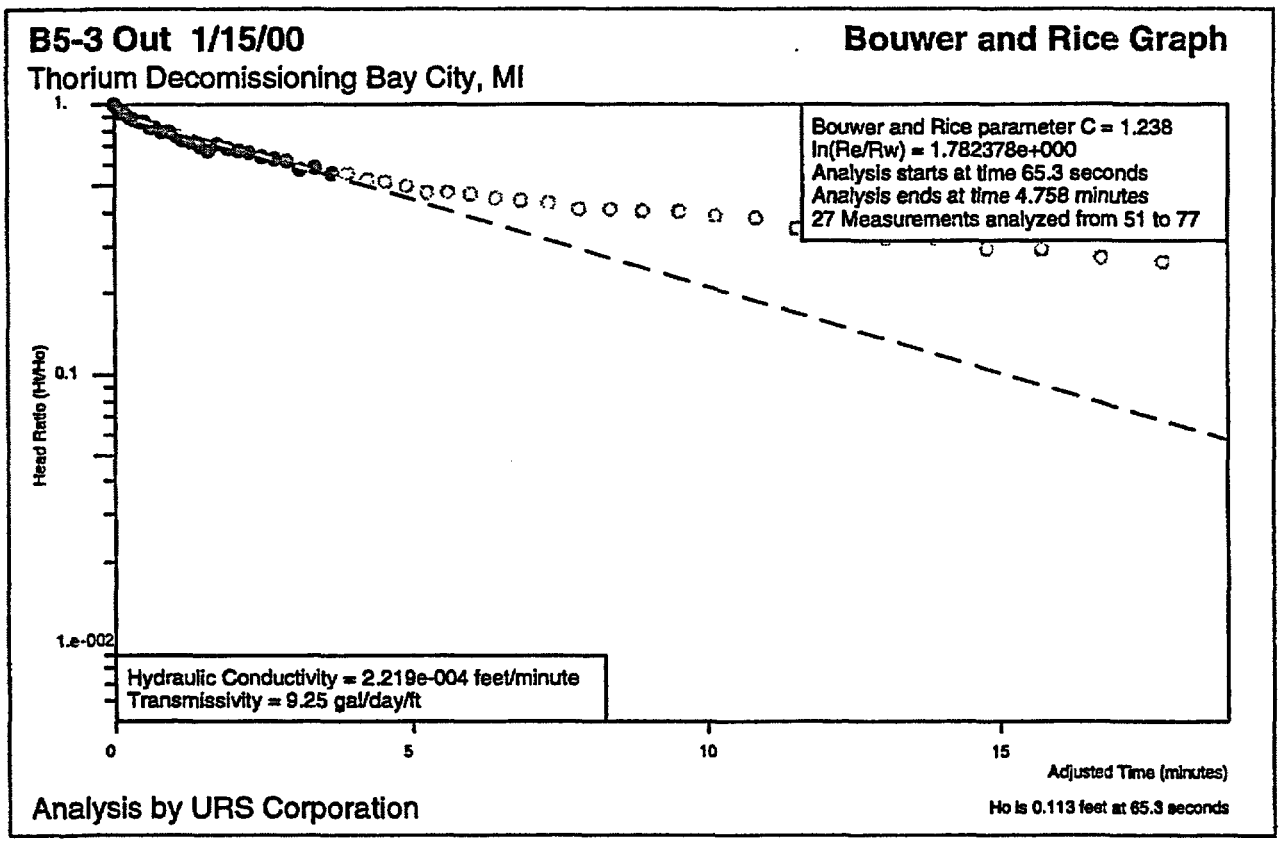
SCREEN TOP: 2.25 ft.
SCREEN BOTTOM: 7.25 ft.
SCREEN TYPE: 0.01-inch slotted PVC
SCREEN DIAMETER: 2-inch

WELL DEVELOPMENT:

