1. **DOE AWARD NUMBER:** DE-FC26-06NT42931

   RECIPIENT: Michigan Technological University

2. **PROJECT TITLE:** An Approach to Recover Hydrocarbons from Currently Off-Limit Areas of the Antrim Formation, MI Using Low-Impact Technologies

   PRINCIPAL INVESTIGATOR: Dr. James R. Wood

3. **REPORT DATE:** October, 2007

   Reporting Period: April 1, 2007 - September 30, 2007

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5. EXECUTIVE SUMMARY

The goal of this project is to develop and execute a novel drilling and completion program in western Antrim County near the Leelanau Peninsula of Northern Michigan (Figures 1 and 2). The target is the gas in the Lower Antrim Formation which is a widespread Upper Devonian (Figure 3) shale that has been a very prolific unconventional (shallow gas) producing horizon (Walter, 1996; Coleman, Liu and Riley, 1988; Dellapenna, 1991), having yielded over 2,000,000,000 MCF to date, about one-third of Michigan's total gas production (Wollensak, 1991). If successful, this project will open up significant acreage now off-limits to gas and oil exploration due to statutory restrictions. In addition to meeting statutory requirements, the proposed drilling plan should produce the resource more efficiently because horizontal wells will be used, and the environmental impact will be lessened since fewer wells will be needed to drain a prospect.

The central problem is that a great deal of potentially productive shale lies within areas that are off-limits to gas development due to surface constraints such topography, wetlands, or housing. In addition to these constraints, the Michigan Department of Environmental Quality (MDEQ) requires that 100 feet of surface casing be set into bedrock below the glacial drift for all drilling (see Appendix I. State Casing Statute Instruction 1-94). The actual requirement is that casing be set through and 100 feet below the lowest aquifer penetrated. This requirement is in effect to protect groundwater resources, and since the glacial drift is everywhere regarded as a potential aquifer, MDEQ routinely requires 100 feet of casing below the glacial drift. Further, fracture stimulation cannot be conducted within 50 feet of the base of the surface casing string. Fracture stimulations (Apotria, Kaiser and Cain, 1994; Decker, Coates and Wicks, 1992; Briggs and Elmore, 1980) to date have been a vital step in improving the deliverability of wells to deem them commercial. As things stand now, a large amount of productive Antrim shale can neither be accessed nor completed in a conventional sense due to State regulations. This leaves a vast resource of domestic gas unobtainable for conventional development.

Our plan is simple and is referred to as the "J-well" design. We propose to drill a vertical or slant well 100 feet below the glacial drift, set required casing, then angle back up to tap the resource lying between the base to the drift and the conventional vertical well (Figure 4). Details of the well are given in the accompanying text, Figure 5 is the planned well bore schematic for the demonstration well, and the drilling plan is presented in Appendix II. Figure 6 is a bedrock subcrop map from the MI DEQ map that shows the Antrim subcrop in gray. Approximate acreage that will become available if this approach proves successful is shown in Figure 7, north of the heavy black line that indicates the cutoff line of where production is limited because of the I-94 drilling restriction (Appendix I).

To date we have passed one major hurdle, obtaining drilling permits from MDEQ for two wells, the demonstration well AG-A-MING 4-12 HD (API: 21-009-58153-0000) and a disposal well AG-A-MING 4-12 HD1 (API: 21-009-58153-0100). These permits were approved in January, 2007 for the location cited above (Antrim County, Michigan, Torch Lake Township, Section 12, T30N-R09W).

We have also made substantial progress on the main deliverables for this project, mainly maps showing the new prospective area opened up and standard geological maps (structure and isopach) of the sub-members of interest in the Antrim Formation. Details are presented in the text. The maps and figures presented in the appendices of this report will be included in the project handbook developed as part of this project.

6. RESULTS OF WORK DURING REPORTING PERIOD

6.1 APPROACH

6.1.1 Data Collection (Task 1.0)

Data for the Lower Peninsula Antrim Trend has been collected from the Michigan DNR, the Michigan Core Repository at Kalamazoo and from MTU files. These data consist of formation top picks (~629,000), well logs, well locations and production histories. We will still gather data from our industry partner, Jordan Energy, LLD, on the demonstration well area as it becomes available, but we have received the plan of the demonstration well (Appendix II. Demonstration Well) as well as detailed information on several new wells in the vicinity of the project well (the Bargy #16-14, Drogt #2-36, Kamp #5-12, Reske #10-24, Cherry Ke #2-36, Paradis #11-36, and the brine disposal well, Dorman B B4-26 SWD) . We also have been given the results from a recent micro-gravity survey that Jordan had run by an independent contractor to help define the base of the glacial drift in the vicinity of the test well.

The project database also includes data from the Michigan Department of Environmental Quality (MI-DEQ), Michigan Public Service Commission, and the Census 2000 TIGER/Line data. The data consists of well locations, formation tops and elevations, oil, gas and CO_2 production data, scanned log images, LAS files (266 LAS files in Northern Michigan; 220 with Antrim formation picks), roads, hydrology, and political boundaries, and water well data in Antrim, Charlevoix and Cheboygan Counties.

Project databases are being organized and documented for the Project Handbook. The three databases for well locations, formation tops, and production are available online on the Michigan DEQ website and are updated periodically. A project database has been created that will link to these databases. A set of queries has been developed that will extract the information needed to reproduce the datasets used in the Project Handbook. This will allow future users of the data to include information from new wells for updated mapping. In particular, the formation tops data needs selective queries performed before mapping can take place.

Measured depths (MD) and true vertical depths (TVD) of formation tops (glacial drift base) are stored in a table by API number, formation code, and method obtained. There are multiple records for some formation tops because top picks from multiple sources are stored in the database. When creating structure and isopach maps, gridding algorithms should be used with one value for each x-y coordinate. A set of instructions and database queries will be included in the Project Handbook that will explain how the formation tops are chosen from the database. For example, when a TVD depth is present in a slanted well, it is chosen over MD. Also, we have developed a sequence of choices for the method obtained. We have also encountered inconsistent data when the method obtained for some tops in a well are obtained from the Geological Survey and some are obtained by company log picks.

Data Sources

Data Category	Source
Well Locations	Michigan DEQ
Formation Tops	Michigan DEQ
Production Data	Michigan DEQ (Oil-Gas-Water, 1982 – present) Michigan Public Service Commission (Gas, Water, CO_2, 1990 – present) Michigan Tech Historic Production (Oil-Gas-Water, Annual by Field 1925-1986)
Gravity Data	Jordan Development Company, LLC
Michigan Bouguer Anomaly Data	University of Texas at El Paso GeoNet - United States Gravity Data Repository System
Digital Well Logs	LAS files – MTU
Raster Logs	Michigan DEQ
Base map shape files	Census 2000 TIGER/Line data Michigan Resource Information System (MIRIS)

6.1.2 Mapping (Task 2.0)

The scope of this project is focused on the Northern section of the Lower Peninsula of Michigan. When reference is made to "Northern Michigan" in this report, the maps have been prepared from data located north of the 400,000 meter line in the Michigan GeoRef coordinate system.

The maps of Northern Michigan contain some common features. The Antrim subcrop is symbolized on the maps in two ways. Some of the maps indicate the Antrim subcrop with a filled gray shade, and the color contour maps indicate the subcrop with a bright pick outline. The heavy black line that runs through the center of the subcrop indicates the northern border of where Antrim gas wells can be drilled following the State of Michigan regulations requiring 100 feet of casing below the glacial drift or any fresh water aquifers. The subcrop area above this line shows the additional Antrim acreage that will become available for exploration and production as a result of the interpretation of the I-94 Instruction for this project.

Images of the maps described below are located in Appendix III. Geologic Maps of this report.

1. **Log Curve Profile**
   A stratigraphic log curve profile has been prepared for the Bargy #16-14 vertical well, which is located in eastern Antrim County, Michigan in the vicinity of the project demonstration area. This profile shows the gamma ray (GR) and density curves (ZDEN) with formation tops to illustrate the signature of the gamma ray as it passes through the Lachine, Paxton and Norwood members of the Antrim Shale.

2. **Structure contour maps: Northern Michigan**
    a. Lachine, Paxton, and Norwood members of the Antrim Shale
    b. Top of Antrim Formation

3. **Structure contour maps: Antrim County, Michigan**
    a. Lachine, Paxton, and Norwood members of the Antrim Shale

4. **Isopach contour maps: Northern Michigan**
    a. Lachine, Paxton, and Norwood intervals of the Antrim Shale
    b. Ellsworth Shale to Antrim Formation
    c. Antrim Shale to Lachine member of Antrim Shale
    d. Glacial Drift

5. **Isopach contour maps: Antrim County, Michigan**
    a. Lachine, Paxton, and Norwood intervals of the Antrim Shale

6. **Symbolized map of bedrock: Northern Michigan**
For each well with formation tops picked, the depth of the Base of the Glacial Drift is equal to the top of the formation that lies directly beneath the Glacial Drift. This formation was extracted to create a symbolized map that shows the trends of which formation characterizes the bedrock.

7. **Bouguer Gravity Anomaly maps**
The Michigan Bouguer Anomaly maps were created from data obtained from the University of Texas at El Paso website for GeoNet – United States Gravity Data Repository System. (http://paces.geo.utep.edu/research/gravmag/gravmag.shtml). The original data was in NAD27 latitude/longitude coordinates, so a conversion was done to produce the maps in Michigan GeoRef.

    a. Northern Michigan
    b. Antrim County, Michigan

8. **Antrim Production History maps: Northern Michigan**
The Antrim production history maps show cumulative production in 5-year intervals. Production data is recorded monthly by production units (PRUs), which may consist of one or more wells connected to a gas line. Production unit locations were determined by assigning each PRU to the section number where most of its wells are located. Then summation queries were used to sum the production section over each 5-year interval. Symbolized maps were then used to show the trends in Antrim production over time.

    a. Gas (1992-1996, 1997-2001, 2002-2006)

    b. CO_2 (1997-2001, 2002-2006)
    Carbon dioxide production began to be separated from the gas production in 1997,

but the year 2000 is the Michigan Public Service Commission deadline for reporting sales gas without CO_2.

c. Water (1992-1996, 1997-2001, 2002-2006)

6.1.3 Regulatory (Task 3.0)

This task was satisfactorily resolved when the Michigan DNR decided to permit the AG-A-MING demonstration well without modification of the instruction I-94. The permit was issued on December 14, 2006 for the AG-A-MING well (see map, Figure 2). Under this Permit (58153) the Michigan DNR, accepted the concept of the "J" well (Figure 5).

6.1.4 CO_2 Mitigation (Task 4.0)

Jordan Development has not yet started to record CO_2 production in the project demonstration area wells.

6.1.5 Synthesis (Task 5.0 Year 1)

The Antrim Play Handbook has been outlined and materials have been gathered for inclusion into the handbook, some of which are included in the appendices of this report. Appendix IV is an accumulation of data about the Antrim Shale prepared by Dr. William B. Harrison, III from Western Michigan University.

Antrim Play Handbook Outline

1. Table of Contents
2. Abstract
3. Antrim Shale, Late Devonian
4. Databases
    - 4.1 API Numbers explanation
    - 4.2 Well Locations Database
    - 4.3 Formation Tops
    - 4.4 Production Data
        - 4.4.1 Michigan DEQ Production Data
        - 4.4.2 Michigan Public Service Commission Gas Production Data
        - 4.4.3 Michigan Tech Historic Production Data
    - 4.5 Well Logs
    - 4.6 Gravity Data
5. Geologic Structure Maps
6. Gravity Anomaly Maps
7. Isopach Maps
8. Production Maps
9. Well Schematics
10. Horizontal Well Bore
    - 9.1 Well Drilling Acronym List
    - 9.2 Jordan Development Drilling Plan for Demonstration Well
11. Best Practices for Co-produced CO_2 Disposal

6.1.6 Demonstration Wells (Task 6.0)

Current Status of Demonstration Well

The demonstration well, A-GA-MING #4-12HD and #4-12HD1 is part of the Milton Bradley Project in west Antrim County developed by Jordan Development Company, LLC. In addition to the LINGO demonstration well, Jordan Development is developing the prospect with twelve vertical wells, and one disposal well (see Figure 2). The horizontal section of the demonstration well must remain within the 240 acre boundary set up in the PRU (PRoduction Unit). The vertical wells will be part of one production unit (PRU), and the demonstration well will be the only well in its PRU. (Since the demonstration well will be producing from its lateral, it will have access to as much or more pay as the vertical wells and will drain a similar area. This is an additional benefit of the LINGO well: it will in some cases replace as many as 4-6 wells with consequent economies and less disruption to the environment. The complete specifications for the A-GA-MING 4-12 as provided by Jordan are provided in Appendix II.

Flow lines and production lines have been installed and production of the vertical wells in the Milton-Bradley project began in June 2007 (Figure 8). Production started with two wells online at the end of June, and by the end of October, 12 vertical wells were online for production. Average daily production for this set of wells is currently at 390 mcf per day.

The demonstration well planned for the project at the AG-A-MING site has been held up by right-of-way negotiations for the past 6-9 months, but two "J" wells that have incorporated the project design were drilled at other nearby Antrim sites, the State Mancelona #2-12 HD3, the State Mancelona #15-13 HD2, and the State Mancelona #15-13A HD1 & HD2 (see map in Figure 9 and Appendix V).

These wells revealed problems with the original design of the "J" well, mainly in terms of disappointing production relative to ordinary vertical wells (Appendix Figure 18-1). However, these wells provide us with an opportunity to redesign and modify the AG-A-MING well before it is drilled. From what we have learned at the Mancelona wells, we believe that it will be necessary to reduce the ascent angle into the Antrim productive zones as well as case and perforate the well.

A Possible Solution

Recent wells drilled in DeWard-Clever (Mancelona wells) and later at Milton Bradley in the demonstration tract have helped straightened out the designs problems with the original "J" well. We now plan to case the horizontal leg of that well to hopefully get better production. We have a positive result for the resolution of the regulatory task, the Michigan DNR accepted the "J" well design as compliant with Instruction I-94. This will open the way for exploration and production in areas of the Antrim that drillers previously avoided. We can apply the unfavorable results from the Mancelona horizontal wells to "lessons learned" category and proceed to redesign the "J" well to a new configuration that will hopefully overcome the problems with the original

design. In a way the delay in the spudding of the demonstration well has benefited the project by allowing us to test the proposed well design in two additional wells before committing it to the project well. We thus have an opportunity to correct problems uncovered. We also plan to include the results and details of the Mancelona wells into the project report since the results are so germane to it.

6.1.7 Well Logging (Task 7.0)

Well logs containing Gamma Ray (GR) have been collected from the vertical wells drilled in the same project area (Milton-Bradley) as the planned DOE LINGO demonstration well. A North-South cross-section has been created which displays the logs by subsea depth over the interval defined by 100 feet above the top of the Lachine member of the Antrim Shale to 50 feet below the top of the Traverse formation (Figure 10). Appendix Figure 16-1 is included in Appendix III. Geologic Maps to show the typical gamma ray signature through the Antrim sub-formation members, the Lachine, Paxton, and Norwood.

6.2 RESULTS AND DISCUSSION

In this section we will provide a preliminary discussion of the maps promised as deliverables in this project. Several of these maps are key products in that they outline the additional prospective area that will become available for exploration and production as a result of the novel permitting and drilling undertaken here. We will also provide a preliminary discussion of the maps promised as deliverables in this project. Several of these maps are key products in that they outline the additional prospective area that will become available for exploration and production as a result of the novel permitting and drilling undertaken here. The map images are displayed in Appendix III. Geologic Mapping.

The Antrim Formation is mainly a gray to black shale with dominantly black, high gamma-ray facies in the lower sections. These lower sections can be distinguished by gamma-ray and have been termed, the Lachine, Paxton, and Norwood members of the Antrim Formation. In general these facies are high in organic matter (3-12 %) and represent anoxic facies deposited in stagnant bottom waters in closed or nearly closed Devonian seaway. They are thus marine sediments and have sufficient organic content to qualify as high-grade source rock. Some sample will burn if exposed to a flame. These are the sought after sections as they are thought to be the source of the Antrim gas, which has been reported to be biogenic (Walter, et. al, 1996). Consequently, it is of interest to map these facies in terms of how they are impacted by the J-well technology. The history and characteristics of the Antrim Shale Gas Play are outlined in Appendix IV. Antrim Shale Play.

Appendix Figures 16-2 through 16-13 are structure and isopach maps for the Lachine, Paxton, and Norwood formations in the Northern Michigan Antrim Trend and also localized to Antrim County. Appendix Figure 16-14 is a spot map showing the identity of the formation immediately under the glacial till (Glacial Till in the Michigan Stratigraphic Code). It is apparent that the sub-till facies distribution is complex and not easily generalized or mapped. At present we feel the spot map as depicted in Appendix Figure 16-14 is the best representation. It is clear to us that prospect development will have to proceed at a very small map scale in the area of interest if the Antrim is to be mapped at the Member level. We will continue to analyze this problem but will likely conclude that our large-scale map is suggestive at best (but does indicate the additional acreage opened up).

More detailed interpretations of the Antrim will be attempted when the maps are complete. At this stage it appears that the erosional edges of the Antrim are “ragged” and unpredictable, possibly due to glacial process in the waning stages of the last glacial retreat. In such cases, detailed information can perhaps be obtained by micro-gravity techniques which have been reported to allow mapping of the till-Antrim contact.

We have a detailed map (Figure 7) of the additional Antrim acreage that will become available for exploration and production as a result of the interpretation of the I-94 Instruction for this project. Also, we can begin to monitor CO_2 production from the new Mancelona wells (both vertical and horizontal) as well as continue with our efforts to obtain historical production records.

As of October 31, 2007 all project tasks are on schedule or completed except for the Ag-A-Ming demonstration well. The initial benchmark for the well was met last December when the Michigan DNR issued a permit for the well. Presently the main obstacle in the drilling of the project demonstration well has been obtaining right-of-way for facilities. A second group has tied up acreage in the vicinity of the proposed demonstration well which prevents access to the gathering facilities and hence delays drilling. Our initial optimism that these negotiations would be completed in time for the September – October timeframe to drill the demonstration well have obviously faded. However similar wells on the other side of the blocking acreage are scheduled to be drilled this year and Jordan is currently working with their partners to secure their permission to substitute one of these wells for the Ag-A-Ming. We will shortly present DOE with a request to switch demonstration wells in order to complete the project on time. The substitution will not materially affect the project as the same well will be drilled as planned for the Ag-A-Ming.

6.3 CONCLUSION

Most of the Lingo project tasks are on schedule with a major milestone (well permitting) accomplished and the task matrix well in hand. Promised deliverable maps are all started and most are nearing completion. The last remaining task is the drilling of the demonstration well. With Jordan's announcement that they recommend a switch from the original demonstration well (the Ag-A-Ming) to a similar well in the same field tract, we anticipate that the demonstration phase will now move along on time. The problem Jordan has encountered obtaining right-of-way for their gathering facilities are not uncommon; they will be resolved eventually but in the interest of meeting the timeline for this project, it is best that we submit a formal request to the DOE for the substitution. This will be submitted shortly.

The major accomplishment so far has to be convincing the Michigan DNR that the approach to tapping Antrim gas reserves via a novel approach involving drilling a lateral through the required casing zone and then angling back up met regulatory requirements. The DNR had no objections and is favorably impressed by the further advantage of the approach in lessening environmental impact as a result of requiring fewer wells and (potentially) providing more efficient drainage.

It is anticipated the more "take home" lessons will emerge as the demonstration well itself is drilled. If it is in place by early September as anticipated, then we will have time to monitor production and access performance during the timeframe of this project. We expect that the drilling program will either serve as a template for similar development, or will provide lessons in "what not to do". This will also be the first time to our knowledge that a lateral has been used to produce Antrim gas. This project has the potential to be another Crystal Field demonstration that convinces the Michigan gas and oil industry to use laterals to develop Antrim production. (Crystal Field was a DOE-sponsored demonstration project in the 1990's that was influential in converting the Michigan Oil and Gas Industry to shift to lateral wells for conventional oil production. DOE Contract No. DE-FC22-94BC14983)

7. PROPRIETARY OR CLASSIFIED DATA

None at present. However Jordan Development Company, LLC has advised us that some aspects of the new demonstration well, if approved by DOE, will need to be held confidential for a short period until leasing issues on related acreage have been resolved. These issues will not effect the drilling of the new demonstration well.

8. STATUS REPORTING

8.1 Cost Status

COST PLAN / STATUS
Michigan Technological University
DE-FC26-06NT42931

Baseline Reporting Quarter	**Year 1** Start: Oct 1, 2006 End: Sept 30, 2007				**Year 2** Start: Oct 1, 2007 End: Sept 30, 2008			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Baseline Cost Plan								
Federal Share	17,000	17,700	107,500	107,539	62,484	62,483	62,483	62,483
Non Federal Share	17,417	17,416	150,000	150,000	150,000	150,338	0	0
Total Planned (Federal and Non-Federal)	34,417	35,116	257,500	257,539	212,484	212,821	62,483	62,483
Cumulative Baseline Cost	**34,417**	**69,533**	**327,033**	**584,572**	**797,056**	**1,009,877**	**1,072,360**	**1,134,843**
Actual Incurred Costs								
Federal Share	10,932	13,652	36,944	29,125				
Non Federal Share	34,830	0	0	3				
Total Incurred (Federal and Non-Federal)	45,762	13,652	36,944	29,128				
Cumulative Incurred Cost	**45,762**	**59,414**	**96,358**	**125,486**				
Variance								
Federal Share	6,068	4,048	70,556	78,414				
Non Federal Share	-17,413	17,416	150,000	149,997				
otal Variance - Quarterly (Federal and Non-Federa	-11,345	21,464	220,556	228,411				
Cumulative Variance	**-11,345**	**10,119**	**230,675**	**459,086**				

8.1.1 Variance Explanation - after 3rd qtr Yr 1

The variance in the third quarter is a result of the drilling being pushed back until late summer. Therefore, no money was paid to the operating partner and no cost share was documented.

8.1.2 Variance Explanation - after 4th qtr Yr 1

The variance in the fourth quarter is a result of the drilling being delayed. Therefore, no money was paid to the operating partner and no cost share was documented. This accounts for $300,000 in cost share and $111,000 in direct payments to the operating partner; $411,000 total (plus $14,000 in overhead). Less funds were spent on the consultant than anticipated, partly because no drilling was conducted.