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD: Surge/Pump

Appendix D

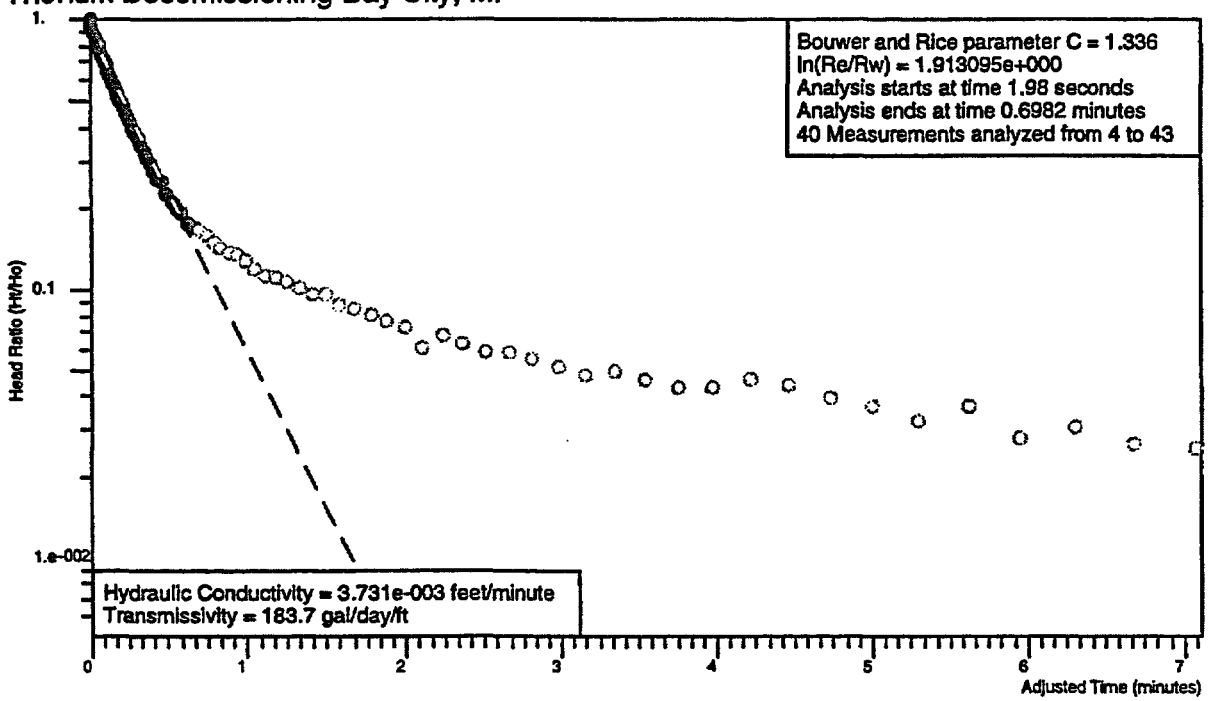
Slug Test Data


B5-3 Out 1/15/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.238
ln(Re/Rw) = 1.782378e+000
Analysis starts at time 65.3 seconds
Analysis ends at time 4.758 minutes
27 Measurements analyzed from 51 to 77
Head Ratio (H/Ho)
1.
0.1
1.e-002
Hydraulic Conductivity = 2.219e-004 feet/minute
Transmissivity = 9.25 gal/day/ft
0
5
10
15
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 0.113 feet at 65.3 seconds

D4-7 Out 1/15/00

Bouwer and Rice Graph

Thorium Decomissioning Bay City, MI



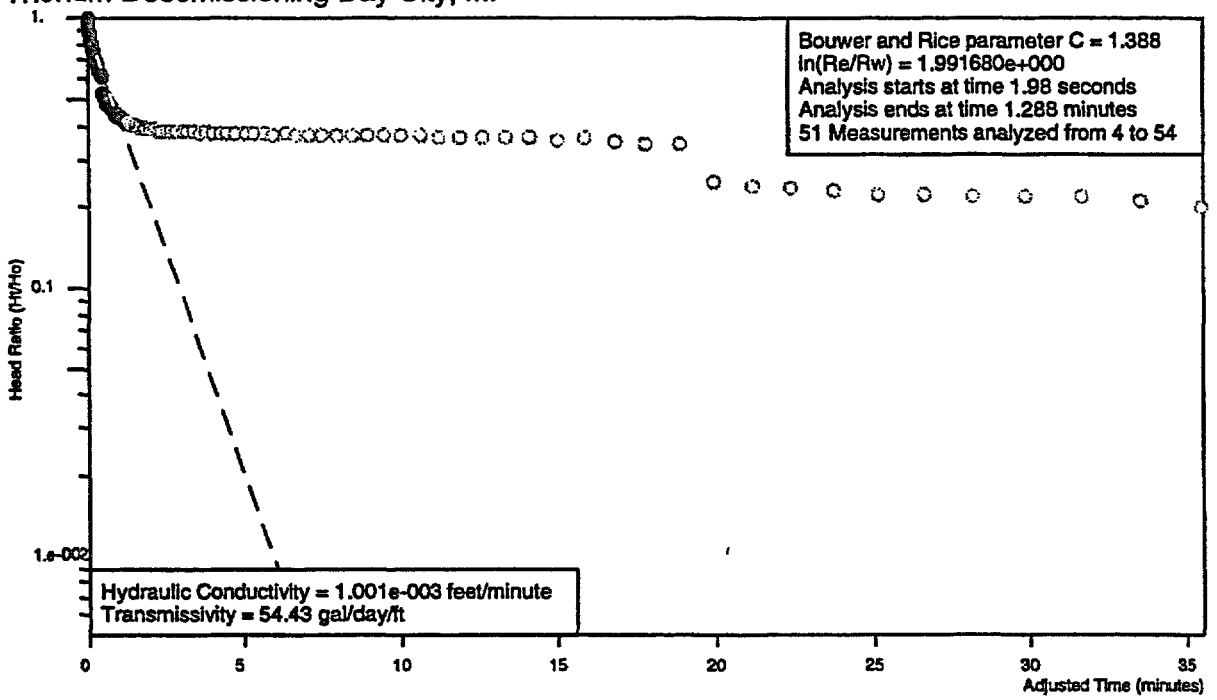
Analysis by URS Corporation

Ho is 1.134 feet at 1.98 seconds

D6-8 Out 1/15/00

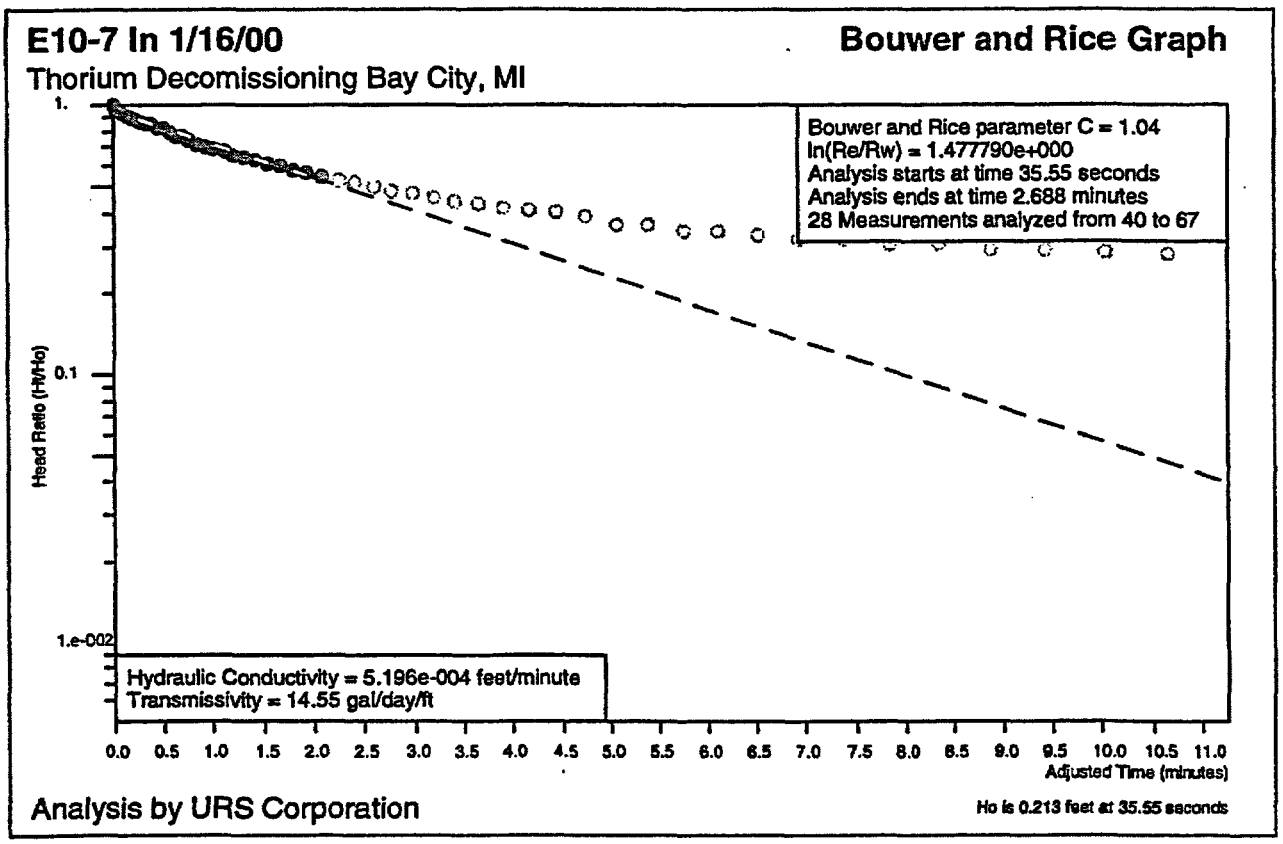
Bouwer and Rice Graph

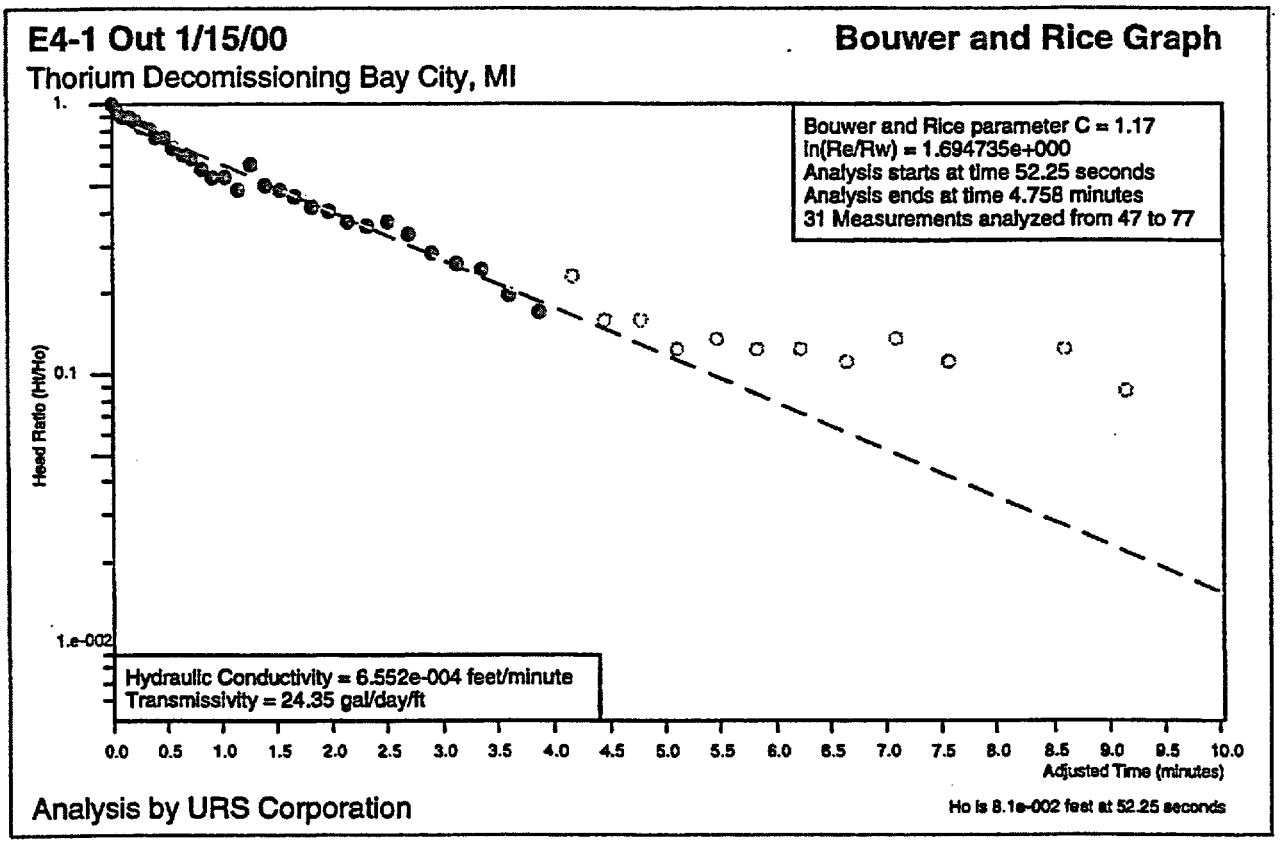
Thorium Decomissioning Bay City, MI