8.2 *Milestone Status*

(Details on Task Statuses are provided in report Section 6.1 Approach)

Task/ Subtask	Critical Path Project Milestone Description	Planned Start Date	Planned End Date	Actual Start Date	Actual End Date	Status
Task 1.0	Data Collection	10/1/2006	7/31/2007	10/1/2006	7/31/2007	Completed; New data will be added as it is made available from our Industry Partner
Task 2.0	Mapping	10/1/2006	9/30/2007	10/1/2006	9/30/2007	Completed; Maps will be updated as new data is made available
Task 3.0	Regulatory Analysis	1/1/2007	12/31/2007	12/1/2006		The Michigan DNR permitted the AG-A-MING demonstration well without modification of the instruction I-94 on December 14, 2006 for the AG-A-MING well. Under this Permit (58153) the Michigan DNR, accepted the concept of the "J" well.
Task 4.0	CO2 Mitigation	1/1/2007	9/30/2007			Task will begin when project demonstration well is spudded
Task 5.0	Synthesis (Year 1)	6/1/2007	9/30/2007	6/1/2007	9/30/2007	The Antrim play handbook has been outlined and partially filled in.
	Synthesis (Year 2)	6/1/2008	9/30/2008			
Task 6.0	Demonstration Wells	3/1/2007	3/31/2008			Negotiations stlll pending on horizontal well, but vertical wells in project area are being monitored
Task 7.0	Well Logging	5/1/2007	7/31/2007	8/1/2008		Some vertical well logs have been collected and made into a cross section through the demonstration project area

9. SUMMARY OF SIGNIFICANT ACCOMPLISHMENTS

1. A major hurdle was cleared when the MDEQ (Michigan Department of Environmental Quality) issued permits for the project demonstration wells in January, 2007. Until these permits were in hand the status of the entire project was uncertain. But the State of Michigan has agreed that the proposed "J-well" solution to drilling the shallow Antrim gas meets environmental requirements. In some cases it is more desirable because it reduces the number of wells and exposes more of the well bore to pay.

2. The demonstration well has been designed (see Appendix Figures 15-1 and 15-2 and the write-up in Appendix II. Demonstration Well) with the slant, drain and horizontal leg. It now remains to drill this configuration (the next hurdle) and then monitor production.

3. The project handbook is about 70% completed, and will include maps and figures from the appendices. Twelve structure and isopach maps have been created for the Lachine, Paxton, and Norwood members of the Antrim Shale, and eight production maps have been produced to show the progression of Antrim gas, water and CO_2 production in five year increments.

10. ACTUAL OR ANTICIPATED PROBLEMS

The "J" well design has now been tested and refined through several cycles of implementation at DeWard-Clever (Mancelona wells). It now appears that casing the hole, perforating and keeping the dip shallow will fix the problems noted earlier.

11. PRODUCTS AND TECHNOLOGY TRANSFER

11.1 Publications

None at this time.

11.2 Website

The project website has been established, and project figures and reports are being added to the site as the project progresses.
http://www.geo.mtu.edu/svl/LINGO/

11.3 Networks or collaboration fostered

None at this time.

11.4 Technologies/Techniques

None at this time.

11.5 Inventions/Patent Applications

None at this time.

11.6 Other products

None at this time.

11.7 Project Meetings

October 16, 2006 The project kickoff meeting was held at the Core Repository in Kalamazoo, Michigan. Attendees were J. Wood, W, Quinlan, W. Harrison and M. Gruener.

December 15, 2006 J. Wood held project consultation meetings with W. Quinlan and E. Taylor in Traverse City, MI.

March 12-14, 2007 The annual DOE project meeting was held in Tampa, Florida. Attendees were J. Wood, C. Asiala, W. Quinlan, W. Harrison, and M. Gruener.

Project Update Meetings, Jordan Development Company, LLC, Traverse City, MI.
November 2006
April 2007
July 2007
October 2007

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13. FIGURES

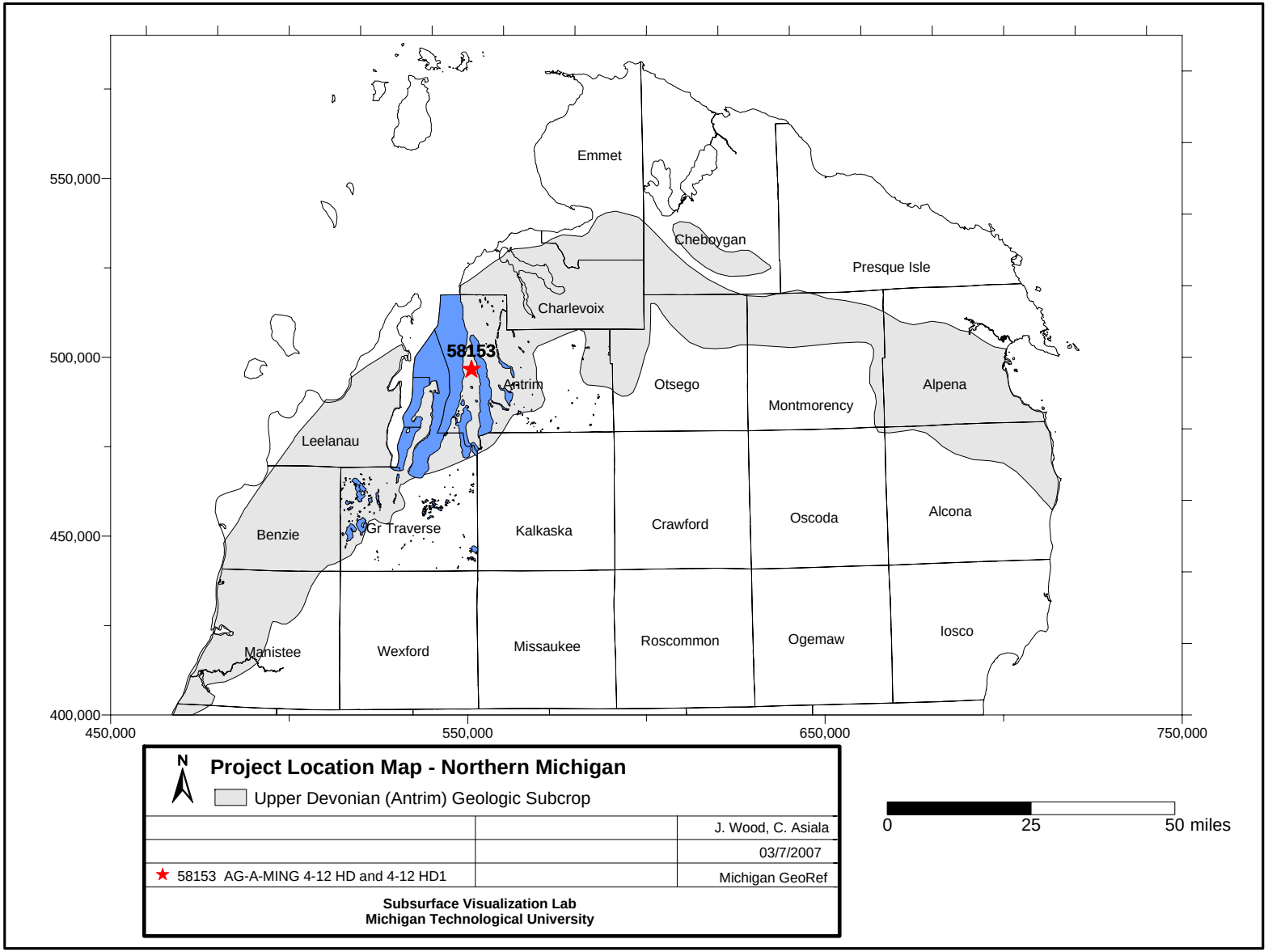


Figure 1. Location map of Northern Michigan. The project demonstration well, AG-A-MING 4-12HD, is designated by a red star, and the gray area is the geologic subcrop of the Upper Devonian which contains the Antrim.

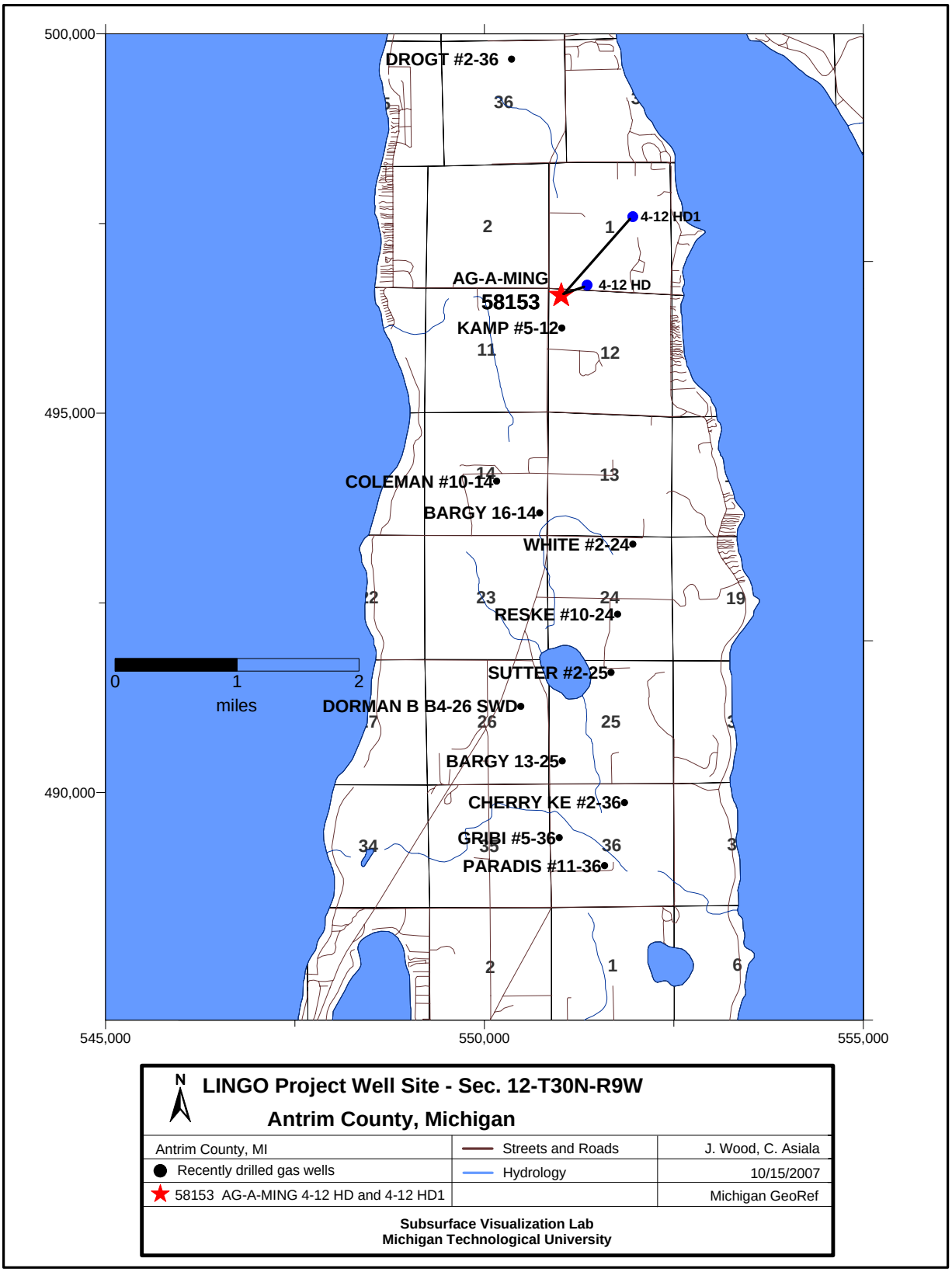


Figure 2. Location map showing planned horizontal laterals of demonstration well, AG-A-Ming 4-12HD and 4-12HD1. Other well locations are recently drilled vertical gas wells and one brine disposal well.

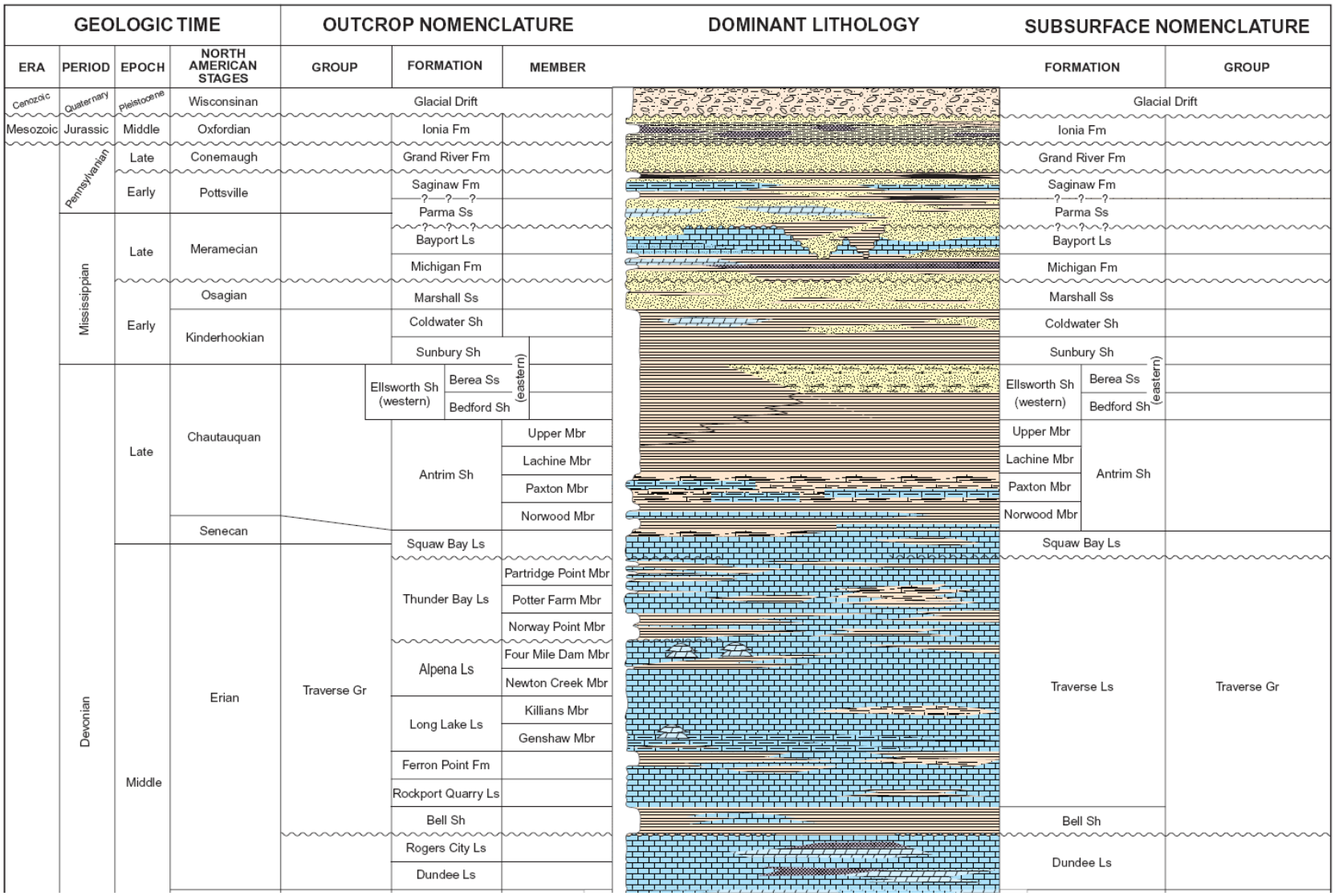


Figure 3. Subset of Michigan stratigraphic column from the Glacial Drift through the Dundee formation (Stratigraphic Nomenclature for Michigan, MI-DEQ).

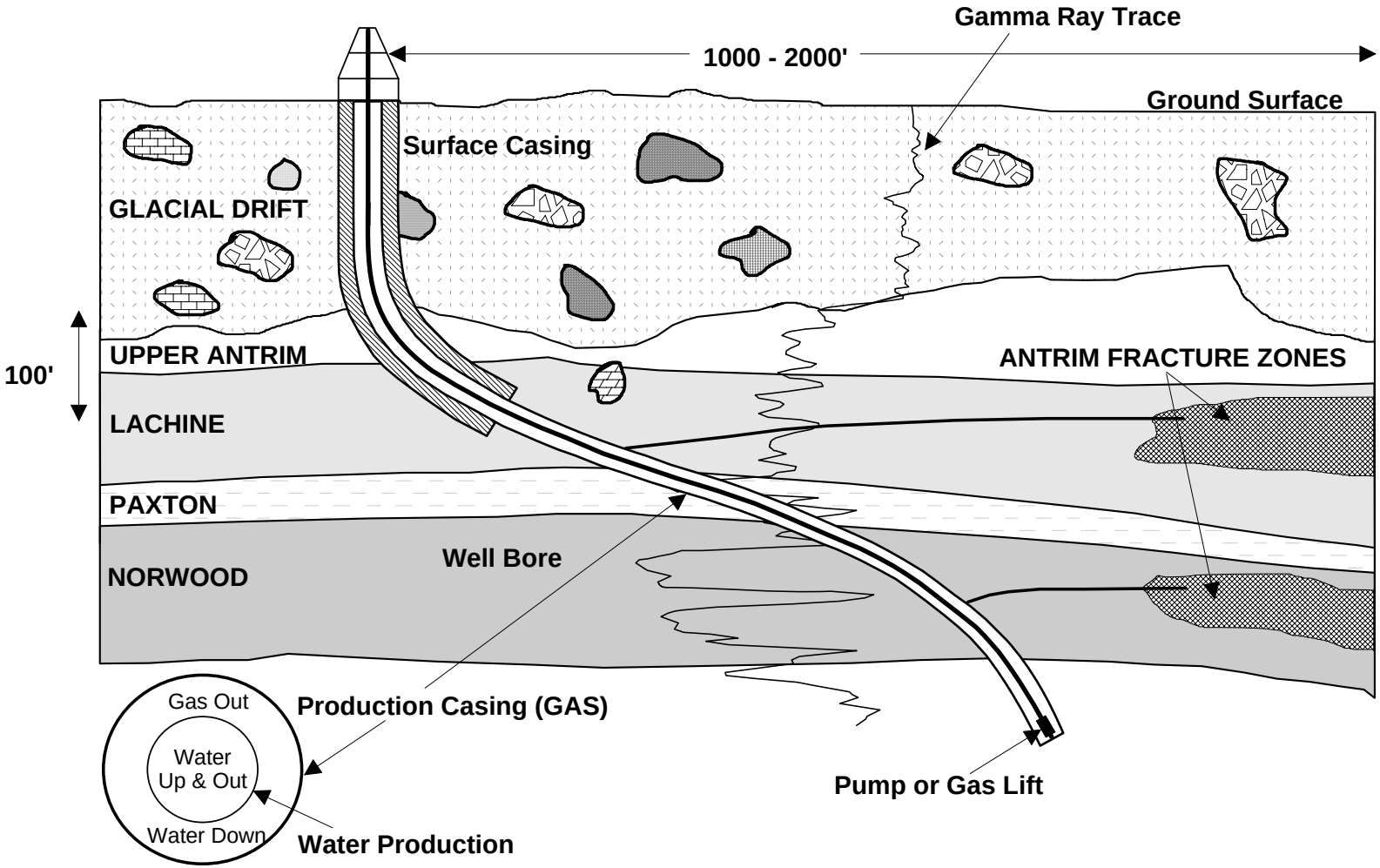
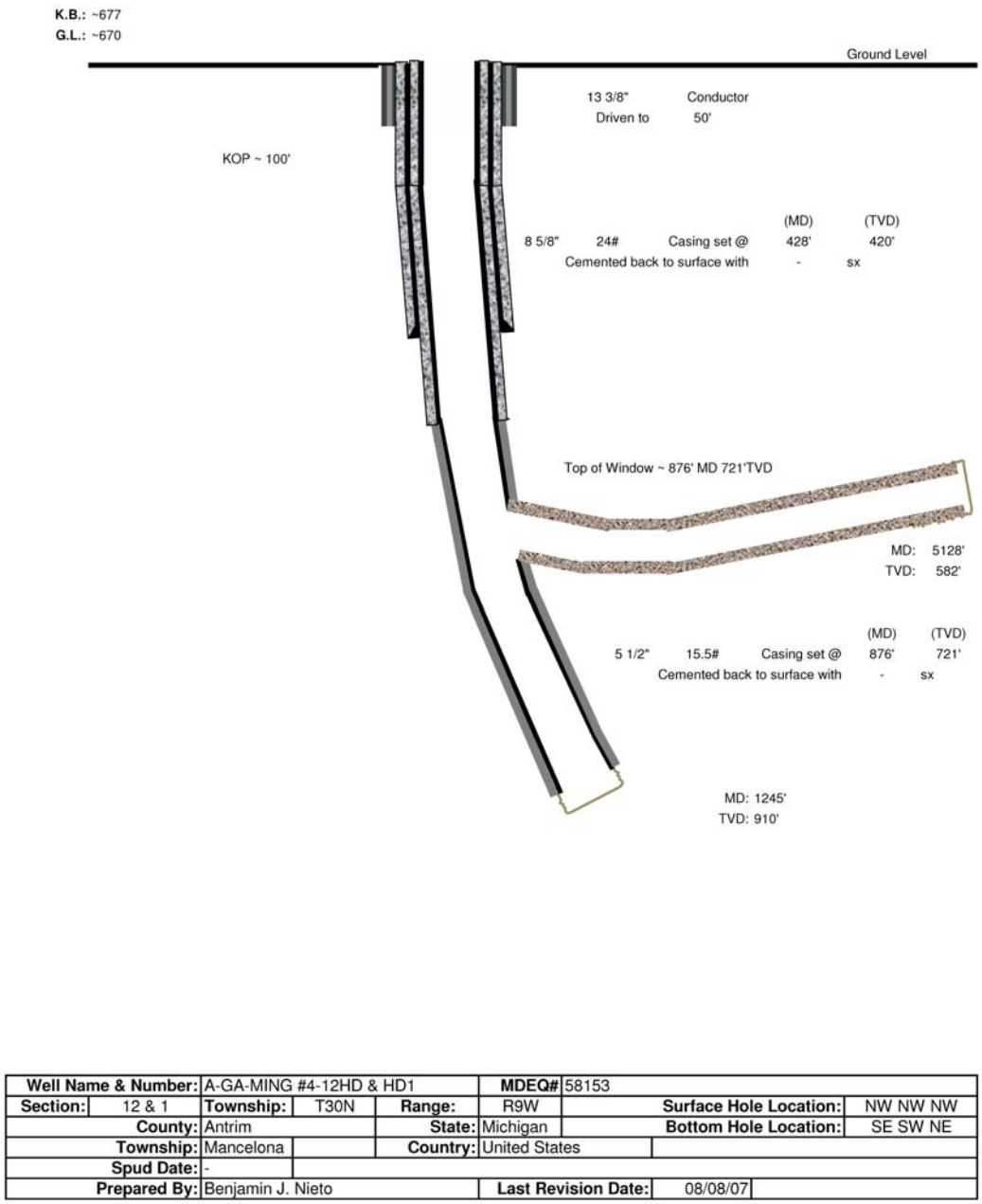


Figure 4. Schematic diagram illustrating the drilling plan to tap the shallow Antrim gas reserves using a slant well in place of a vertical well and casing it so that it satisfies Michigan regulatory statutes. Horizontal wells will branch out to the pay zones of the slant well. Note that the laterals can slope upward to drain water to the pump at the bottom of the slant well. Gas is produced in the outer tubing and goes directly to the surface. Water is drained to the bottom of the slant well and pumped up the inner annulus. The gamma ray log illustrates the highly variable nature of the radioactivity in the Antrim which can be used to locate and guide the drill bit using MWD (Measurement While Drilling) technology.



Well Name & Number:	A-GA-MING #4-12HD & HD1			**MDEQ#**	58153		
Section:	12 & 1	**Township:**	T30N	**Range:**	R9W	**Surface Hole Location:**	NW NW NW
County:	Antrim			**State:**	Michigan	**Bottom Hole Location:**	SE SW NE
Township:	Mancelona			**Country:**	United States		
Spud Date:	-						
Prepared By:	Benjamin J. Nieto			**Last Revision Date:**	08/08/07		

Figure 5. Well bore schematic of the A-GA-MING demonstration well located in the Milton-Bradley project in western Antrim County, MI.

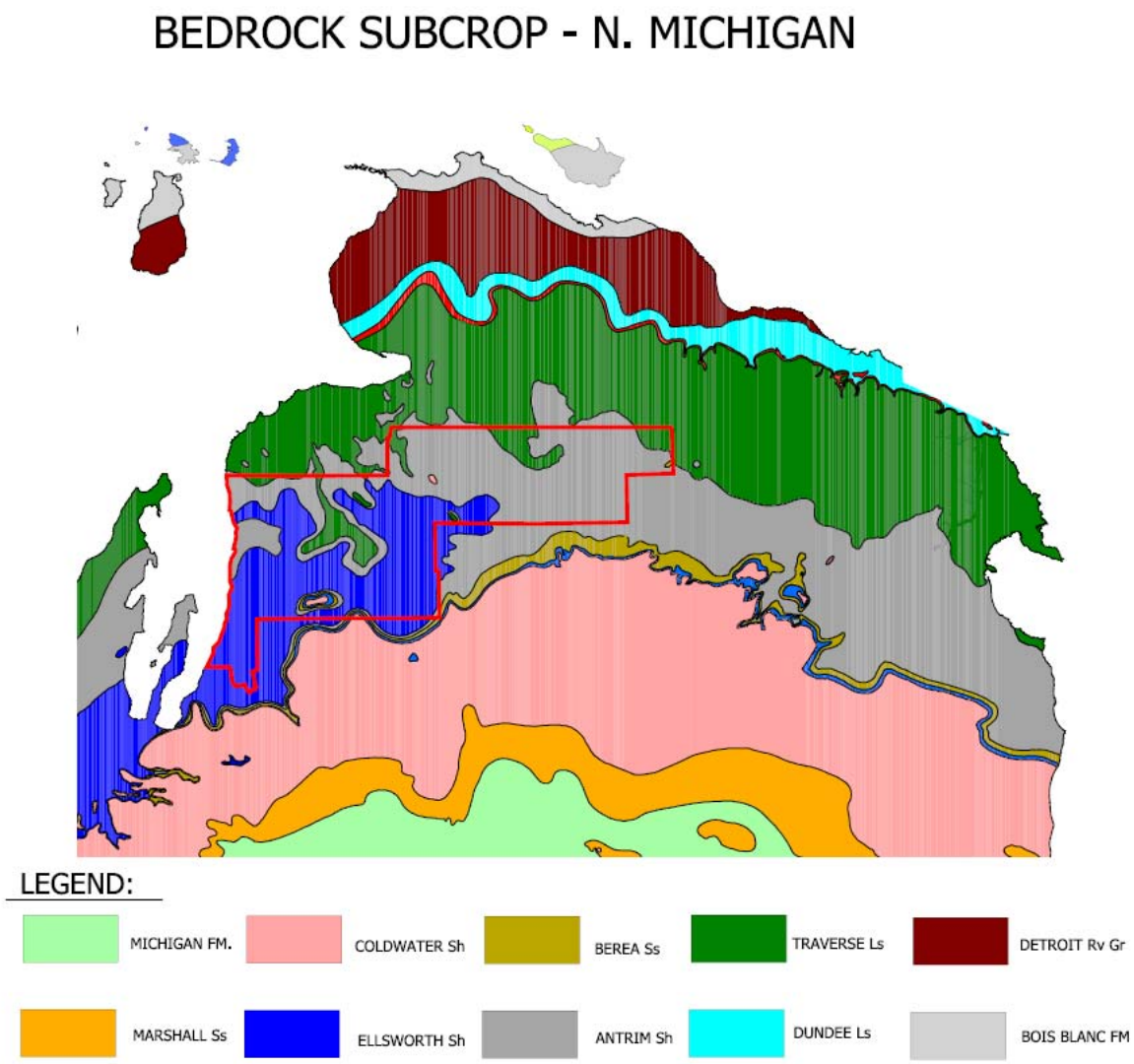


Figure 6. Bedrock subcrop map of Northern Michigan developed by the Michigan Department of Environmental Quality. The gray area depicting the Antrim Shale is an indication of the area which could be expanded for gas exploration upon the success of this project.

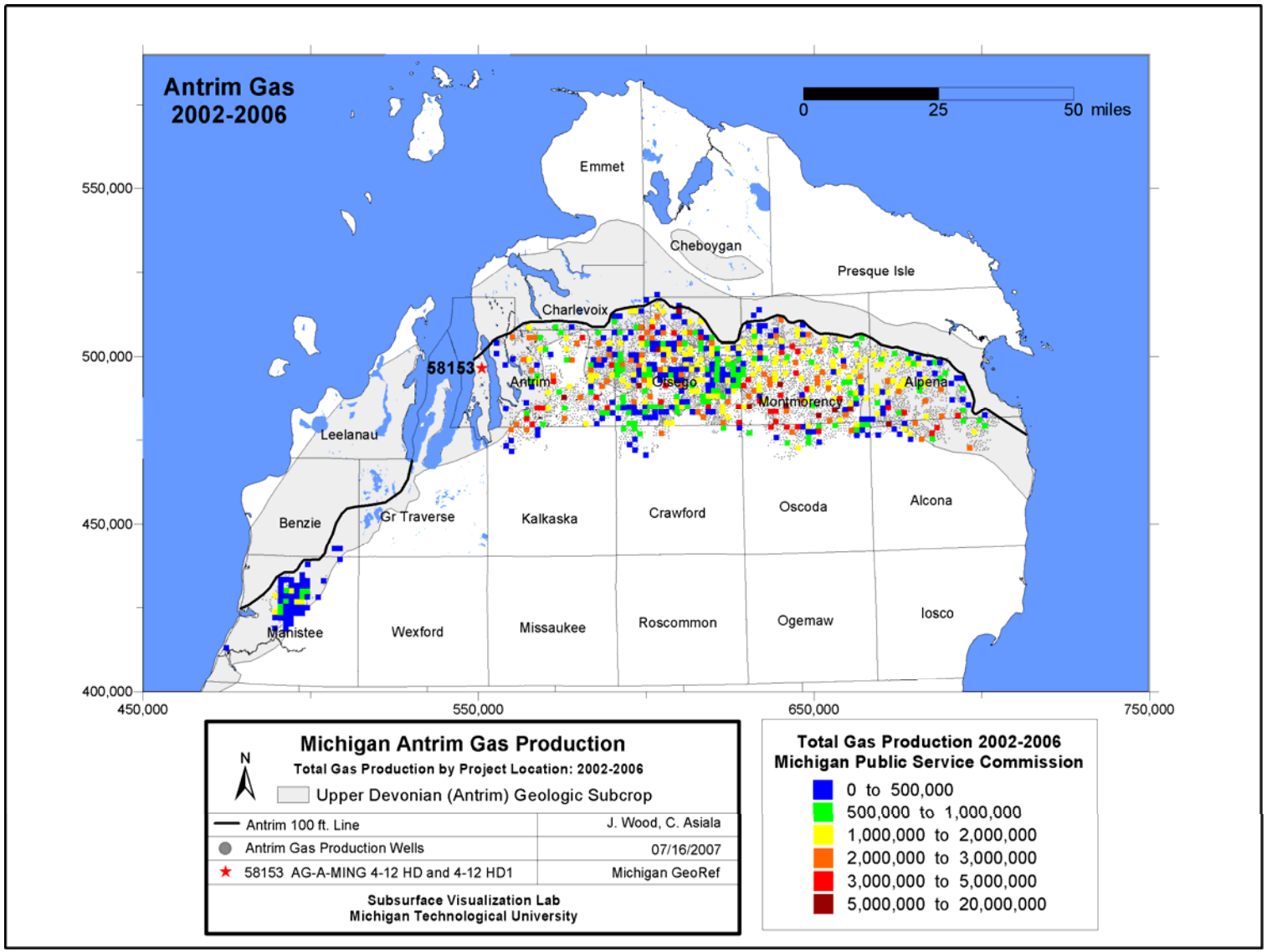


Figure 7. Five-year Antrim gas production map of Northern Michigan. The gray shaded area is the Antrim subcrop and the black line indicates the cutoff line of where production is limited because of the I-94 drilling restriction (Appendix I). The gray area above this line shows the area of the Antrim that could be opened up for Antrim gas production through the efforts of this DOE project.

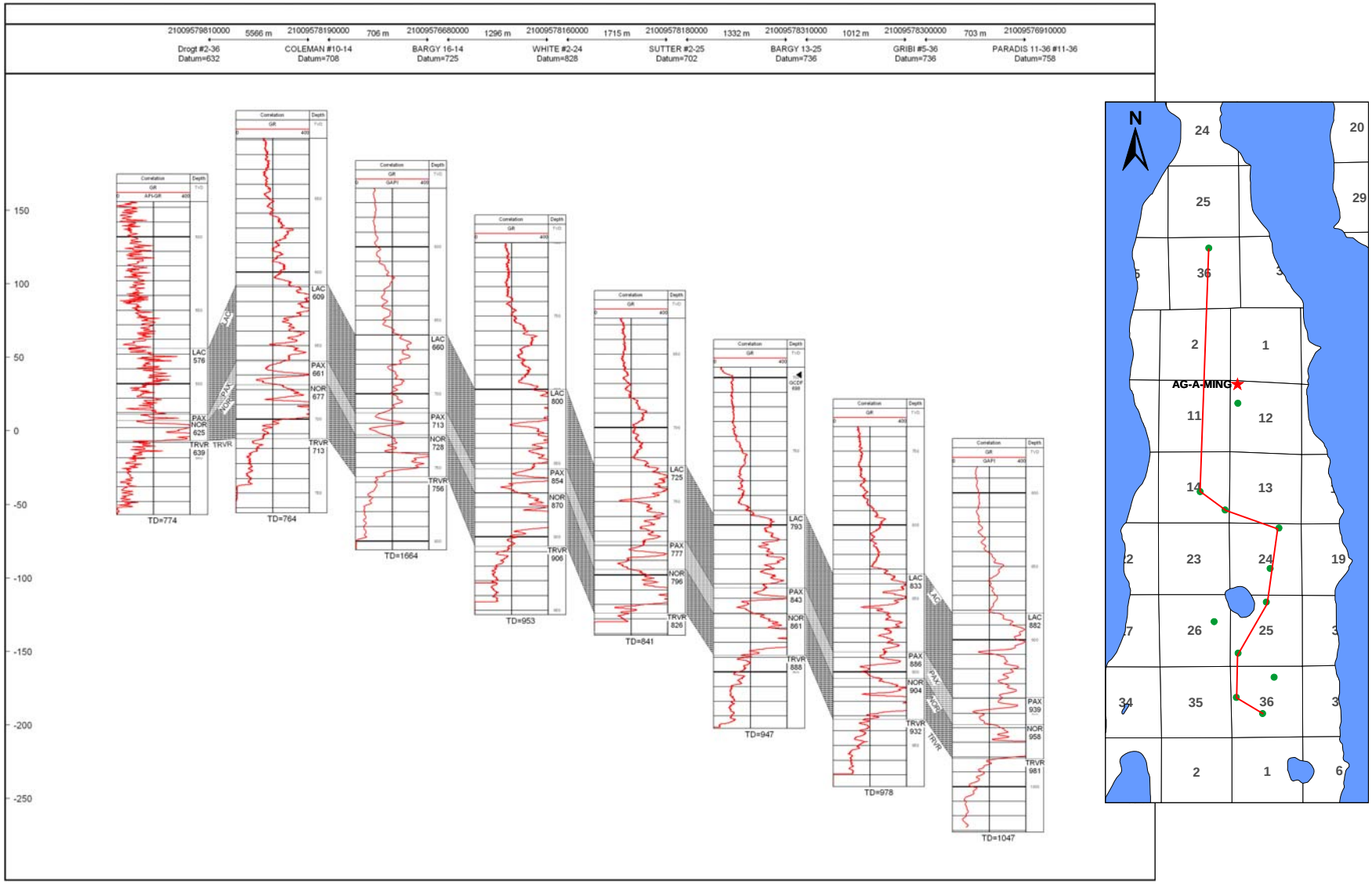


Figure 8. North-South cross section of the wells drilled in the vicinity of the demonstration well showing the interval of 100 feet above the Lachine formation to 50 feet below the Traverse.

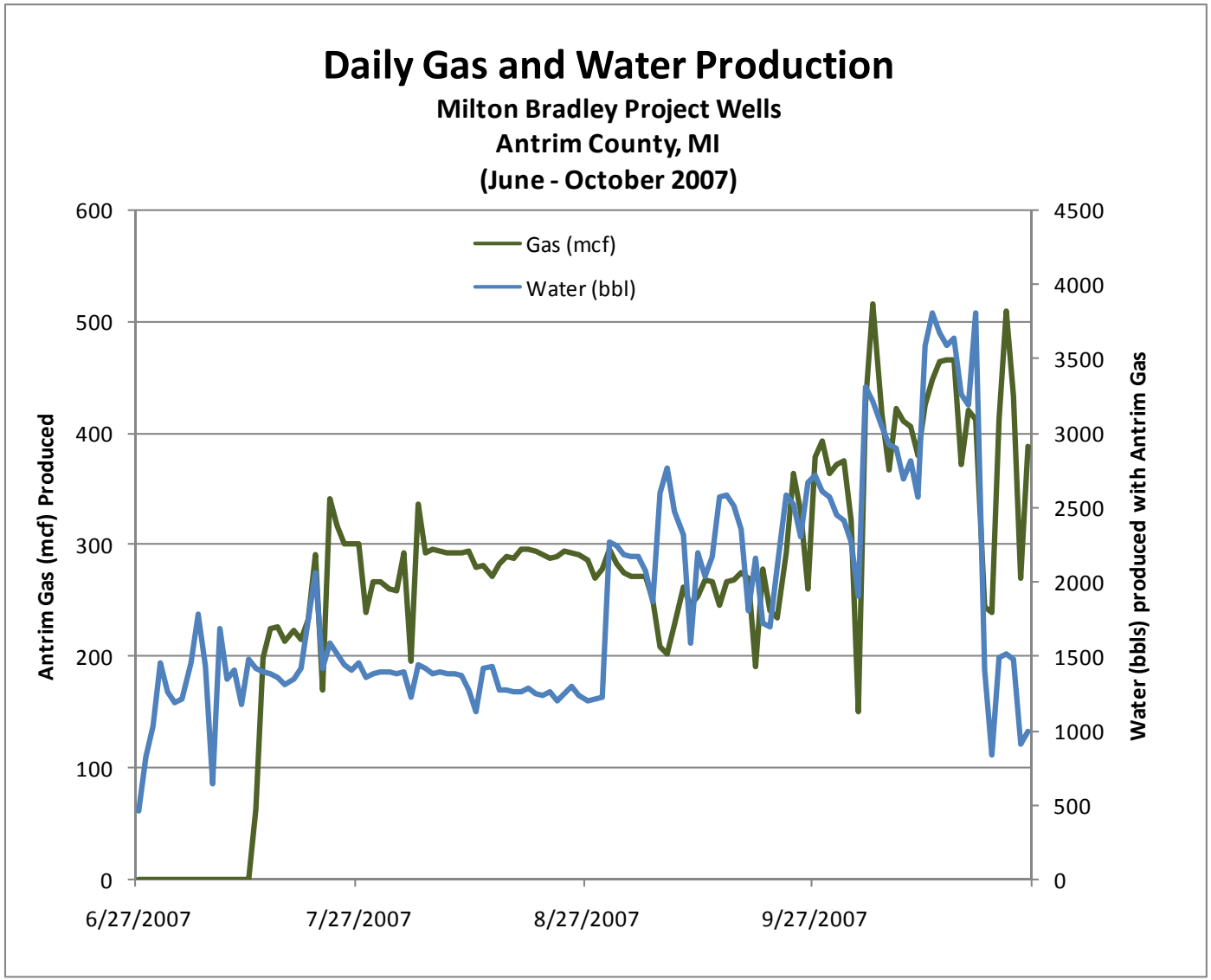


Figure 9. Antrim gas and water produced with Antrim gas from the vertical wells in the vicinity of the LINGO project demonstration well. Five wells were online by September 1st, and ten wells were online by the beginning of October. (Actual production values are presented in Appendix II. Demonstration Well).

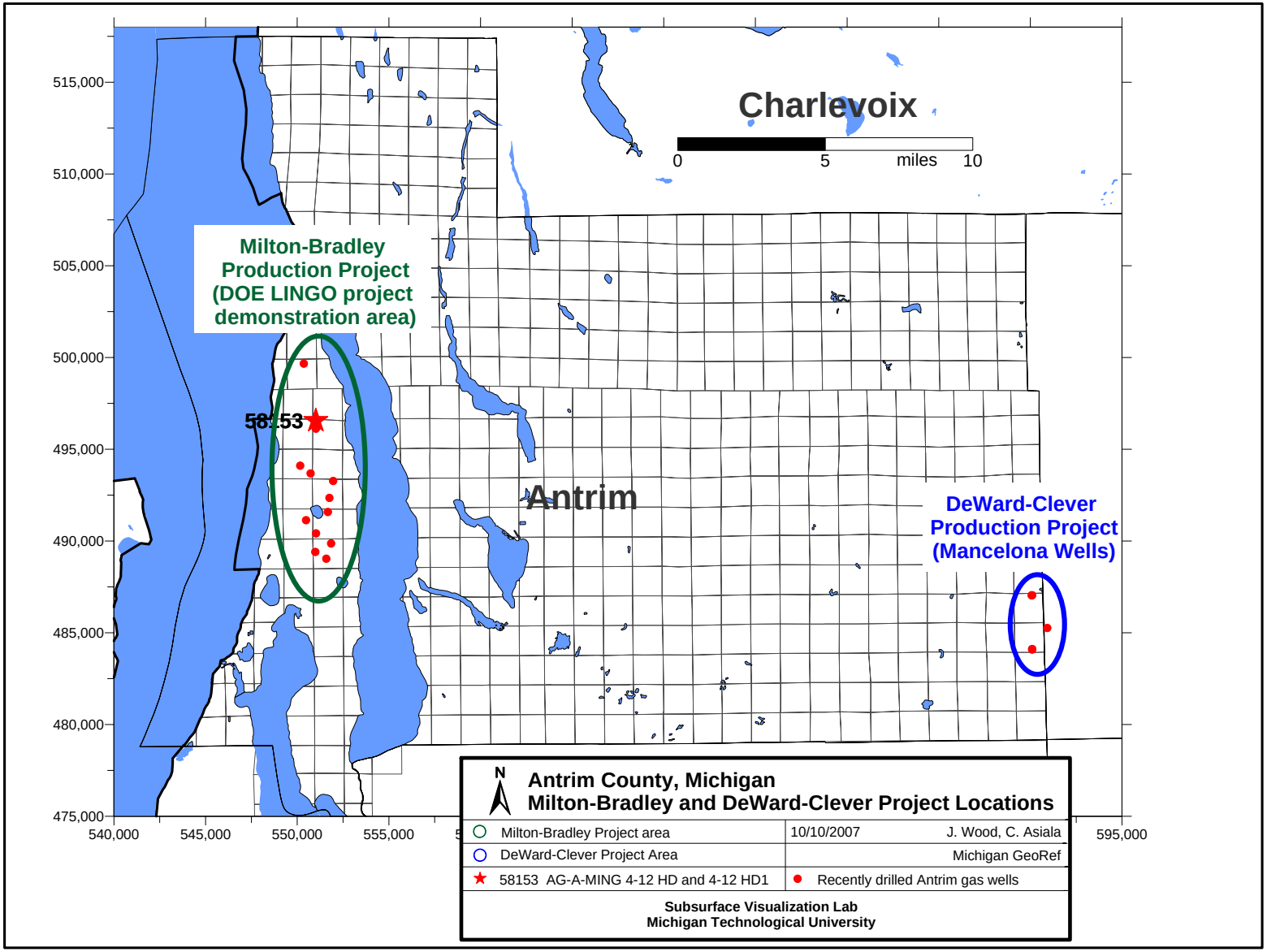


Figure 10. Location map comparing the locations of the DOE LINGO project area, Milton-Bradley, to the DeWard-Clever project area, where the "J" well configuration for the horizontal wells has been put to practice.

14. APPENDIX I. State Casing Statute Instruction 1-94

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

SUPERVISOR OF WELLS INSTRUCTION 1-94
CERTIFICATION OF CASING AND SEALING OF SURFACE CASING

INTRODUCTION

The Supervisor of Wells Act, 1939 PA 61, as amended (Act 61), prohibits oil field practices which may cause pollution, damage to or destruction of fresh water supplies. The purpose of these instructions is to further ensure the protection of fresh ground water. For all wells drilled pursuant to Act 61 after the effective date of these instructions, the Supervisor of Wells will require that a knowledgeable geologist or mud logger determine the proper depth to set surface casing to ensure that the casing will properly seal and protect all fresh water aquifers. The following requirements are issued in conjunction with and in addition to the provisions of Rule 301, 302, 303, 306, and 309 of the Rules promulgated pursuant to Act 61 (Rules), Supervisor's Instruction No. 1-87 (S.I. 1-87) and Special Order No. 2-73, amended (S.O. 2-73). This Instruction shall become effective January 15, 1994.