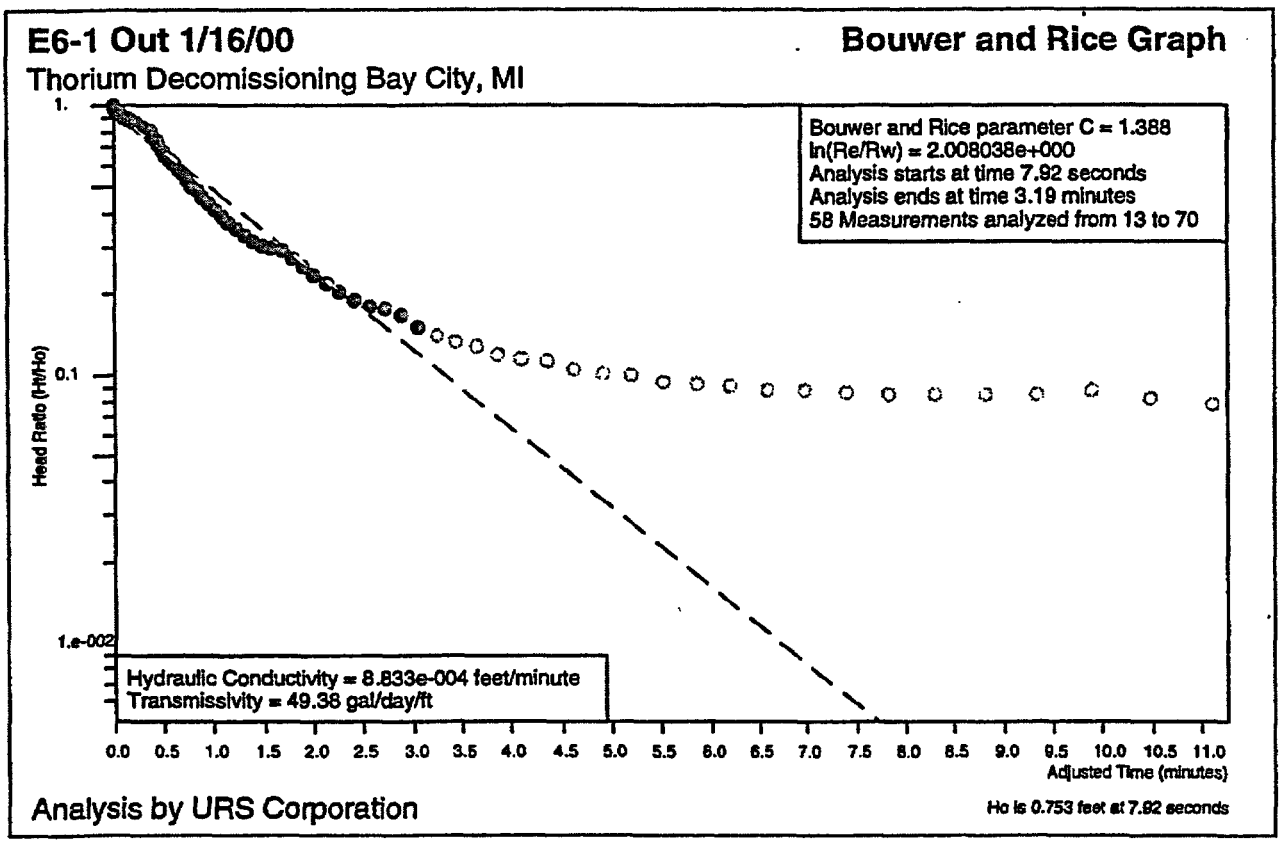


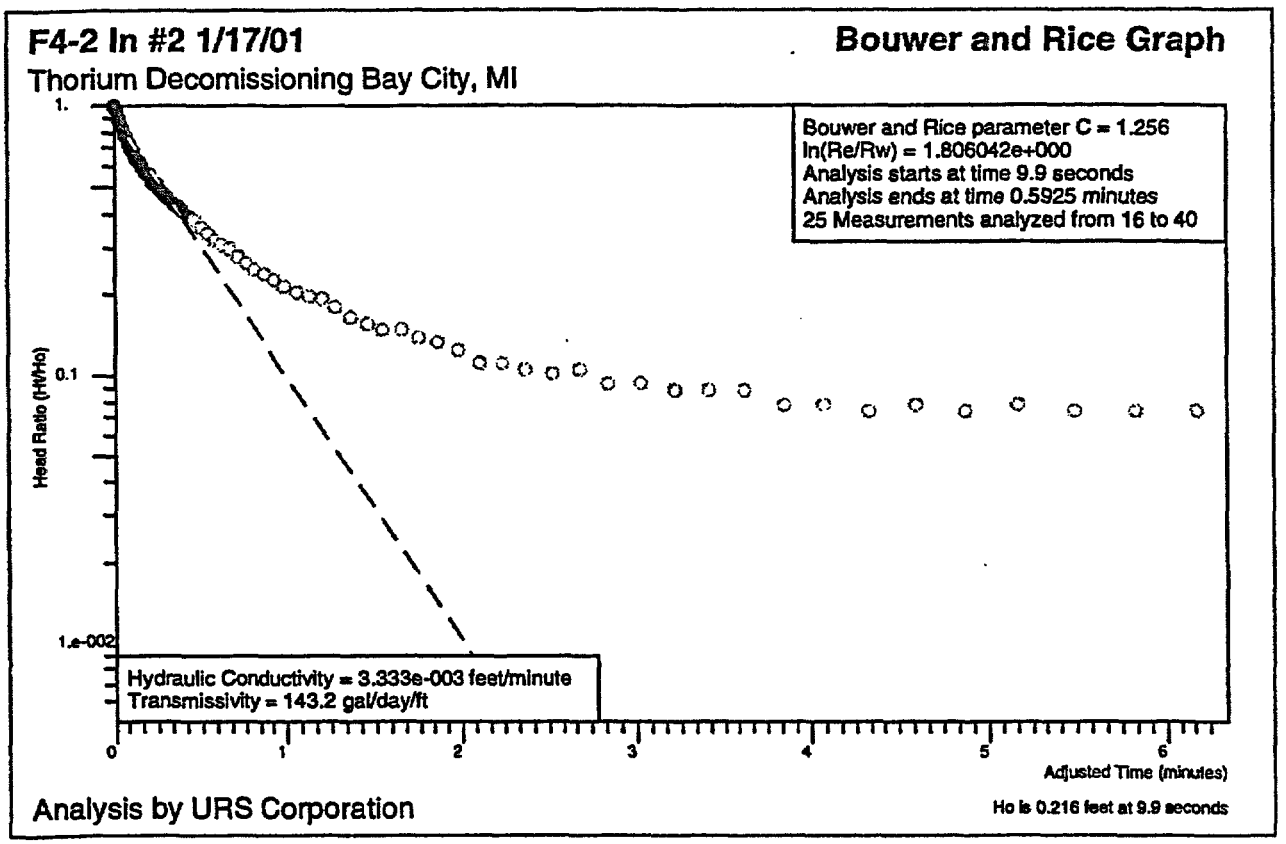
Analysis by URS Corporation

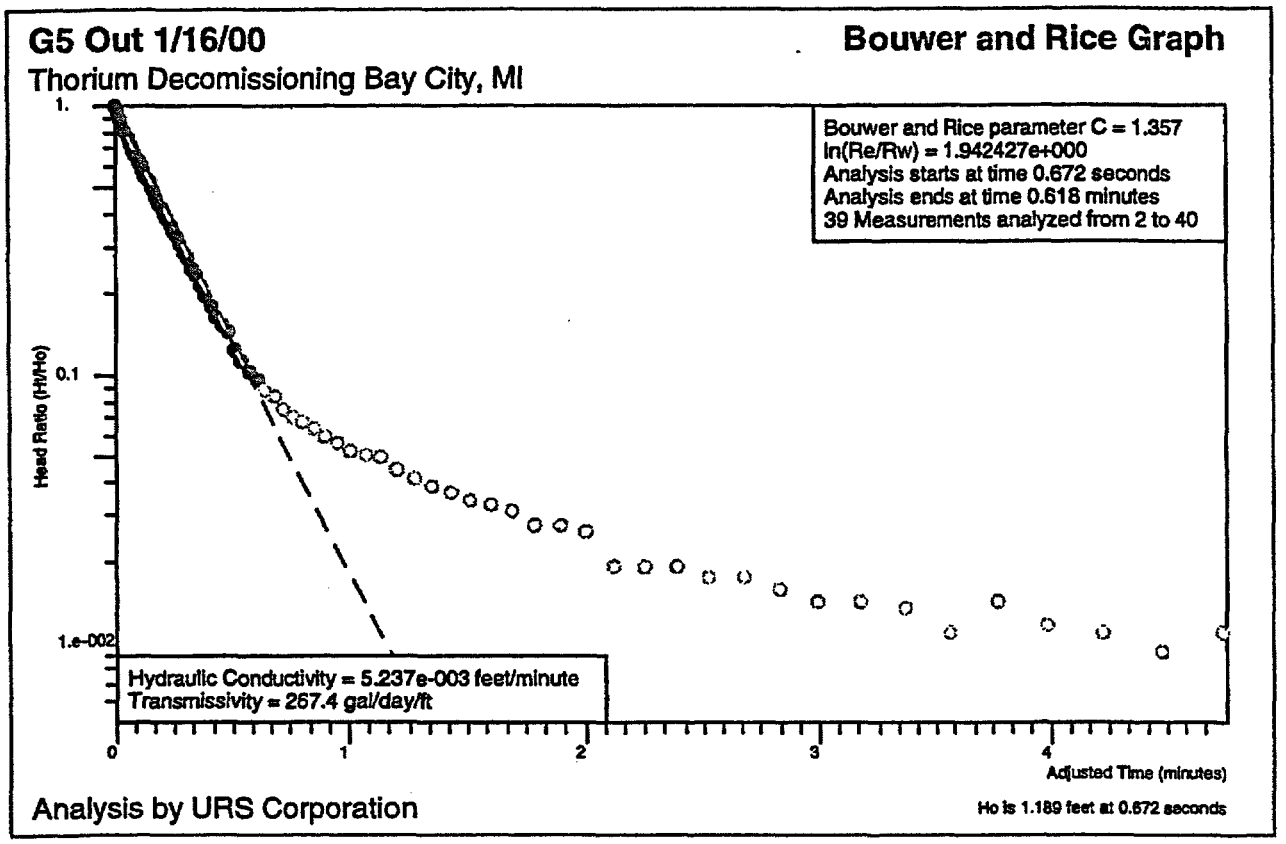
Ho is 1.167 feet at 1.98 seconds

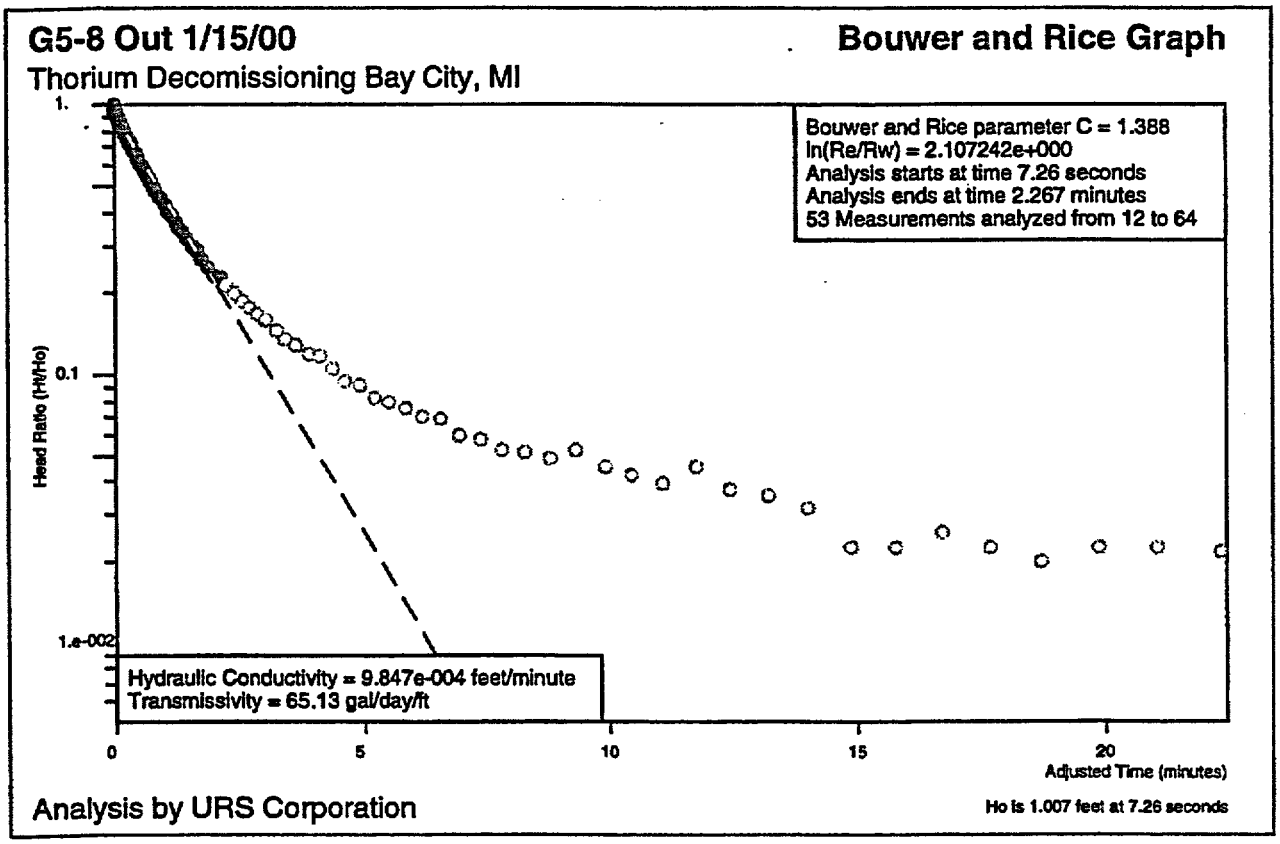

E10-7 In 1/16/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.04
ln(Re/Rw) = 1.477790e+000
Analysis starts at time 35.55 seconds
Analysis ends at time 2.688 minutes
28 Measurements analyzed from 40 to 67
Head Ratio (Ht/Ho)
1.
0.1
1.e-002
Hydraulic Conductivity = 5.196e-004 feet/minute
Transmissivity = 14.55 gal/day/ft
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 0.213 feet at 35.55 seconds


E4-1 Out 1/15/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.17
ln(Re/Rw) = 1.694735e+000
Analysis starts at time 52.25 seconds
Analysis ends at time 4.758 minutes
31 Measurements analyzed from 47 to 77
Hydraulic Conductivity = 6.552e-004 feet/minute
Transmissivity = 24.35 gal/day/ft
Head Ratio (Hi/Ho)
1.
0.1
1.e-002
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 8.1e-002 feet at 52.25 seconds


E6-1 Out 1/16/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.388
ln(Re/Rw) = 2.008038e+000
Analysis starts at time 7.92 seconds
Analysis ends at time 3.19 minutes
58 Measurements analyzed from 13 to 70
Head Ratio (Ht/Ho)
1.
0.1
1.e-002
Hydraulic Conductivity = 8.833e-004 feet/minute
Transmissivity = 49.38 gal/day/ft
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 0.753 feet at 7.92 seconds