INSTRUCTION

1. Casing shall be run from the surface to a depth no less than:

   a. 100 feet into competent bedrock and
   b. 100 feet below all fresh water aquifers occurring below the glacial drift.

The casing shall be cemented in accordance with the Rules, S.O. 2-73, S.I. 1-87, and Supervisor of Wells requirements.

2. Each application and permit to drill shall provide geologic and depth information necessary to comply with the surface casing requirements stated in #1 above.

3. A knowledgeable geologist or mud logger on site shall determine the proper depth as provided in item #1 at which to set surface casing. To further ensure the protection of fresh ground water supplies, the running of casing and the cementing operation shall be supervised by the drilling rig tool pusher and/or a qualified representative of the permittee.

4. The geologist or mud logger shall enter into the drilling rig daily log book the following:

   a. The depth to bedrock.
   b. The base of other fresh water aquifers as specified by the permit to drill.
   c. The total depth of the surface casing hole.
   d. The signature and name of the geologist/mud logger.

5. The drilling rig tool pusher or qualified representative of the permittee shall enter in the drilling rig daily log book the following:

   a. Depth where surface casing was set.
   b. Amount and volume of cement used.
   c. Amount and volume of cement circulated to surface.
   d. Amount and volume of additional cement used if grouted.
   e. Any problems encountered while running or cementing the surface casing.
   f. The signature and name of the person certifying this information.

6. Within thirty days of the completion of the drilling operation, the permittee of the drilling operation shall furnish a certification of the proper sealing and protection of fresh water aquifers on a form prescribed by the Supervisor of Wells. The certification shall be signed by the geologist or mud logger who determined the depth to set the surface casing and by the permittee or a company officer. The certification shall describe any unusual hole conditions or problems encountered during the drilling or while running or cementing the casing.

Date: 12/15/93

R. Thomas Segall

R. THOMAS SEGALL
ASSISTANT SUPERVISOR OF WELLS

15. APPENDIX II. Demonstration Well

Appendix Figure 15-1. Directional drilling survey showing 240-acre spacing and slant of horizontal lateral.

Appendix Figure 15-2. Well bore schematic of project demonstration well.

Appendix Table 15-2. Production log for the Milton-Bradley project vertical wells. This table shows daily production for all wells in the production unit with monthly totals and daily averages on each page.

15.1 Well Drilling Acronym List

BOD	Base of Drift
CBL	Cement Bond Log
CCL	Casing Collar Log
CIBP	Cast Iron Bridge Plug
CSG	Casing
DDC	Directional Drilling Contractors
ESP	Electrical Submersible Pump
KCL	Potassium Chloride
KOP	Kick Off Point
LT&C	Long Threads and Collars
MIRU	Move In and Rig Up
MWD	Measurement While Drilling
MWL	Measurement Wire Line
PBTD	Plug Back Total Depth
RD	Rig Down
RU	Rig Up
TD	Total Depth
TIH	Trip In Hole
TOH	Trip Out of Hole
TVD	True Vertical Depth

15.2 Jordan Development Drilling Plan for Demonstration Well

A-GA-MING #4-12HD
DRILLING PROGNOSIS
(March 7, 2007)

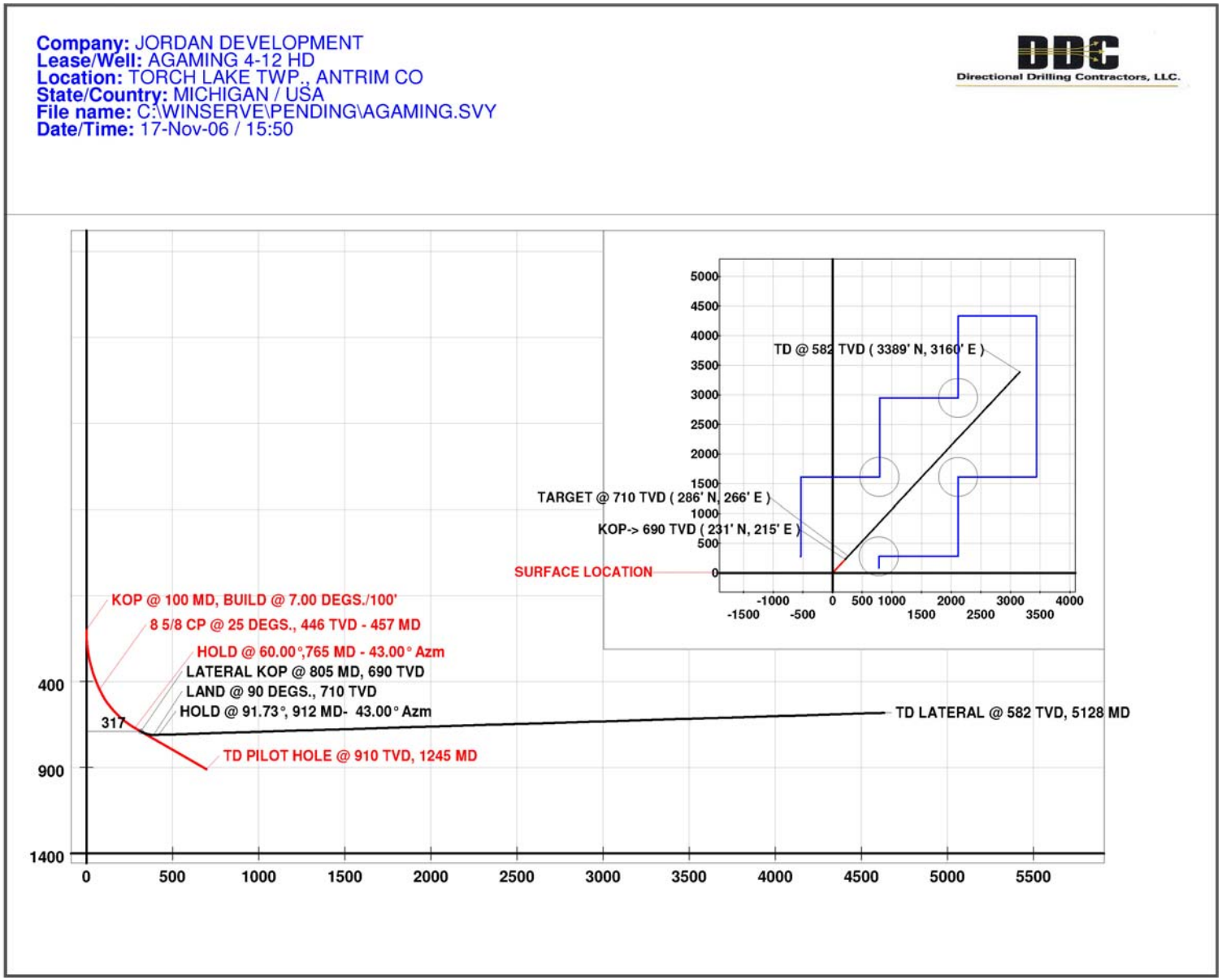
---

1. MIRU.
2. Drill 12-1/4" hole to KOP at approximately 100'.
3. RU DDC. TIH with directional tools to drill surface hole ahead to an angle of approximately 23 degrees at surface casing point (projected to approximately 430' with BOD at approximately 320').
   Land pipe as close to minimum set depth requirement as possible to conserve TVD which will be required to build needed angle below surface CSG.
4. Run 32# J-55 8-5/8" CSG to TD and cement to surface.
5. Drill out cement and shoe.
6. TIH with directional tools and 7-7/8" bit. Test CSG and shoe.
7. RU Geologist.
8. Drill ahead on Pilot Hole in accordance with directional drilling plan, building to an angle across the Lachine and Norwood of approximately 65 degrees.
   Drill to a TVD depth of approximately 850' TVD to allow at least 100' TVD of sump to set production pump. TOH.
9. Run 5-1/2" 15.5# J-55 LT&C CSG to TD and cement to surface.
10. RU MWL. Run Gauge Ring to PBTD.
11. Run Gamma/CCL/CBL. RD MWL
12. TIH with DP and CIBP and set for combined Norwood and Lachine leg. TOH.
13. RU Baker. TIH with Whipstock and one trip milling system.
14. Orient Whipstock with MWD and set. Mill Window section.
15. TOH and lay down mills. RD Baker.
16. Circulate hole clean with 3% KCL mud.
16. TIH with 4-3/4" bit and motor and cut curve, landing at the base of the Norwood.
17. TOH.
18. TIH with motor and drill ahead on combined Norwood/Lachine lateral section in accordance with directional plan. Some inclination will also be required to compensate for rise in formation dip in the northerly direction.

    Above all, the entire lateral should be drilled at an incline to allow produced fluid to drain back to the heel during production

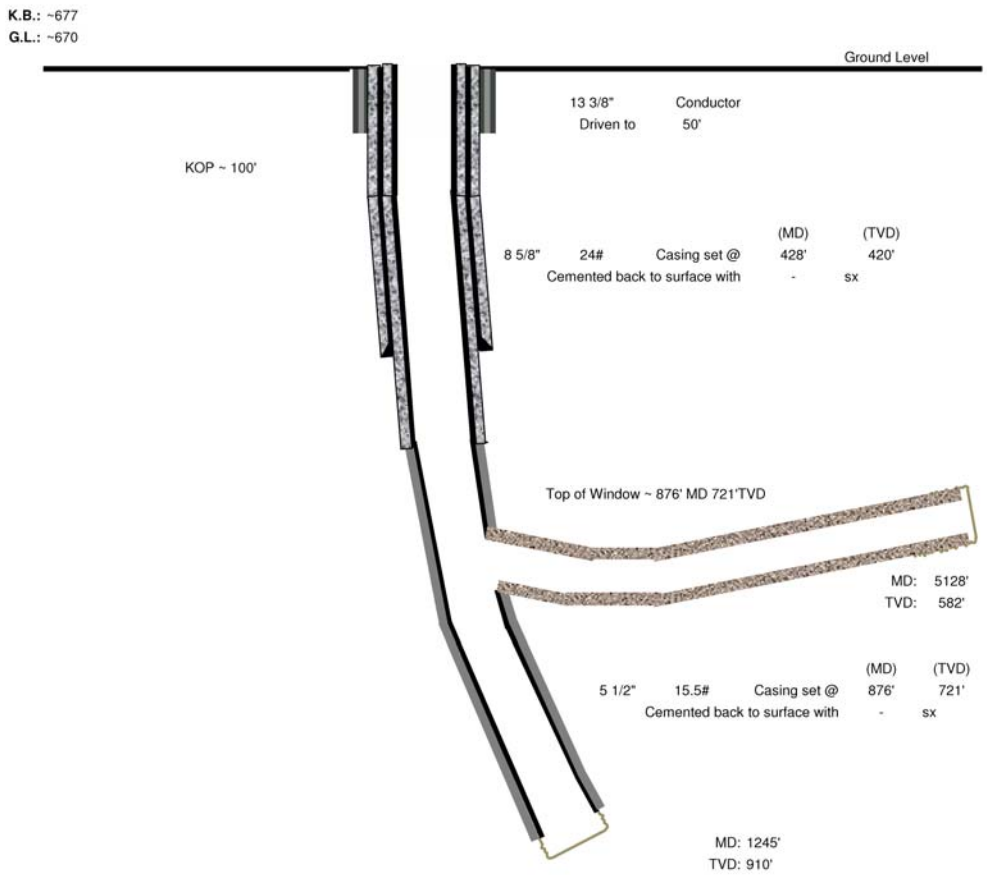
19. Circulate hole clean. Pump out of hole to remove any remaining cuttings. TOH.
20. TIH with 45 degree circulating sub. Rotate and wash to TD. Pump out of hole.

21. Make up retrieving tools. TIH and retrieve Whipstock. TOH.
22. TIH with bit. Drill up CIBP and chase to TD.
23. TOH.
24. TIH with ESP.
25. RD. Release Rig.



Appendix Figure 15-1. Directional drilling survey showing 240-acre spacing and slant of horizontal lateral.

A-GA-MING #4-12HD & HD1



Well Name & Number:	A-GA-MING #4-12HD & HD1			**MDEQ#**	58153		
Section:	12 & 1	**Township:**	T30N	**Range:**	R9W	**Surface Hole Location:**	NW NW NW
County:	Antrim			**State:**	Michigan	**Bottom Hole Location:**	SE SW NE
Township:	Mancelona			**Country:**	United States		
Spud Date:	-						
Prepared By:	Benjamin J. Nieto			**Last Revision Date:**	08/08/07		

Appendix Figure 15-2. Well bore schematic of project demonstration well.

Appendix Table 15-3. Production log for the Milton-Bradley project vertical wells. This table shows daily production for all wells in the production unit with monthly totals and daily averages on each page.

JORDAN DEVELOPMENT COMPANY, L.L.C.
DAILY REPORT

FACILITY: MILTON BRADLEY CENTRAL
MONTH: June, 2007

											Compressor 1				*Compressor 2*				
Date	Gas (mcf)	Water (bbl)	Lift Gas	Fuel Gas	FLP Tbg	FLP Csg	Sep psi	Wells On	Wells Pump	Wells Lift	Run Time	Init Suct	Final Disch	Compr (rpm)	Run Time	Init Suct	Final Disch	Compr (rpm)	Comments
6/27/2007	0	460	174	39	10	0	0.0	2		2	12.0	0.5	600	880					Online 6/26/07 6:00p
6/28/2007	0	821	278	39	10	0	0.0	2		2	16.0	0.5	500	750					
6/29/2007	0	1,035	287	67	10	0	0.0	2		2	18.0	0.5	960	750					Purged north lines.
6/30/2007	0	1,454	538	47	10	0	0.0	2		2	18.0	0.5	600	750					
Total:	0	3,770	1,277	192															
Avg:	0	943	319	48	10	0	0.0	2		2	16.0	0.5	665	783					

JORDAN DEVELOPMENT COMPANY, L.L.C.
DAILY REPORT

FACILITY: **MILTON BRADLEY CENTRAL**
MONTH: **July, 2007**

											Compressor 1				Compressor 2				
Date	Gas (mcf)	Water (bbl)	Lift Gas	Fuel Gas	FLP Tbg	FLP Csg	Sep psi	Wells On	Wells Pump	Wells Lift	Run Time	Init Suct	Final Disch	Compr (rpm)	Run Time	Init Suct	Final Disch	Compr (rpm)	Comments
7/1/2007	0	1,264	427	71	10	2	2.0	2		2	24.0	0.5	600	725					
7/2/2007	0	1,188	232	54	10	2	2.0	4		4	17.0	0.5	300	725					Out of gas.
7/3/2007	0	1,210	544	58	10	2	2.0	4		4	24.0	0.5	400	725					
7/4/2007	0	1,453	725	64	10	2	2.0	4		4	24.0	0.5	800	725					
7/5/2007	0	1,787	935	69	10	2	2.0	4		4	24.0	0.5	800	725					
7/6/2007	0	1,437	499	70	10	2	2.0	4		4	24.0	0.5	820	725					
7/7/2007	0	646	441	72	10	2	2.0	4		4	22.5	0.5	900	870					SWD pump vibrator.
7/8/2007	0	1,682	324	70	10	2	2.0	4		4	24.0	0.5	1,000	825					
7/9/2007	0	1,341	302	75	10	2	2.0	4		4	24.0	0.5	1,046	825					
7/10/2007	0	1,405	336	73	10	2	2.0	4		4	24.0	0.5	1,045	825					
7/11/2007	0	1,171	323	65	10	2	2.0	4		4	21.0	0.5	1,042	840					Comp oil psi.
7/12/2007	0	1,484	583	79	10	2	2.0	4		4	24.0	0.5	1,044	840					
7/13/2007	63	1,415	596	87	10	2	2.0	4		4	24.0	0.5	1,046	875					Payback gas comple
7/14/2007	198	1,394	532	78	10	2	2.0	4		4	24.0	0.5	1,042	840					
7/15/2007	225	1,382	582	79	10	2	2.0	4		4	24.0	0.5	1,045	845					
7/16/2007	226	1,363	596	79	10	2	2.0	4		4	24.0	0.5	1,046	860					
7/17/2007	213	1,306	594	80	10	2	2.0	4		4	24.0	0.5	1,047	850					
7/18/2007	223	1,346	592	79	10	2	2.0	4		4	24.0	0.5	1,042	855					
7/19/2007	214	1,422	780	79	10	2	2.0	4		4	24.0	0.5	1,065	855					
7/20/2007	233	1,741	826	94	10	2	2.0	4		4	24.0	0.5	1,060	870					
7/21/2007	290	2,058	1,036	102	11	3	3.0	4		4	24.0	2.0	1,058	960					
7/22/2007	169	1,421	1,030	109	85	85	85.0	4		4	24.0	5.0	1,047	970					Comp dump hung op
7/23/2007	340	1,591	877	110	10	2	2.0	4		4	24.0	0.5	1,046	1,045					
7/24/2007	316	1,515	983	113	10	2	2.0	4		4	24.0	0.5	1,043	1,080					
7/25/2007	300	1,445	875	112	10	2	2.0	4		4	24.0	0.5	1,046	1,080					
7/26/2007	300	1,412	856	107	10	2	2.0	4		4	24.0	0.5	1,045	1,080					
7/27/2007	301	1,457	922	110	10	2	2.0	4		4	24.0	0.5	1,040	1,050					Meters recalibrated.
7/28/2007	239	1,360	824	110	10	2	2.0	4		4	24.0	0.5	1,042	1,050					Cutback lift, using m
7/29/2007	266	1,382	772	86	10	1	1.0	4		4	24.0	0.5	1,042	950					
7/30/2007	266	1,394	879	88	10	1	1.0	4		4	24.0	0.5	1,040	850					
7/31/2007	260	1,393	886	97	10	1	1.0	4		4	24.0	0.5	1,036	950					
Total:	4,642	43,865	20,709	2,619															
Avg:	150	1,415	668	84	12	5	4.6	4		4	23.6	0.7	957	880					

10/29/2007

JORDAN DEVELOPMENT COMPANY, L.L.C.
DAILY REPORT

FACILITY: MILTON BRADLEY CENTRAL
MONTH: August, 2007

Date	Gas (mcf)	Water (bbl)	Lift Gas	Fuel Gas	FLP Tbg	FLP Csg	Sep psi	Wells On	Wells Pump	Wells Lift	Compressor 1 Run Time	Compressor 1 Init Suct	Compressor 1 Final Disch	Compressor 1 Compr (rpm)	Compressor 2 Run Time	Compressor 2 Init Suct	Compressor 2 Final Disch	Compressor 2 Compr (rpm)	Comments
8/1/2007	258	1,379	892	98	10	2	2.0	4		4	24.0	0.5	1,040	960					O2 meter in for repai
8/2/2007	293	1,394	892	98	10	2	2.0	4		4	24.0	0.5	1,042	960					Meter factor correcte
8/3/2007	196	1,223	897	108	40	40	2.0	4		4	24.0	0.5	1,130	1,000					10hrs high line psi.
8/4/2007	335	1,445	892	104	10	2	2.0	4		4	24.0	0.5	1,030	1,000					
8/5/2007	293	1,415	895	102	10	2	2.0	4		4	24.0	0.5	1,045	1,000					
8/6/2007	296	1,378	898	103	10	2	2.0	4		4	24.0	0.5	1,042	1,000					
8/7/2007	294	1,390	895	102	10	2	2.0	4		4	24.0	0.5	1,044	1,000					RTU failure, lift, wate
8/8/2007	293	1,385	895	102	10	2	2.0	4		4	24.0	0.5	1,040	1,000					RTU failure, lift, wate
8/9/2007	293	1,380	880	104	10	2	2.0	4		4	24.0	0.5	1,045	1,000					
8/10/2007	292	1,369	887	102	10	2	2.0	4		4	24.0	0.5	1,050	1,000					
8/11/2007	294	1,273	886	101	10	2	2.0	4		4	24.0	0.5	1,040	1,000					
8/12/2007	279	1,125	734	86	10	2	2.0	4		4	22.0	0.5	1,042	980					Comp low suction.
8/13/2007	281	1,415	891	101	10	2	2.0	4		4	24.0	0.5	1,041	985					
8/14/2007	272	1,432	894	104	10	2	2.0	4		4	24.0	0.5	1,046	985					
8/15/2007	283	1,278	891	98	10	2	2.0	4		4	24.0	0.5	1,030	1,040					
8/16/2007	289	1,270	893	98	10	2	2.0	4		4	24.0	0.5	1,044	1,040					
8/17/2007	288	1,262	895	99	10	2	2.0	4		4	24.0	0.5	1,042	990					Chg V.C. in sales .79
8/18/2007	295	1,265	895	101	10	2	2.0	4		4	24.0	0.5	1,050	990					
8/19/2007	295	1,287	896	98	10	2	2.0	4		4	24.0	0.5	1,046	1,000					
8/20/2007	294	1,250	896	98	10	2	2.0	4		4	24.0	0.5	1,030	990					
8/21/2007	291	1,241	896	97	10	2	2.0	4		4	24.0	0.5	1,060	995					
8/22/2007	288	1,266	875	100	10	2	2.0	4		4	24.0	0.5	1,048	1,000					
8/23/2007	289	1,199	838	99	10	2	2.0	4		4	24.0	0.5	1,042	1,000					
8/24/2007	294	1,255	825	96	10	2	2.0	4		4	24.0	0.5	1,040	990					
8/25/2007	293	1,299	833	96	10	2	2.0	4		4	24.0	0.5	1,040	990					
8/26/2007	290	1,238	835	96	10	2	2.0	4		4	24.0	0.5	1,040	990					
8/27/2007	286	1,202	836	97	10	2	2.0	4		4	24.0	0.5	1,040	990					
8/28/2007	269	1,208	784	91	10	2	2.0	4		4	22.0	0.5	1,040	990					Comp Service.
8/29/2007	278	1,220	737	89	10	2	2.0	4		4	24.0	0.5	1,040	990					Comp Svc, Dorman
8/30/2007	296	2,268	1,033	111	10	3	3.0	5		5	24.0	0.5	1,040	1,050					
8/31/2007	282	2,246	1,084	117	10	2	2.0	5		5	22.0	0.5	1,040	1,120					Chg magneto.
Total:	8,869	42,257	27,270	3,096															
Avg:	286	1,363	880	100	11	3	2.0	4		4	23.8	0.5	1,045	1,001					

10/29/2007

JORDAN DEVELOPMENT COMPANY, L.L.C.
DAILY REPORT

FACILITY: **MILTON BRADLEY CENTRAL**
MONTH: **September, 2007**

											Compressor 1				*Compressor 2*				
Date	Gas (mcf)	Water (bbl)	Lift Gas	Fuel Gas	FLP Tbg	FLP Csg	Sep psi	Wells On	Wells Pump	Wells Lift	Run Time	Init Suct	Final Disch	Compr (rpm)	Run Time	Init Suct	Final Disch	Compr (rpm)	Comments
9/1/2007	275	2,179	1,109	124	10	2	2.0	5		5	24.0	0.5	1,040	1,080					
9/2/2007	272	2,173	1,154	123	10	2	2.0	5		5	24.0	0.5	1,030	1,080					
9/3/2007	271	2,169	1,113	123	10	2	2.0	5		5	24.0	0.5	1,050	1,090					
9/4/2007	272	2,072	1,097	123	10	2	2.0	5		5	24.0	0.5	1,047	1,080					
9/5/2007	250	1,873	996	110	13	5	5.0	5		5	21.0	0.5	1,042	1,120					SWD pump failure, C
9/6/2007	208	2,597	1,226	115	13	5	5.0	6		6	22.0	3.0	1,040	1,175					New well tie-in.
9/7/2007	201	2,763	1,375	132	12	5	5.0	6		6	24.0	3.0	1,045	1,175					
9/8/2007	227	2,469	1,315	130	12	5	5.0	6		6	24.0	3.0	1,043	1,175					
9/9/2007	261	2,318	1,291	131	12	5	5.0	6		6	24.0	3.0	1,040	1,175					
9/10/2007	246	1,590	1,030	107	11	5	5.0	6		6	21.0	3.0	1,045	1,170					Hi-temp, repl 3 spark
9/11/2007	253	2,196	1,168	124	12	5	5.0	6		6	20.0	3.0	1,042	1,175					Repl magneto & spar
9/12/2007	268	2,042	1,305	127	11	5	5.0	6		6	22.0	3.0	1,038	1,175					Power failure.
9/13/2007	267	2,169	1,176	126	11	5	5.0	6		6	24.0	3.0	1,035	1,177					Sutter #2-25 online 5
9/14/2007	245	2,577	1,253	120	11	4	4.0	7		7	24.0	3.0	1,035	1,180					New well tie-in, 3 wel
9/15/2007	267	2,582	1,372	133	12	5	5.0	7		7	24.0	3.0	1,038	1,180					
9/16/2007	268	2,515	1,379	133	12	5	5.0	7		7	24.0	4.0	1,035	1,180					
9/17/2007	274	2,357	1,375	133	12	5	5.0	7		7	24.0	4.0	1,038	1,180					
9/18/2007	269	1,813	1,158	114	11	5	5.0	7		7	22.0	4.0	1,042	1,180					White #2-24 online 5
9/19/2007	190	2,160	1,227	114	11	5	5.0	8		8	24.0	4.0	1,046	1,180					New well tie-in, 5 wel
9/20/2007	277	1,722	1,149	122	11	5	5.0	8		8	24.0	4.0	1,048	1,180					Booster, Comp tie-in.
9/21/2007	240	1,701	1,092	115	11	5	5.0	8	1	7	19.0	4.0	1,042	1,180					Booster, Comp tie-in.
9/22/2007	234	2,104	880	100	11	3	3.0	8	1	7	18.0	2.0	1,038	1,180					Comp equip problem
9/23/2007	293	2,582	1,163	131	11	4	4.0	8	1	7	24.0	3.0	1,044	1,180					
9/24/2007	363	2,522	1,195	135	20	4	4.0	8	1	7	24.0	3.0	1,046	1,180					
9/25/2007	329	2,302	1,116	129	20	4	4.0	8	1	7	22.0	3.0	1,038	1,180					New well Tie-in, Para
9/26/2007	260	2,674	1,464	146	20	4	4.0	9	1	8	24.0	3.0	1,046	1,175					Cont tie-in.
9/27/2007	377	2,719	1,356	159	20	3	3.0	9	1	8	22.0	2.0	1,052	1,175					Exhaust temp, repl s
9/28/2007	392	2,614	1,354	153	20	2	2.0	9	1	8	24.0	1.5	1,043	1,175					
9/29/2007	363	2,573	1,324	145	20	2	2.0	9	1	8	24.0	1.0	1,039	1,180					
9/30/2007	372	2,445	1,309	152	20	2	2.0	9	1	8	24.0	1.0	1,044	1,180					
Total:	8,284	68,572	36,521	3,829															
Avg:	276	2,286	1,217	128	13	4	4.0	7	1	7	23.0	2.5	1,042	1,163					

10/29/2007

JORDAN DEVELOPMENT COMPANY, L.L.C.
DAILY REPORT

FACILITY: **MILTON BRADLEY CENTRAL**
MONTH: **October, 2007**

											Compressor 1				Compressor 2				
Date	Gas (mcf)	Water (bbl)	Lift Gas	Fuel Gas	FLP Tbg	FLP Csg	Sep psi	Wells On	Wells Pump	Wells Lift	Run Time	Init Suct	Final Disch	Compr (rpm)	Run Time	Init Suct	Final Disch	Compr (rpm)	Comments
10/1/2007	375	2,413	1,282	153	20	2	2.0	9	1	8	24.0	1.0	1,042	1,170					
10/2/2007	321	2,273	1,268	149	20	2	2.0	9	1	8	22.0	1.0	1,038	1,180					Well tie-in, Cullimore
10/3/2007	150	1,899	1,323	123	20	2	2.0	10	1	9	24.0	1.0	1,033	1,180					
10/4/2007	426	3,312	1,539	149	20	2	2.0	10	1	9	24.0	1.0	1,046	1,180					
10/5/2007	515	3,221	1,446	153	20	2	2.0	10	1	9	24.0	1.0	1,040	1,180					
10/6/2007	417	3,016	1,276	141	20	2	2.0	10	1	9	24.0	1.0	1,047	1,180					
10/7/2007	367	2,918	1,206	135	20	2	2.0	10	1	9	24.0	0.5	1,072	1,180					
10/8/2007	421	2,902	1,257	131	20	2	2.0	10	1	9	24.0	0.5	1,044	1,180					Hi-temp.
10/9/2007	410	2,694	1,030	128	20	2	2.0	10	1	9	24.0	0.5	1,070	1,180					
10/10/2007	406	2,811	1,087	124	20	2	2.0	10	1	9	24.0	0.5	1,060	1,120					Rig on location.
10/11/2007	379	2,572	1,036	121	20	2	2.0	10	1	9	24.0	0.5	1,065	1,120					
10/12/2007	425	3,586	1,060	120	20	2	2.0	10	2	8	24.0	0.5	1,038	1,120					
10/13/2007	447	3,808	1,069	128	20	2	2.0	10	2	8	24.0	0.5	1,042	1,160					
10/14/2007	464	3,682	1,071	133	20	2	2.0	10	2	8	24.0	0.5	1,100	1,170					
10/15/2007	465	3,586	1,123	135	20	2	2.0	10	2	8	24.0	0.5	1,066	1,170					White #12-24 online
10/16/2007	465	3,644	1,232	135	20	2	2.0	11	2	9	24.0	0.5	1,050	1,168					Gribi #5-36 online at
10/17/2007	372	3,264	1,116	126	20	2	2.0	12	2	10	24.0	0.5	1,040	1,180					
10/18/2007	420	3,187	1,041	122	20	2	2.0	12	2	10	21.0	1.0	1,052	1,182					Electrical problems.
10/19/2007	412	3,810	1,386	144	40	2	2.0	12	2	10	24.0	1.0	1,055	1,170					
10/20/2007	244	3,690	1,403	129	35	2	2.0	12	2	10	16.0	1.0	1,068	1,160					Sep hi-level, clean s
10/21/2007	239	1,262	841	100	28	2	2.0	12	2	10	14.0	3.0	1,200	1,170					Repl rings on 3rd sta
10/22/2007	412	3,645	1,487	143	30	2	2.0	12	2	10	24.0	3.0	1,120	1,170					
10/23/2007	508	3,628	1,511	156	30	2	2.0	12	2	10	24.0	3.0	1,100	1,180					
10/24/2007	432	3,400	1,482	160	30	2	2.0	12	2	10	24.0	3.0	1,200	1,180					3hrs hi-line psi, plant
10/25/2007	269	2,030	908	166				12	2	10	24.0								20hrs hi-line psi.
10/26/2007	387	2,645	995	105				12	2	10	24.0								Hi-line psi, plant repa
Total:	10,148	78,898	31,475	3,509															
Avg:	390	3,035	1,211	135	23	2	2.0	11	2	9	23.1	1.1	1,070	1,168					

10/29/2007

16. APPENDIX III. Geologic Maps

The maps in this appendix have been developed using the most recent data from the Michigan Department of Environmental Quality. These are preliminary maps in the study, and will be analyzed and refined as the project progresses. The map set consists of structure and isopach maps of the three Antrim formations (Lachine, Paxton, and Norwood) over the Northern Lower Peninsula of Michigan, and also over Antrim County, Michigan. Also included in the map set is a spot map showing the formation directly at the Base of Glacial Drift, isopach maps of the Glacial Drift, Ellsworth, and Antrim formations, and five-year Antrim production maps.

Appendix Figure 16-1. The Bargy #16-14 is located in the same project area as the demonstration well. This log display shows the typical signature of the Gamma Ray for the three Antrim Shale members, the Lachine, Paxton, and Norwood.

Appendix Figure 16-2. Structure map of the Lachine member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.

Appendix Figure 16-3. Structure map of the Paxton member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.

Appendix Figure 16-4. Structure map of the Norwood member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.

Appendix Figure 16-5. Structure contour map of Lachine Formation over Antrim County, MI. Contour interval is 50 feet.

Appendix Figure 16-6. Structure contour map of Paxton formation over Antrim County, MI. Contour interval is 50 feet.

Appendix Figure 16-7. Structure contour map of Norwood formation over Antrim County, MI. Contour interval is 50 feet.

Appendix Figure 16-8. Isopach map of Lachine formation, contour interval is 5 feet.

Appendix Figure 16-9. Isopach map of Paxton formation, contour interval is 5 feet.

Appendix Figure 16-10. Isopach map of Norwood formation, contour interval is 5 feet.

Appendix Figure 16-11. Isopach map of Lachine formation over Antrim County, MI. Contour interval is 5 feet.

Appendix Figure 16-12. Isopach map of Paxton formation over Antrim County, MI. Contour interval is 5 feet.

Appendix Figure 16-13. Isopach map of Norwood formation over Antrim County, MI. Contour interval is 5 feet.

Appendix Figure 16-14. Bedrock formation map showing the formation directly below the Glacial Drift.

Appendix Figure 16-15. Glacial Drift Isopach map with a contour interval of 50 feet, using the Inverse to a Power gridding algorithm.

Appendix Figure 16-16. Isopach map of the Ellsworth Shale to the top of the Antrim Shale in Northern Michigan. Contour Interval is 25 feet. The Ellsworth Shale exists mostly in the western part of the Michigan Basin.

Appendix Figure 16-17. Isopach map of the Antrim Shale to the top of the Lachine member of the Antrim Shale in Northern Michigan. Contour Interval is 25 feet.

Appendix Figure 16-18. Michigan Bouguer Anomaly map created from data obtained from the University of Texas El Paso website for GeoNet – United States Gravity Data Repository System. (http://paces.geo.utep.edu/research/gravmag/gravmag.shtml)

Appendix Figure 16-19. Michigan Bouguer Anomaly map zoomed to Antrim County, and created from data obtained from the University of Texas El Paso website for GeoNet – United States Gravity Data Repository System.

Appendix Figure 16-20. Summation of historic Antrim gas produced from 1992 through 1996 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

Appendix Figure 16-21. Summation of historic Antrim gas produced from 1997 through 2001 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

Appendix Figure 16-22. Summation of historic Antrim gas produced from 2002 through 2006 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

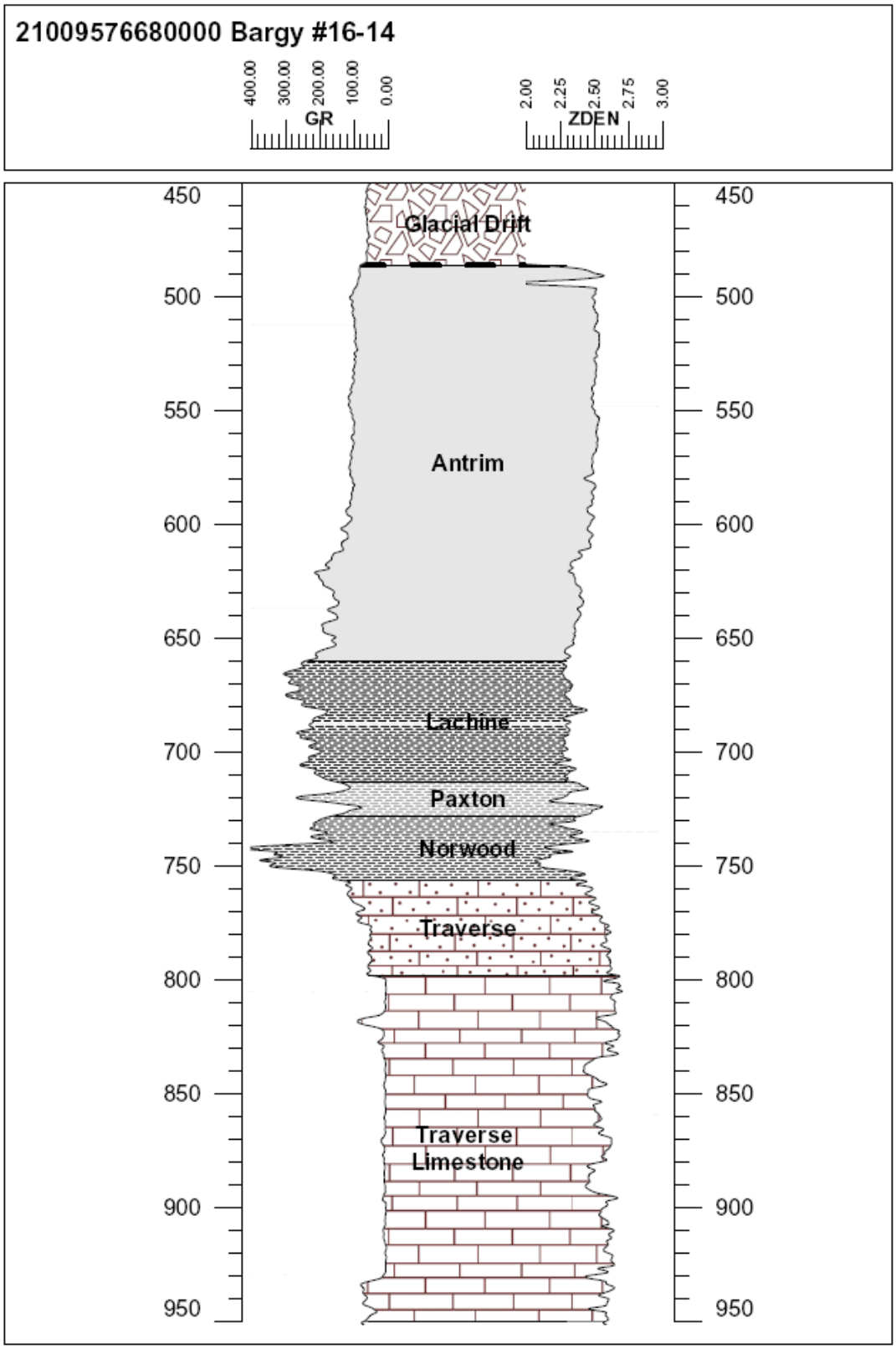
Appendix Figure 16-23. Summation of historic Antrim CO_2 produced from 1997 through 2001 measured in MCF. Colored blocks represent the sum of CO_2 produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

Appendix Figure 16-24. Summation of historic Antrim CO2 produced from 2002 through 2006 measured in MCF. Colored blocks represent the sum of CO2 produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

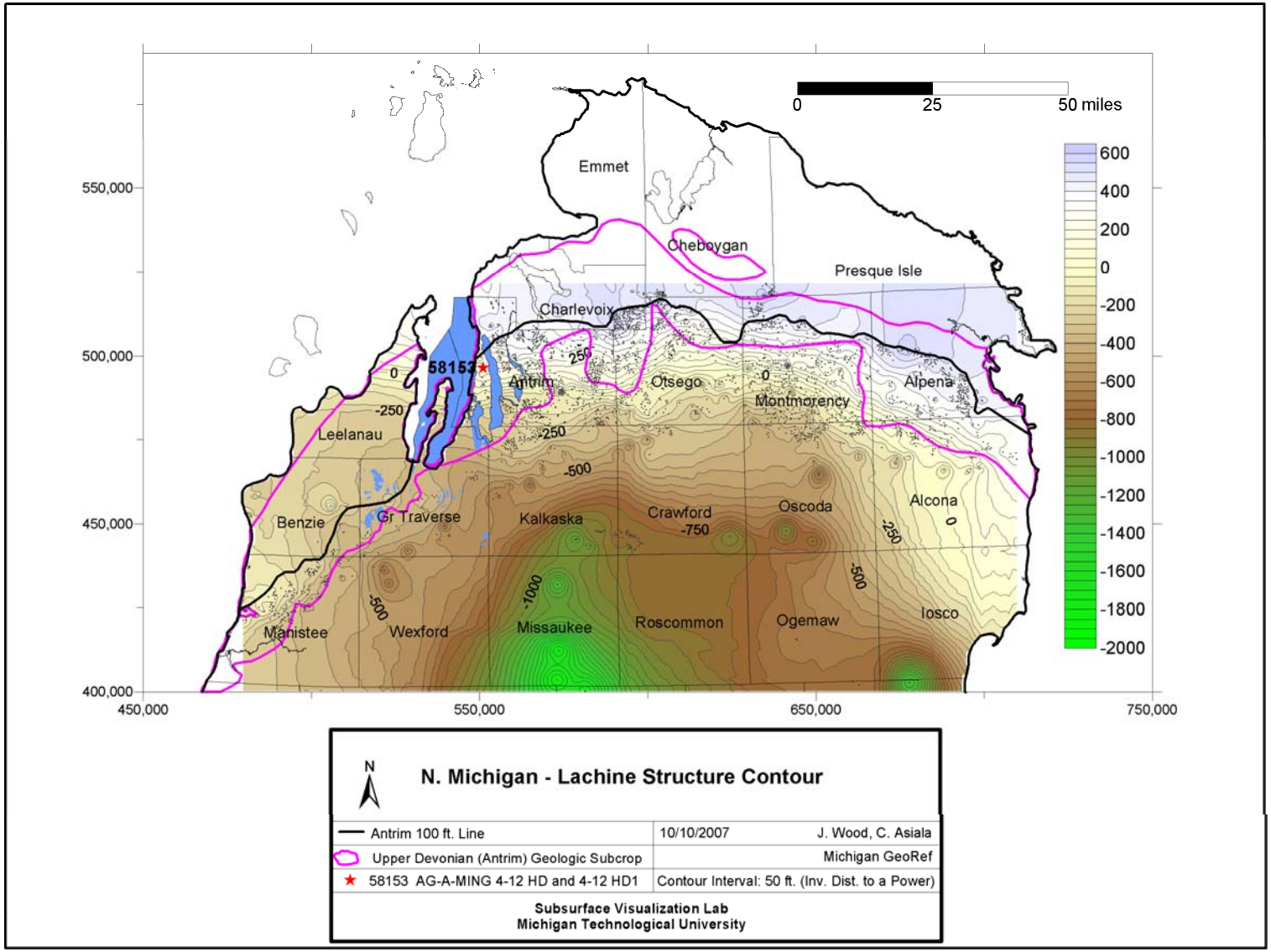
Appendix Figure 16-25. Summation of historic water produced with Antrim gas from 1992 through 1996 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

Appendix Figure 16-26. Summation of historic water produced with Antrim gas from 1997 through 2001 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

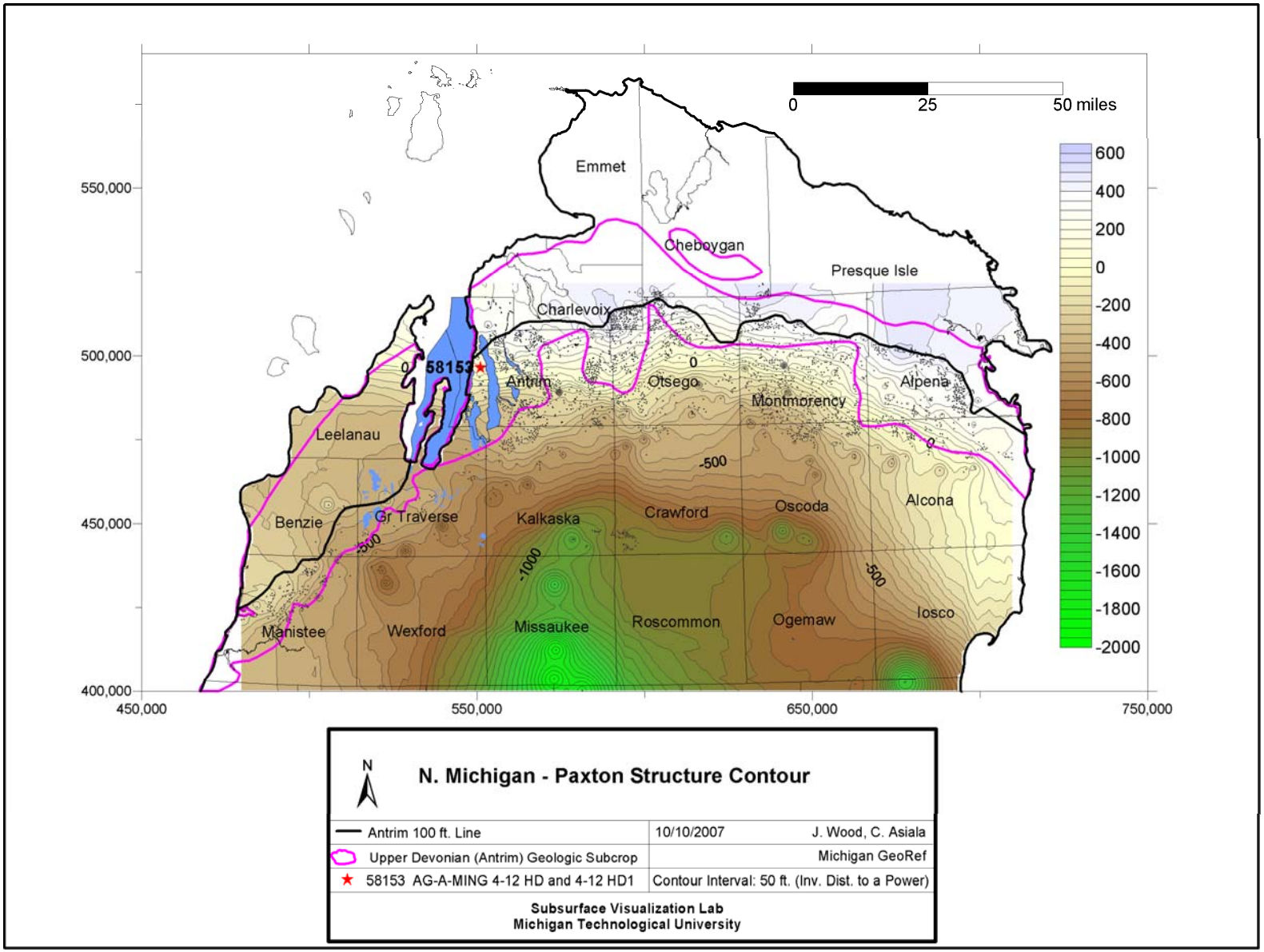
Appendix Figure 16-27. Summation of historic water produced with Antrim gas from 2002 through 2006 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