F4-2 In #2 1/17/01
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.256
ln(Re/Rw) = 1.806042e+000
Analysis starts at time 9.9 seconds
Analysis ends at time 0.5925 minutes
25 Measurements analyzed from 16 to 40
Head Ratio (H/Ho)
1.
0.1
1.e-002
Hydraulic Conductivity = 3.333e-003 feet/minute
Transmissivity = 143.2 gal/day/ft
0
1
2
3
4
5
6
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 0.216 feet at 9.9 seconds

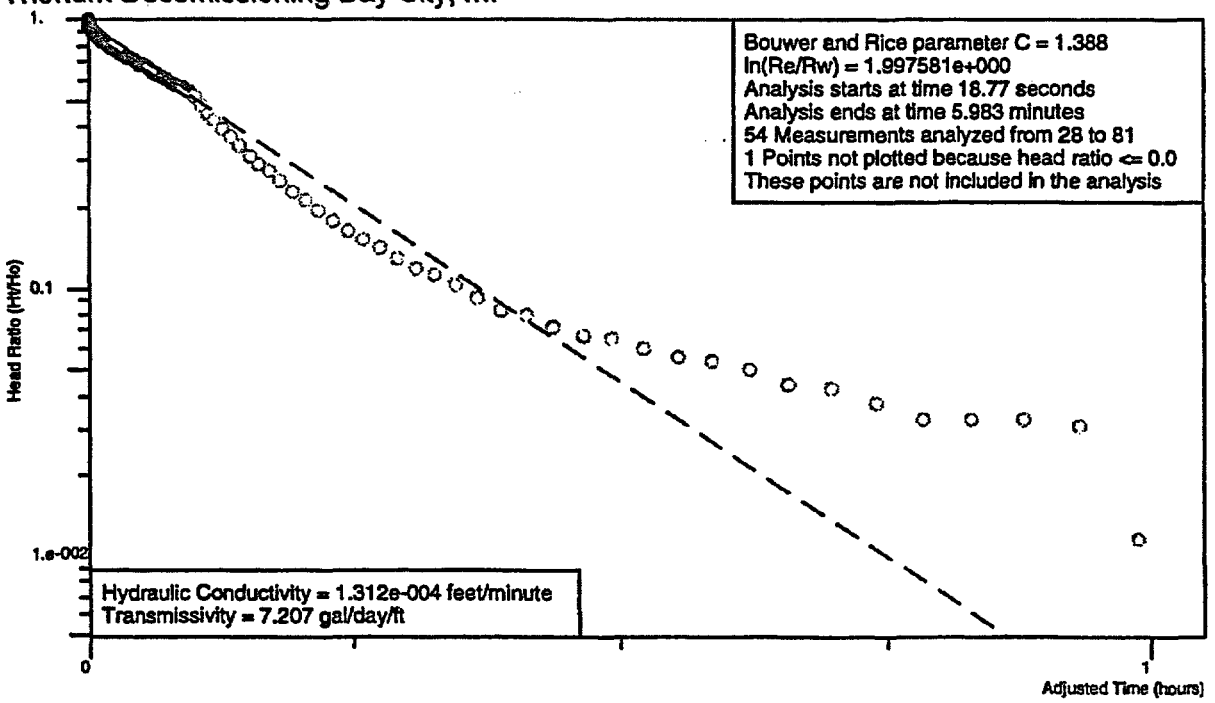

G5 Out 1/16/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.357
ln(Re/Rw) = 1.942427e+000
Analysis starts at time 0.672 seconds
Analysis ends at time 0.618 minutes
39 Measurements analyzed from 2 to 40
Head Ratio (H/Ho)
1.
0.1
1.e-002
Hydraulic Conductivity = 5.237e-003 feet/minute
Transmissivity = 267.4 gal/day/ft
0
1
2
3
4
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 1.189 feet at 0.672 seconds


G5-8 Out 1/15/00
Bouwer and Rice Graph
Thorium Decomissioning Bay City, MI
Bouwer and Rice parameter C = 1.388
ln(Re/Rw) = 2.107242e+000
Analysis starts at time 7.26 seconds
Analysis ends at time 2.267 minutes
53 Measurements analyzed from 12 to 64
Hydraulic Conductivity = 9.847e-004 feet/minute
Transmissivity = 65.13 gal/day/ft
Head Ratio (H/Ho)
1.
0.1
1.e-002
0
5
10
15
20
Adjusted Time (minutes)
Analysis by URS Corporation
Ho is 1.007 feet at 7.26 seconds

G6-9 Out 1/15/00

Bouwer and Rice Graph

Thorium Decomissioning Bay City, MI



Analysis by URS Corporation

Ho is 0.613 feet at 18.77 seconds