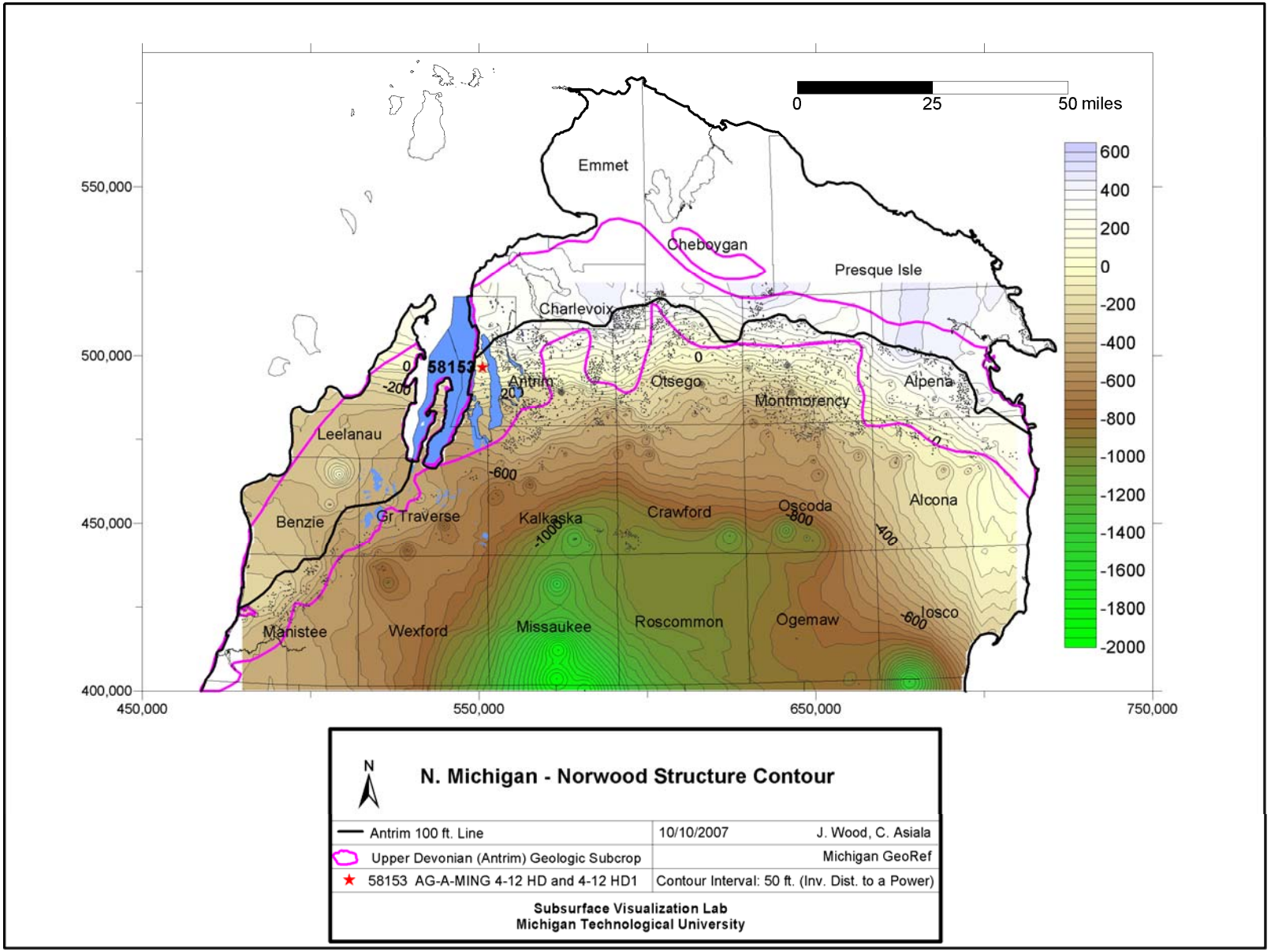
Appendix Figure 16-1. The Bargy #16-14 is located in the same project area as the demonstration well. This log display shows the typical signature of the Gamma Ray for the three Antrim Shale members, the Lachine, Paxton, and Norwood.



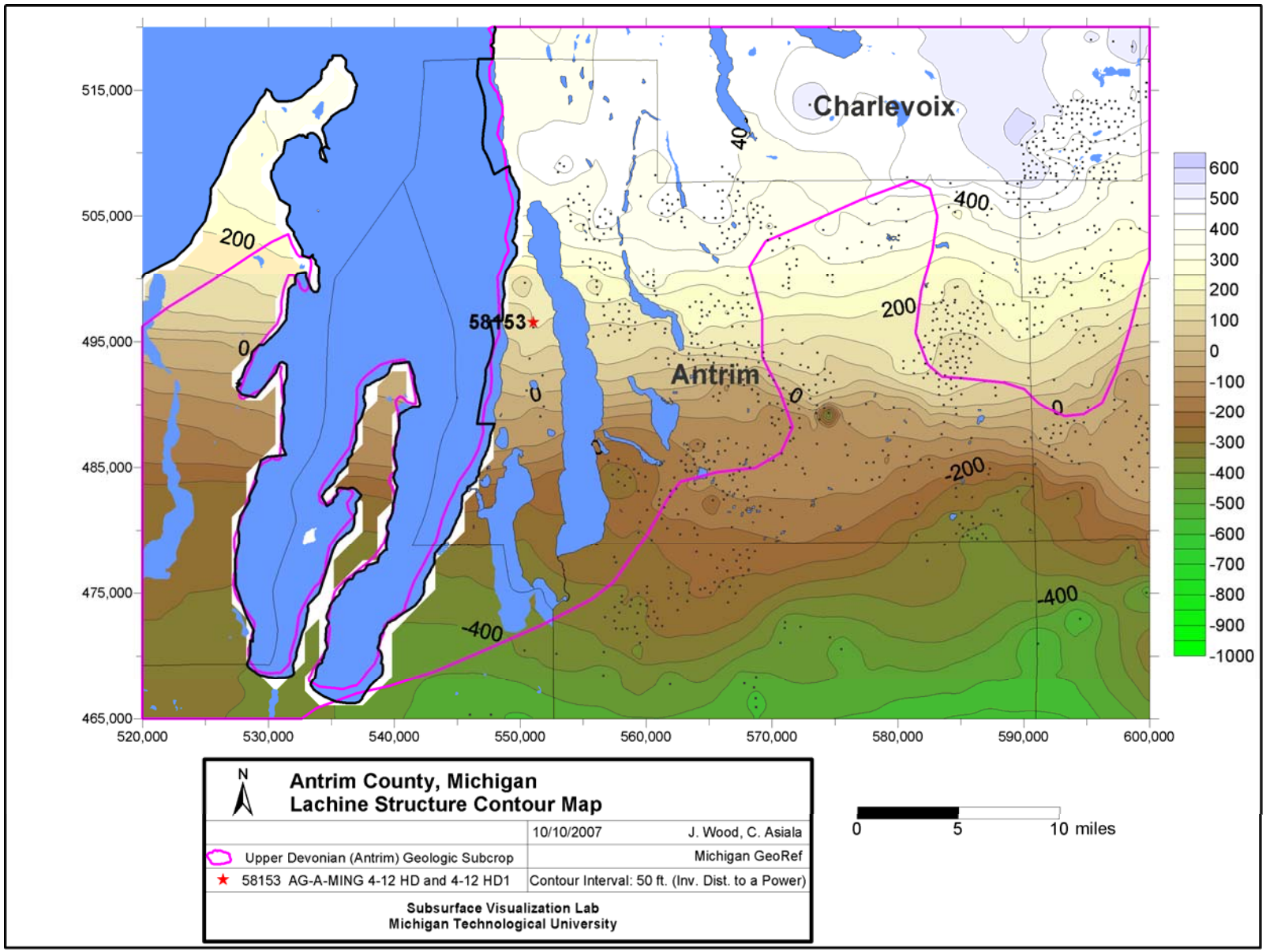
Appendix Figure 16-2. Structure map of the Lachine member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.



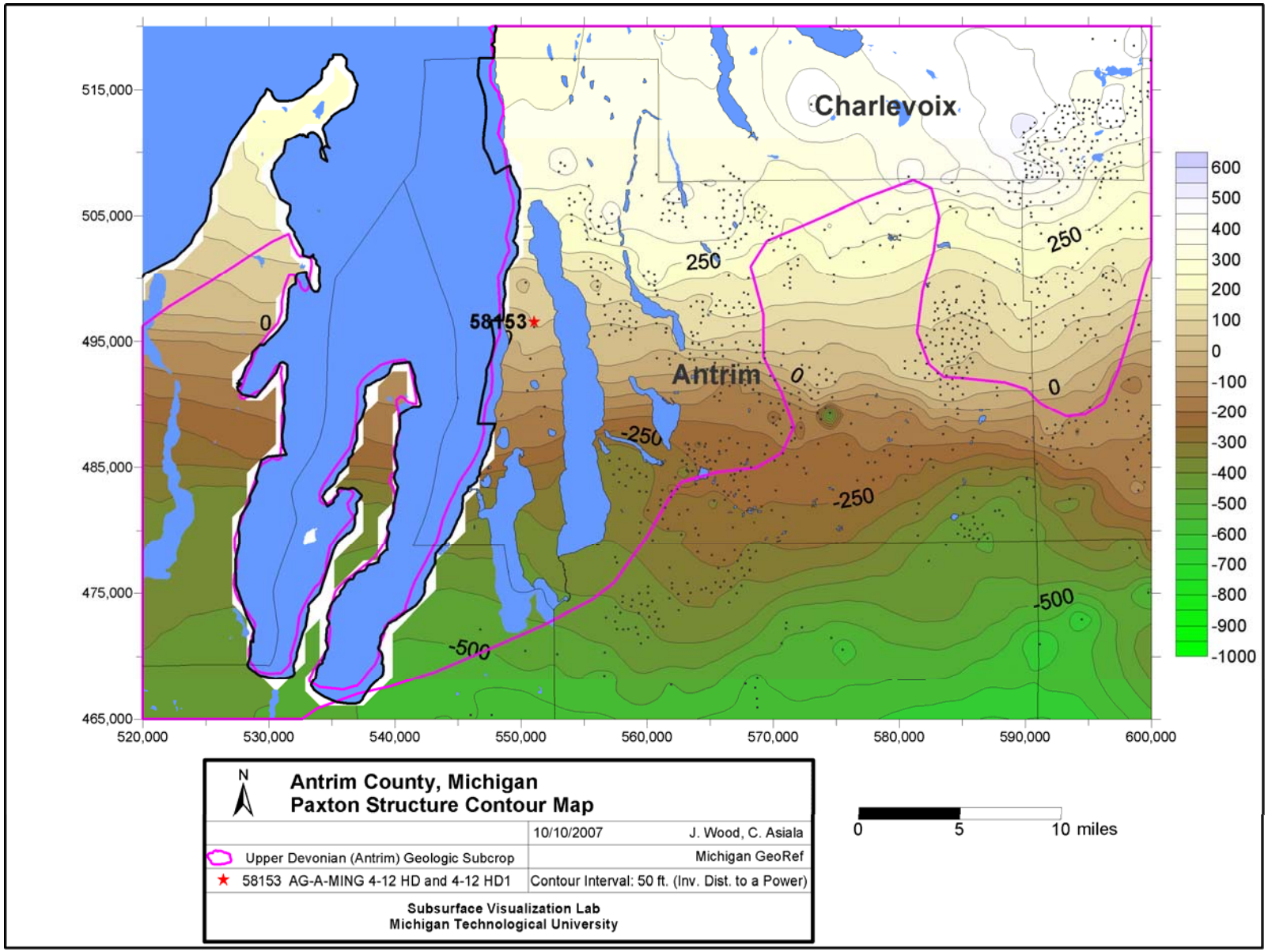
Appendix Figure 16-3. Structure map of the Paxton member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.



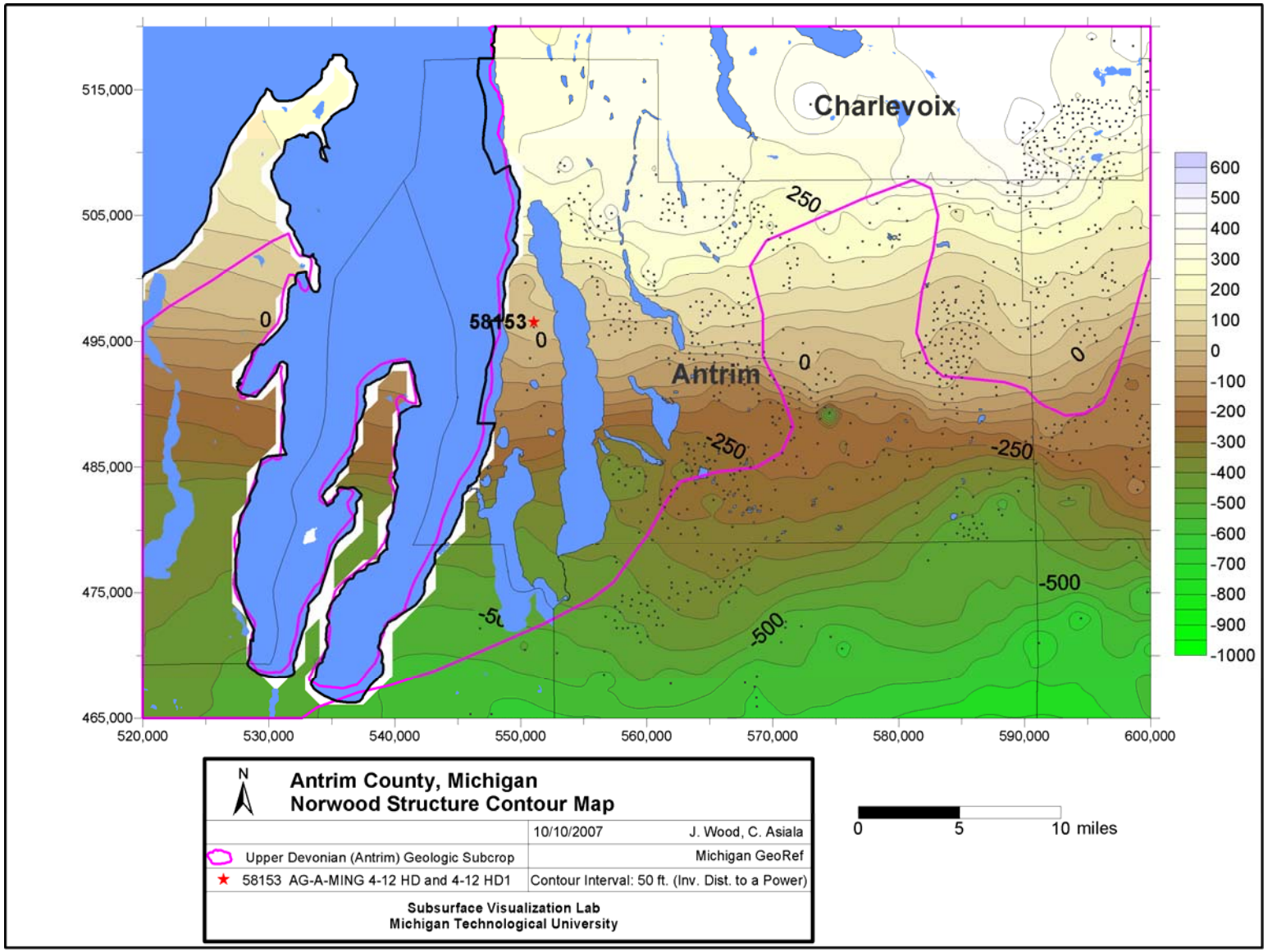
Appendix Figure 16-4. Structure map of the Norwood member of the Antrim formation in Northern Michigan. Contour Interval is 50 feet.



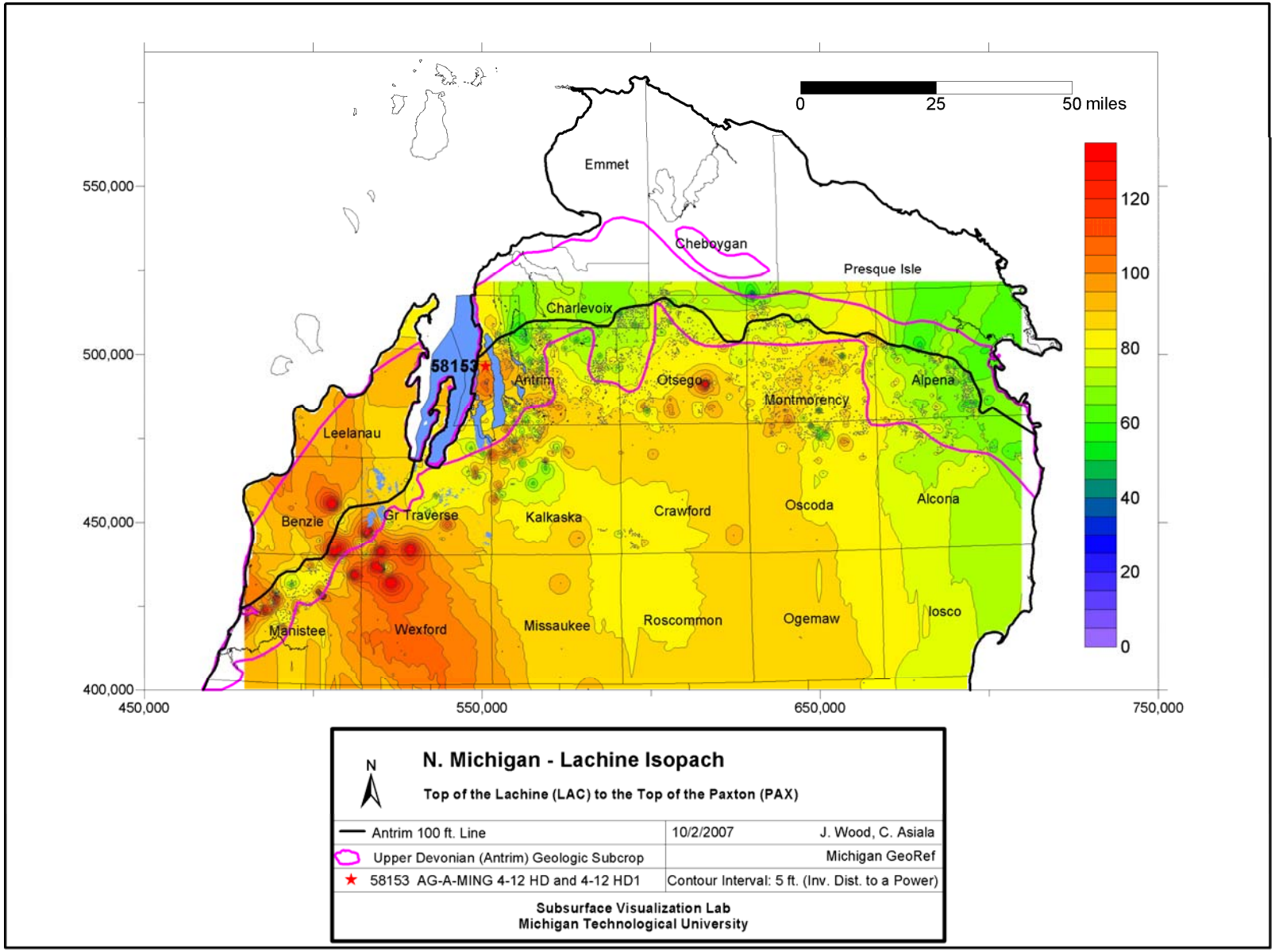
Appendix Figure 16-5. Structure contour map of Lachine Formation over Antrim County, MI. Contour interval is 50 feet.



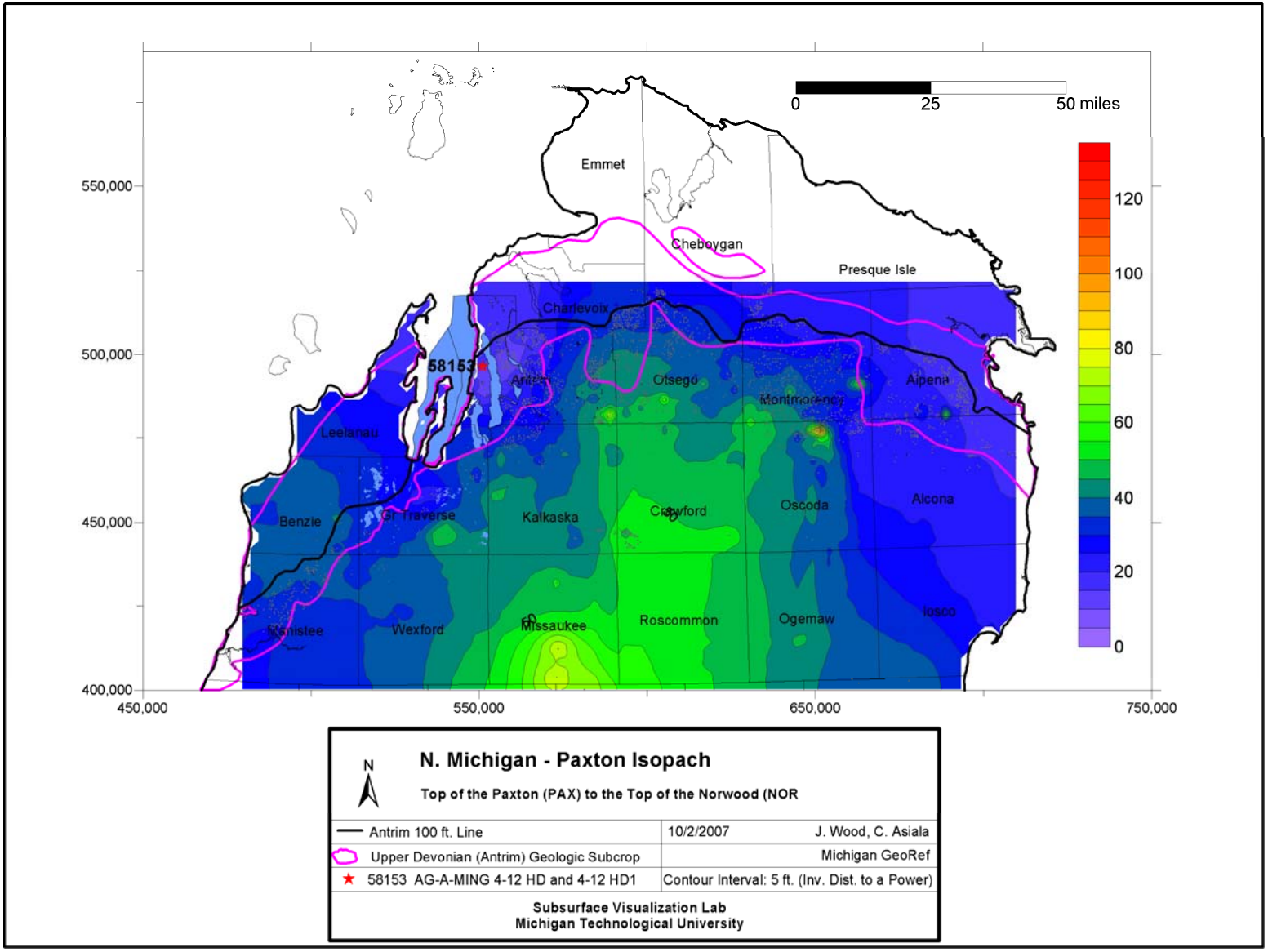
Appendix Figure 16-6. Structure contour map of Paxton formation over Antrim County, MI. Contour interval is 50 feet.



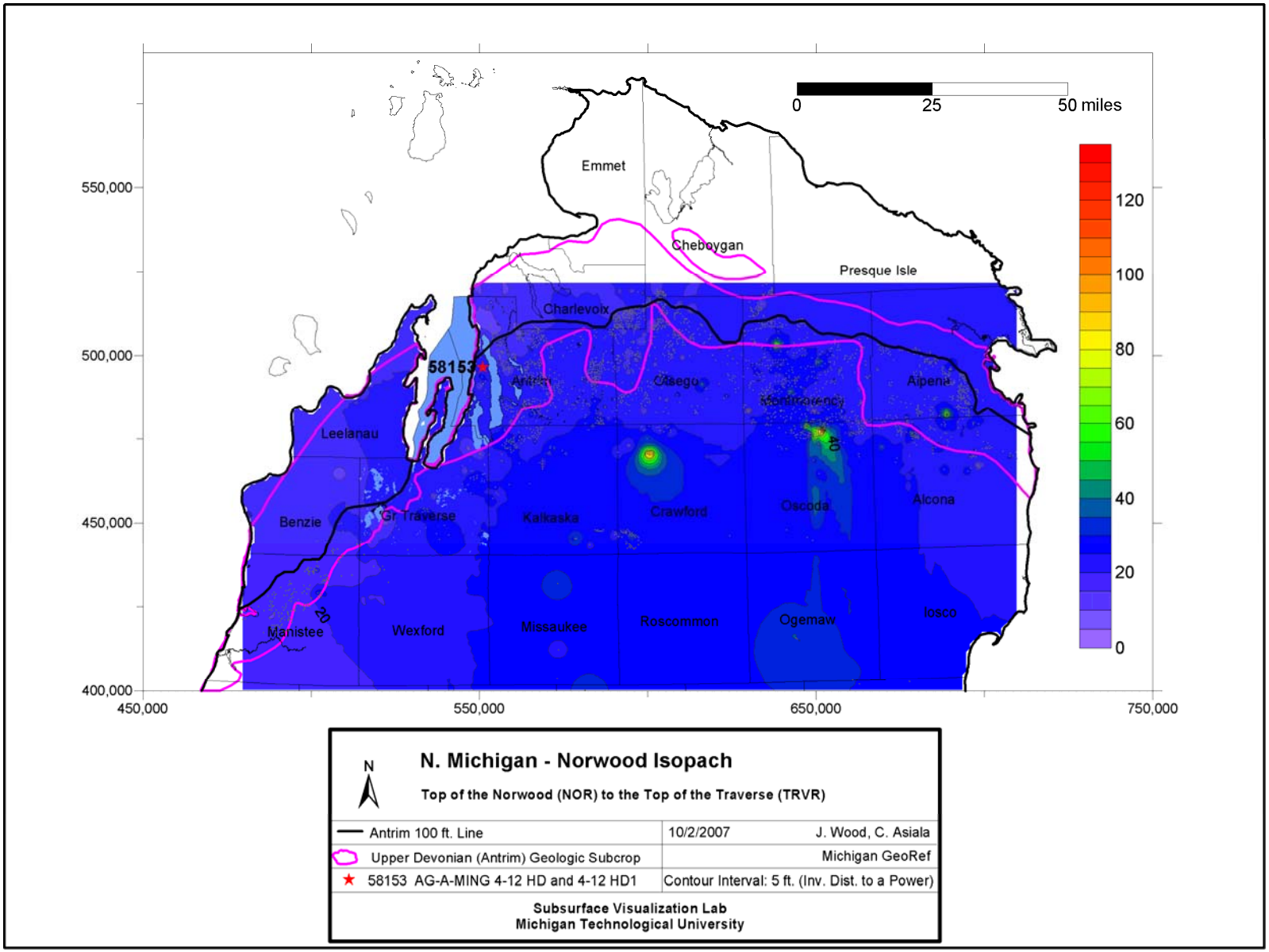
Appendix Figure 16-7. Structure contour map of Norwood formation over Antrim County, MI. Contour interval is 50 feet.



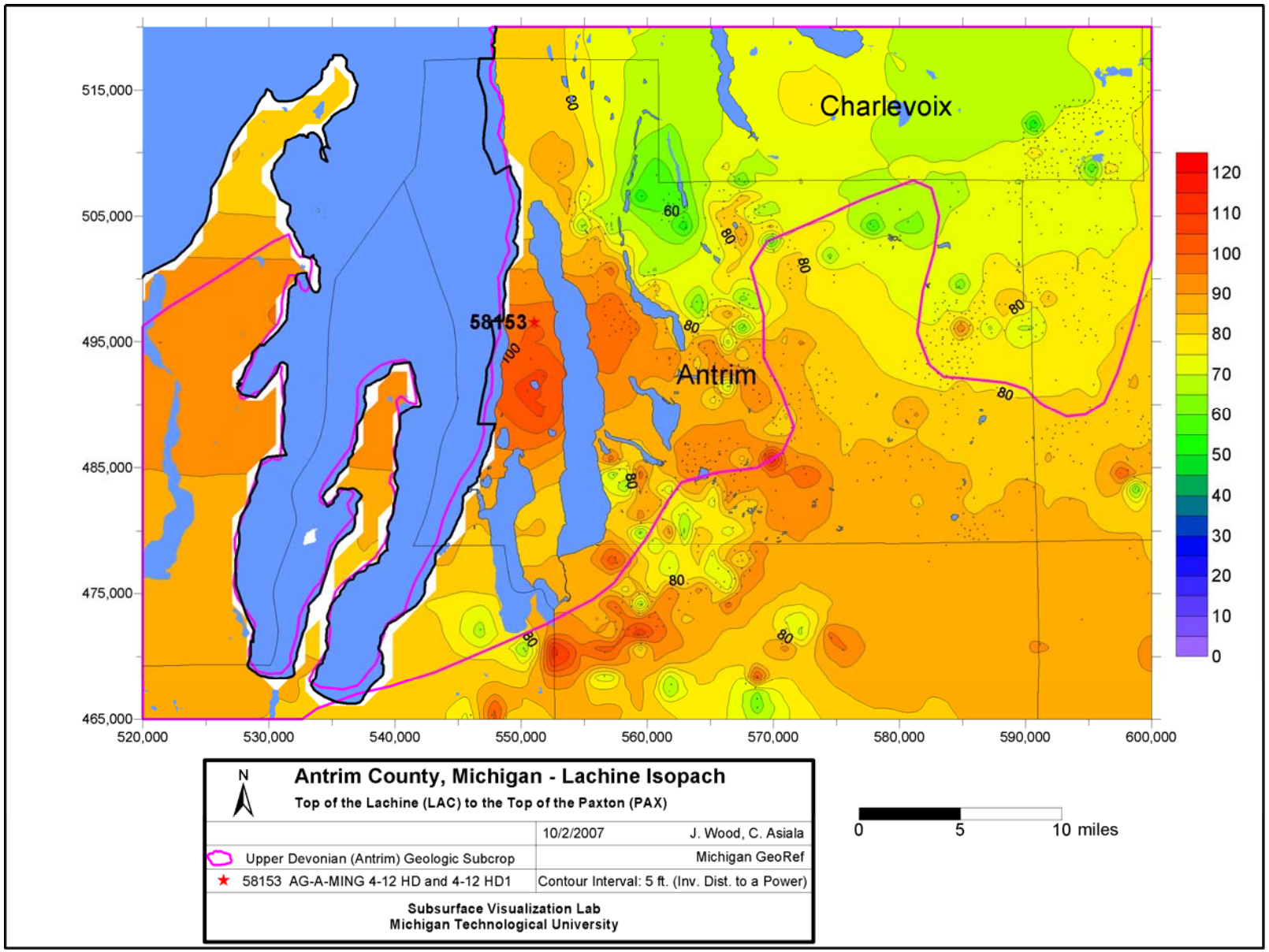
Appendix Figure 16-8. Isopach map of Lachine formation, contour interval is 5 feet.



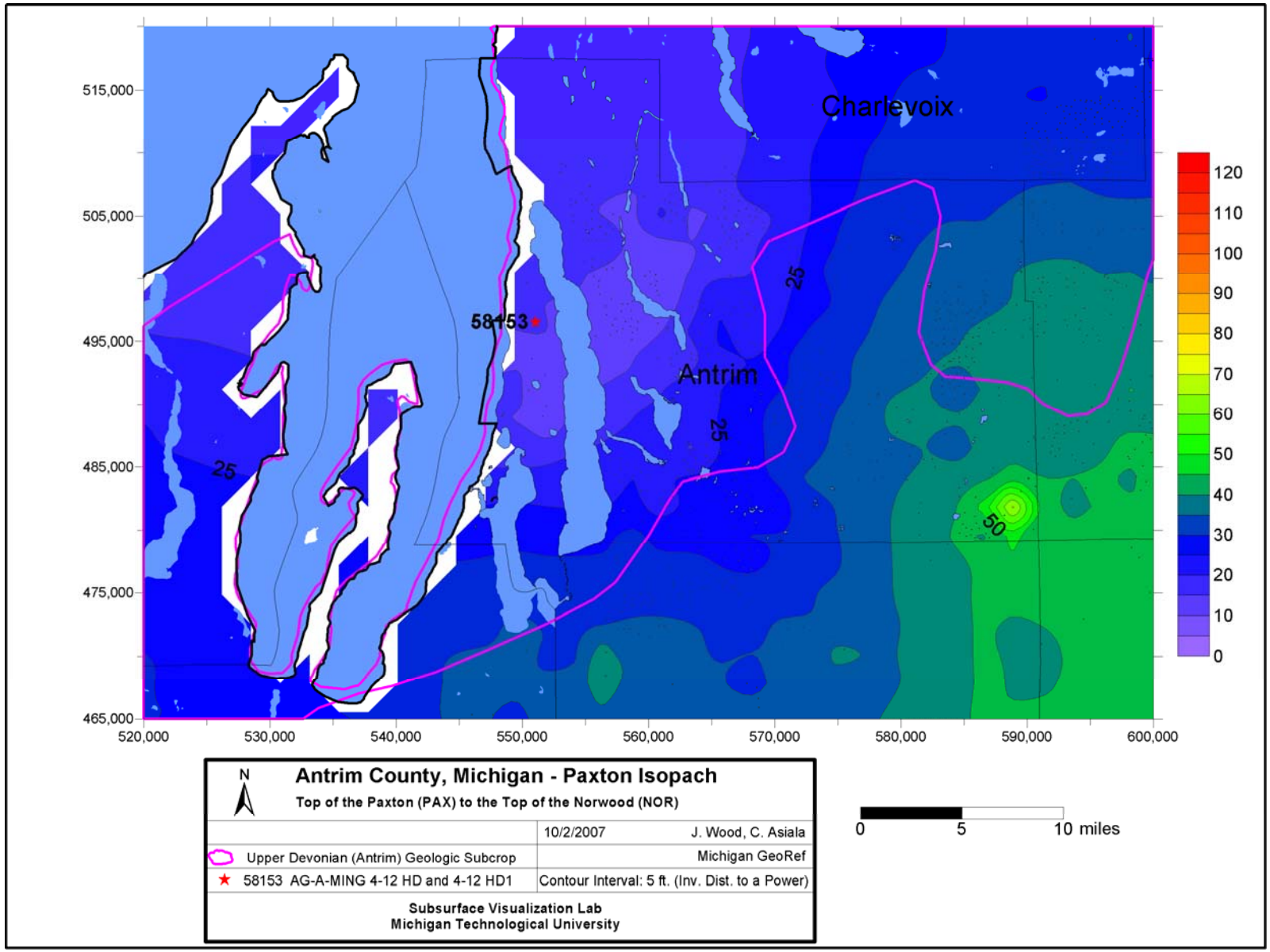
Appendix Figure 16-9. Isopach map of Paxton formation, contour interval is 5 feet.



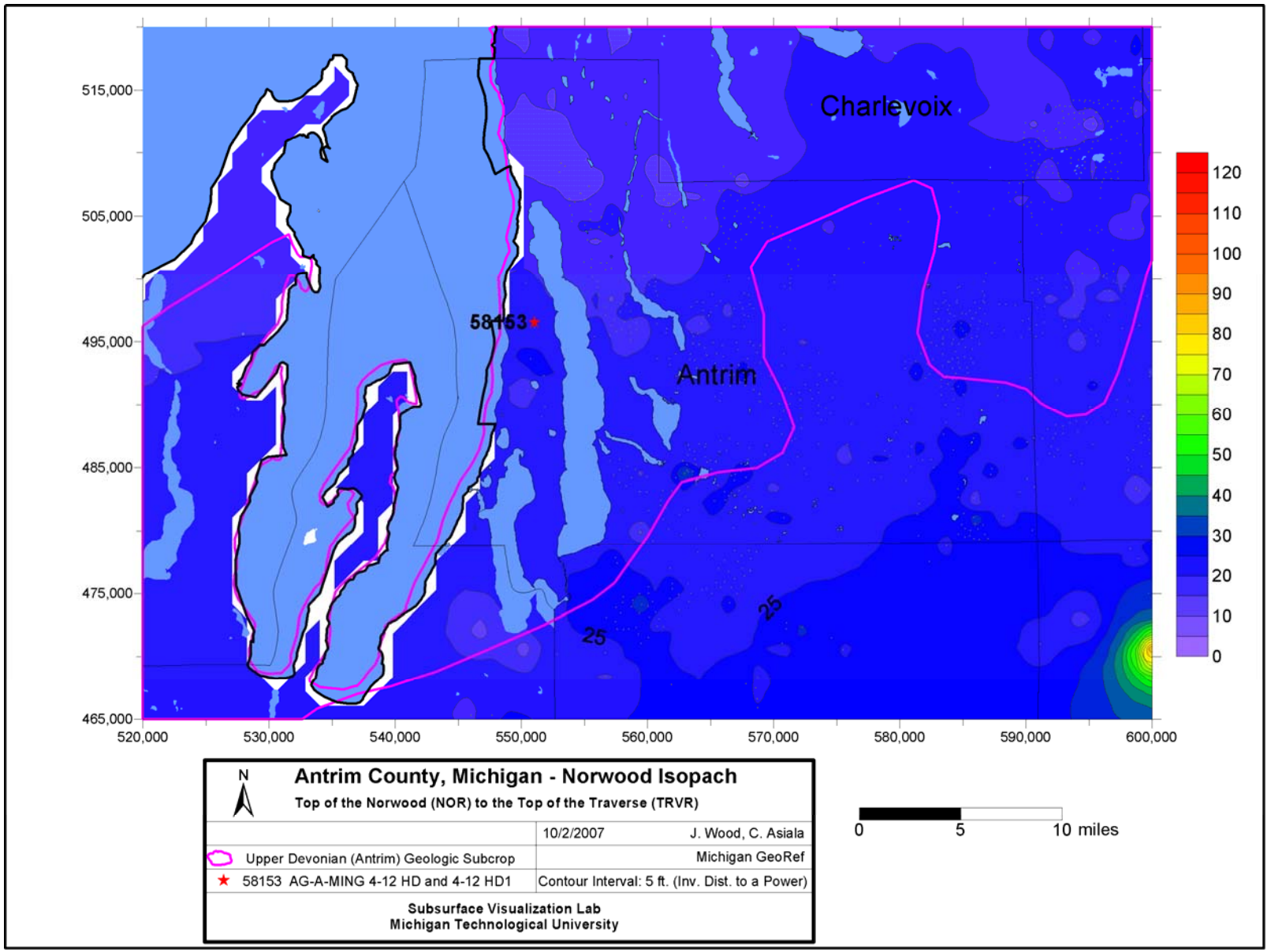
Appendix Figure 16-10. Isopach map of Norwood formation, contour interval is 5 feet.



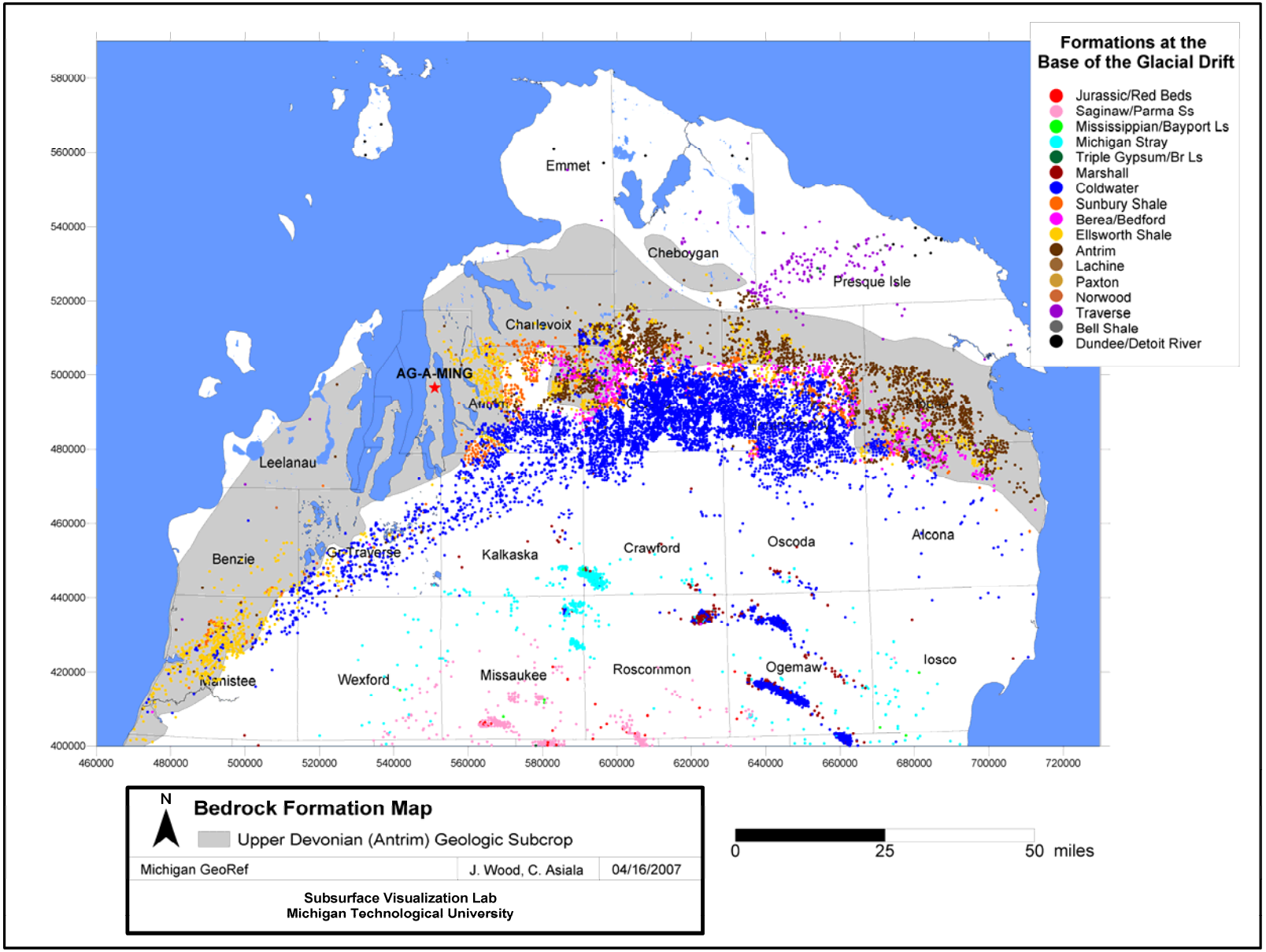
Appendix Figure 16-11. Isopach map of Lachine formation over Antrim County, MI. Contour interval is 5 feet.



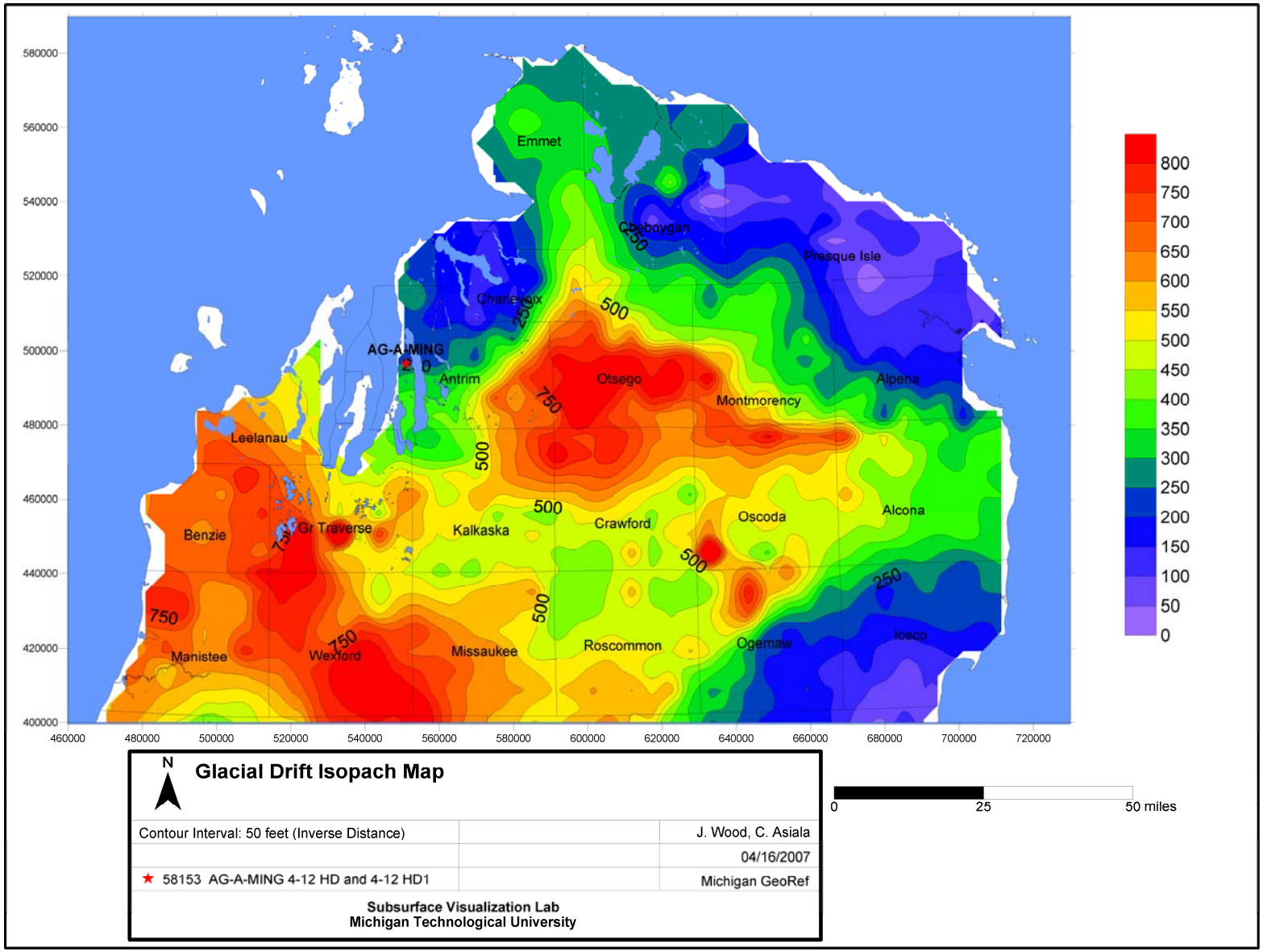
Appendix Figure 16-12. Isopach map of Paxton formation over Antrim County, MI. Contour interval is 5 feet.



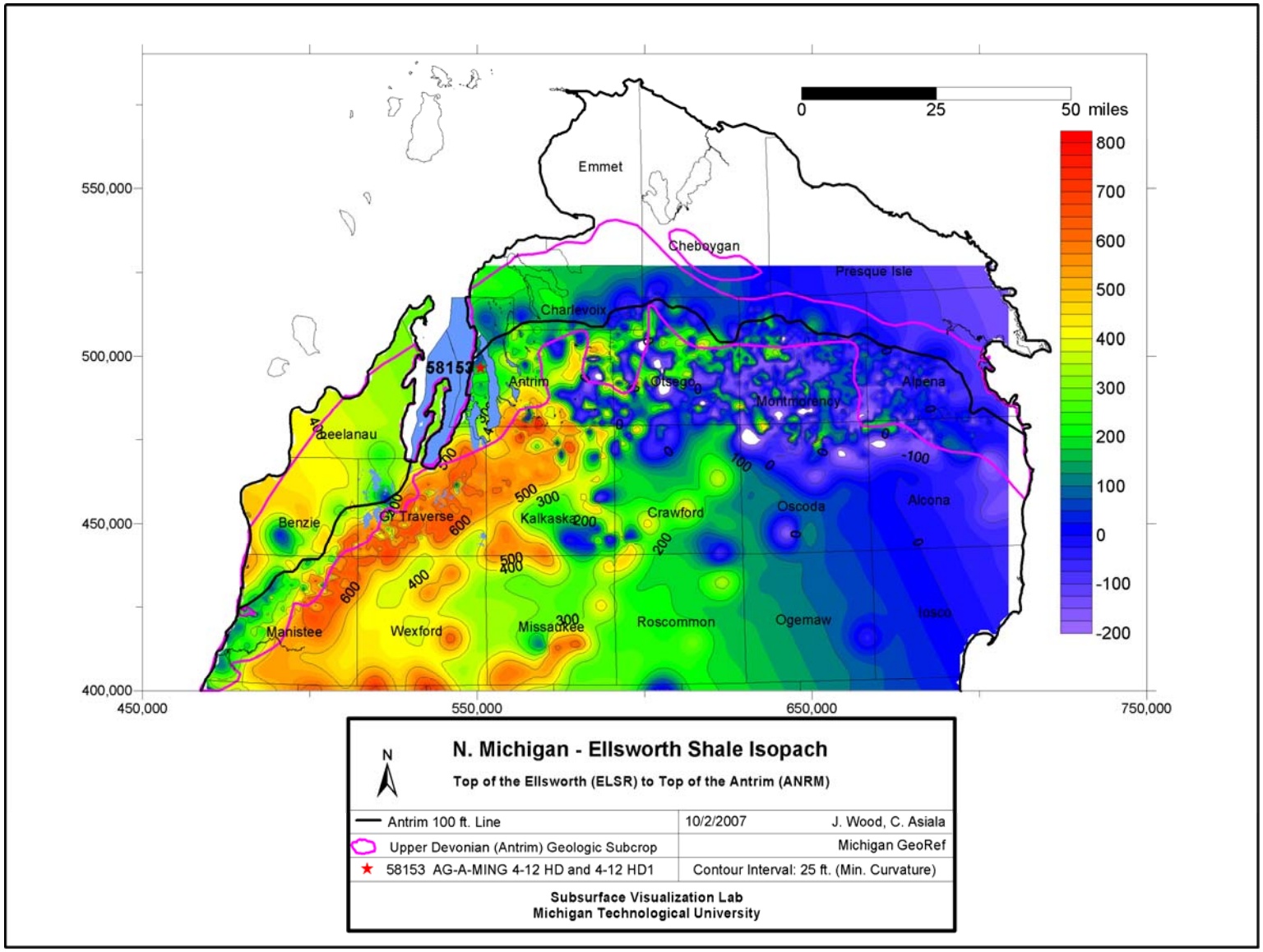
Appendix Figure 16-13. Isopach map of Norwood formation over Antrim County, MI. Contour interval is 5 feet.



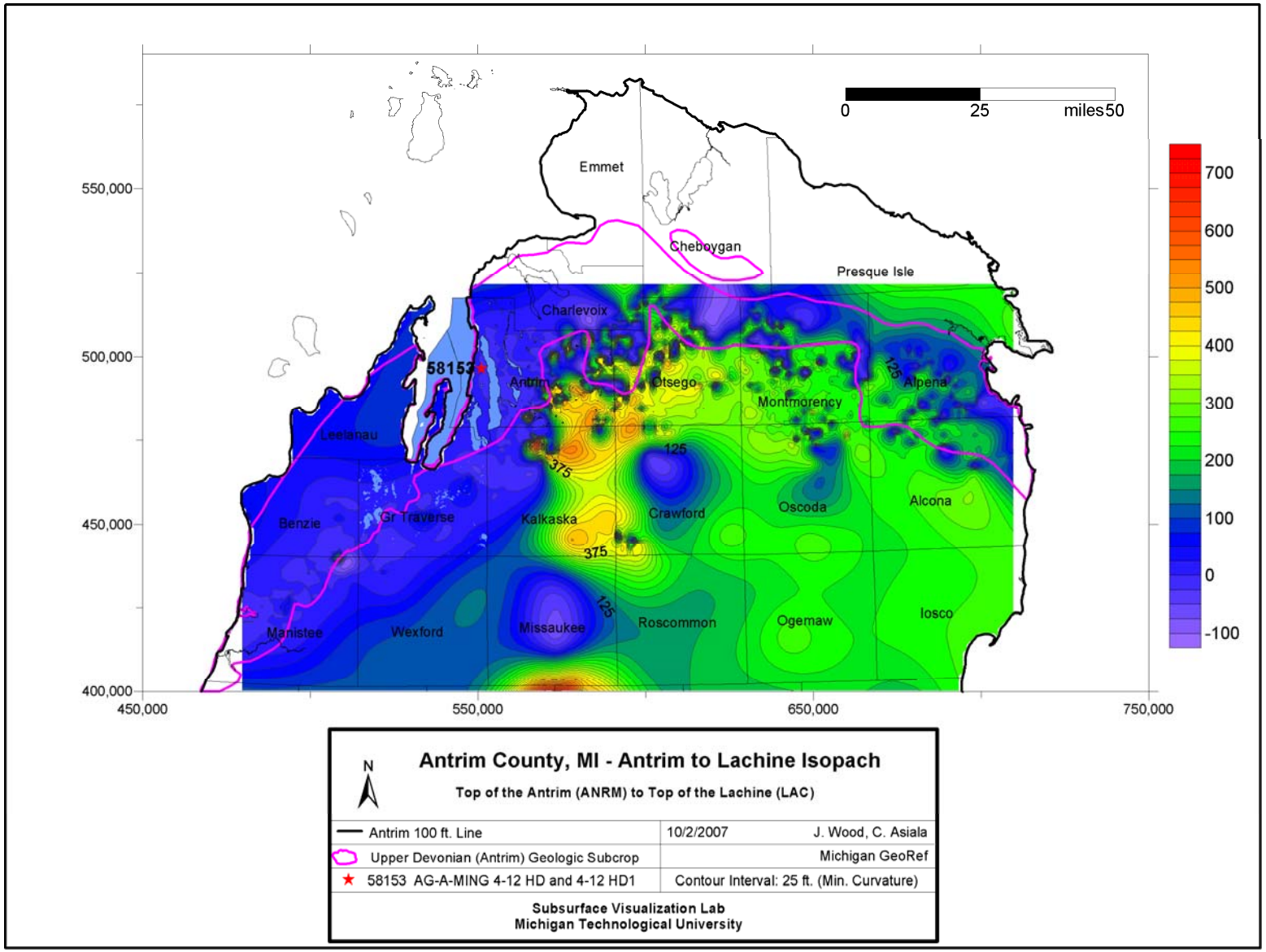
Appendix Figure 16-14. Bedrock formation map showing the formation directly below the Glacial Drift.



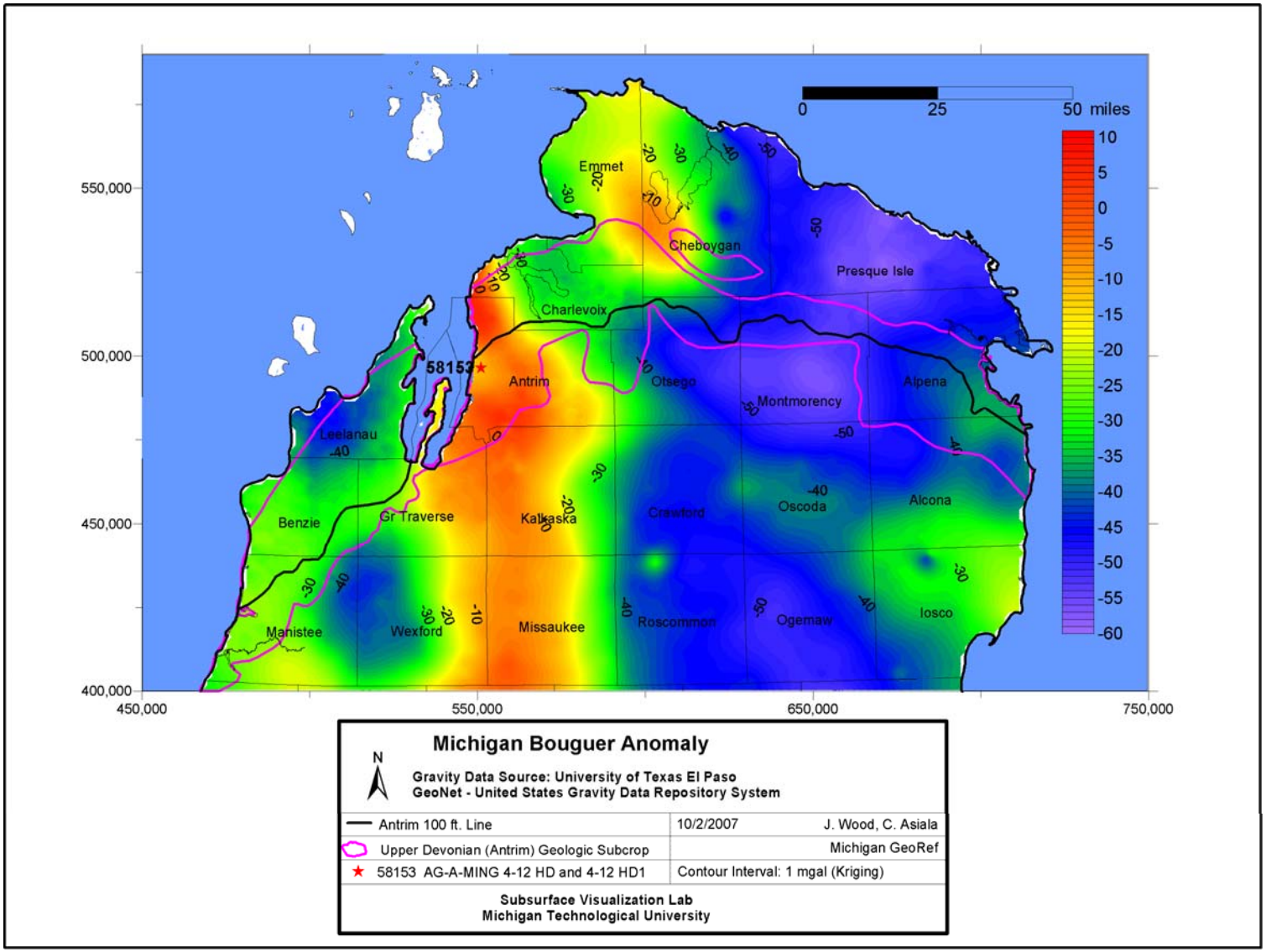
Appendix Figure 16-15. Glacial Drift Isopach map with a contour interval of 50 feet, using the Inverse to a Power gridding algorithm.



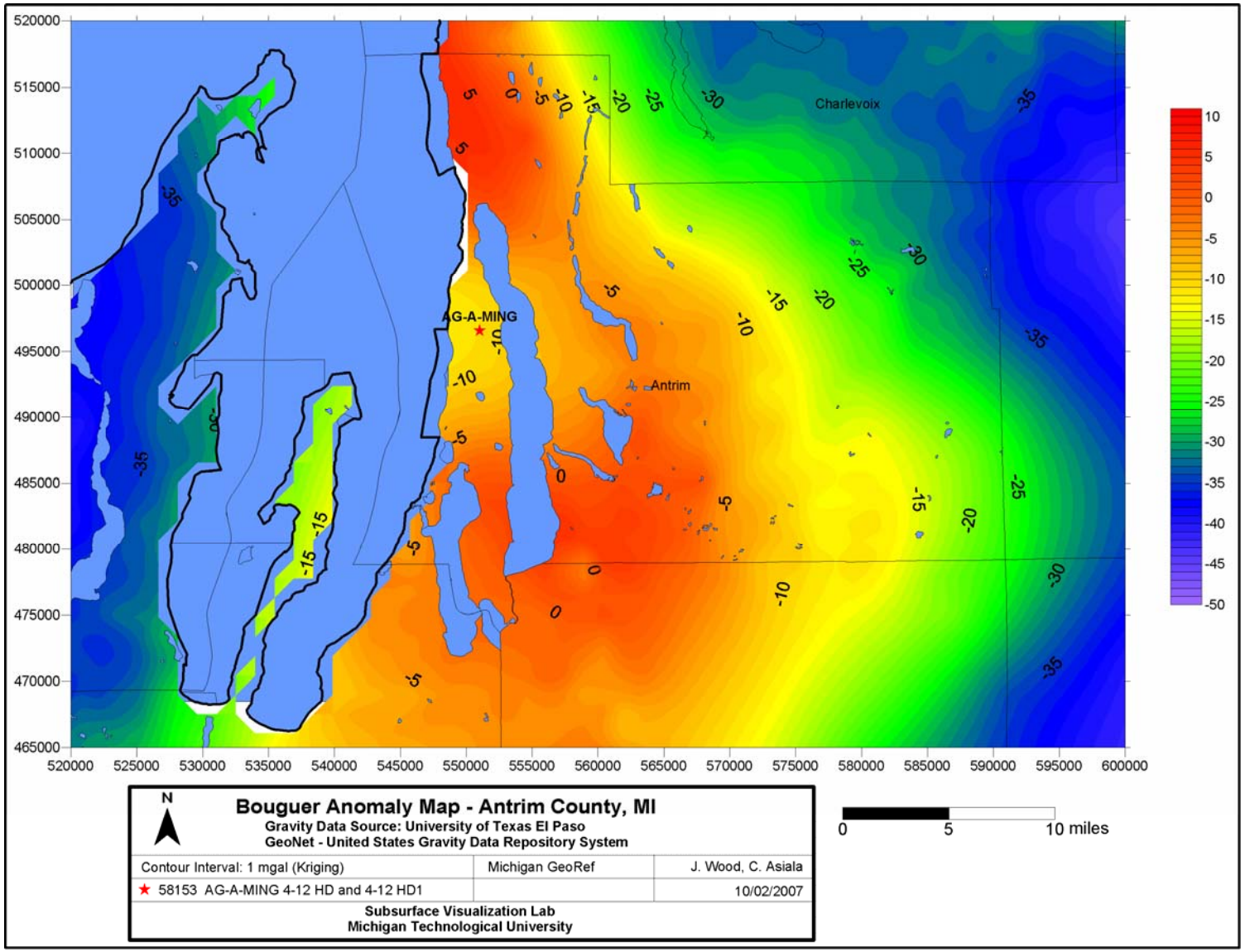
Appendix Figure 16-16. Isopach map of the Ellsworth Shale to the top of the Antrim Shale in Northern Michigan. Contour Interval is 25 feet. The Ellsworth Shale exists mostly in the western part of the Michigan Basin.



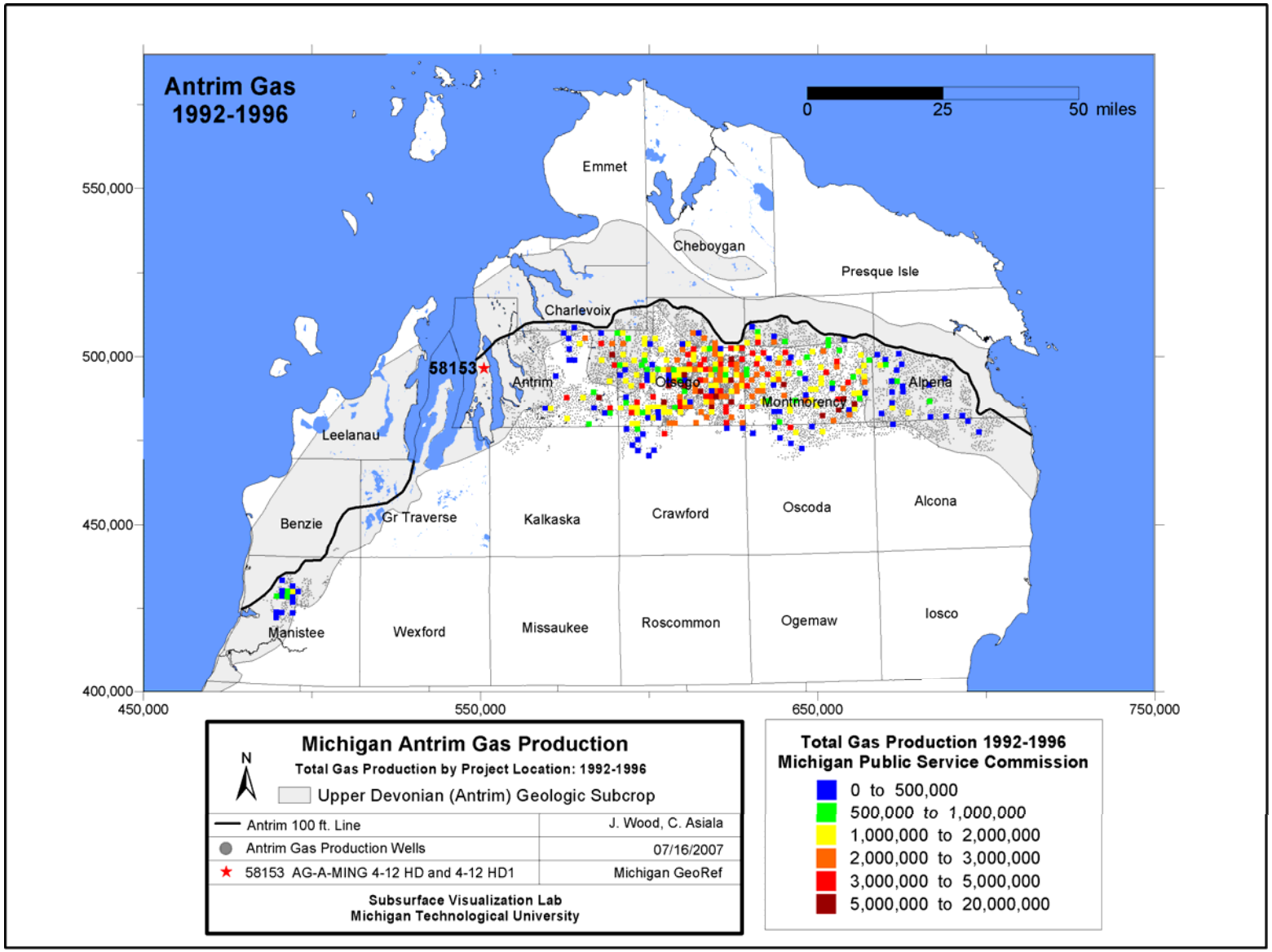
Appendix Figure 16-17. Isopach map of the Antrim Shale to the top of the Lachine member of the Antrim Shale in Northern Michigan. Contour Interval is 25 feet.



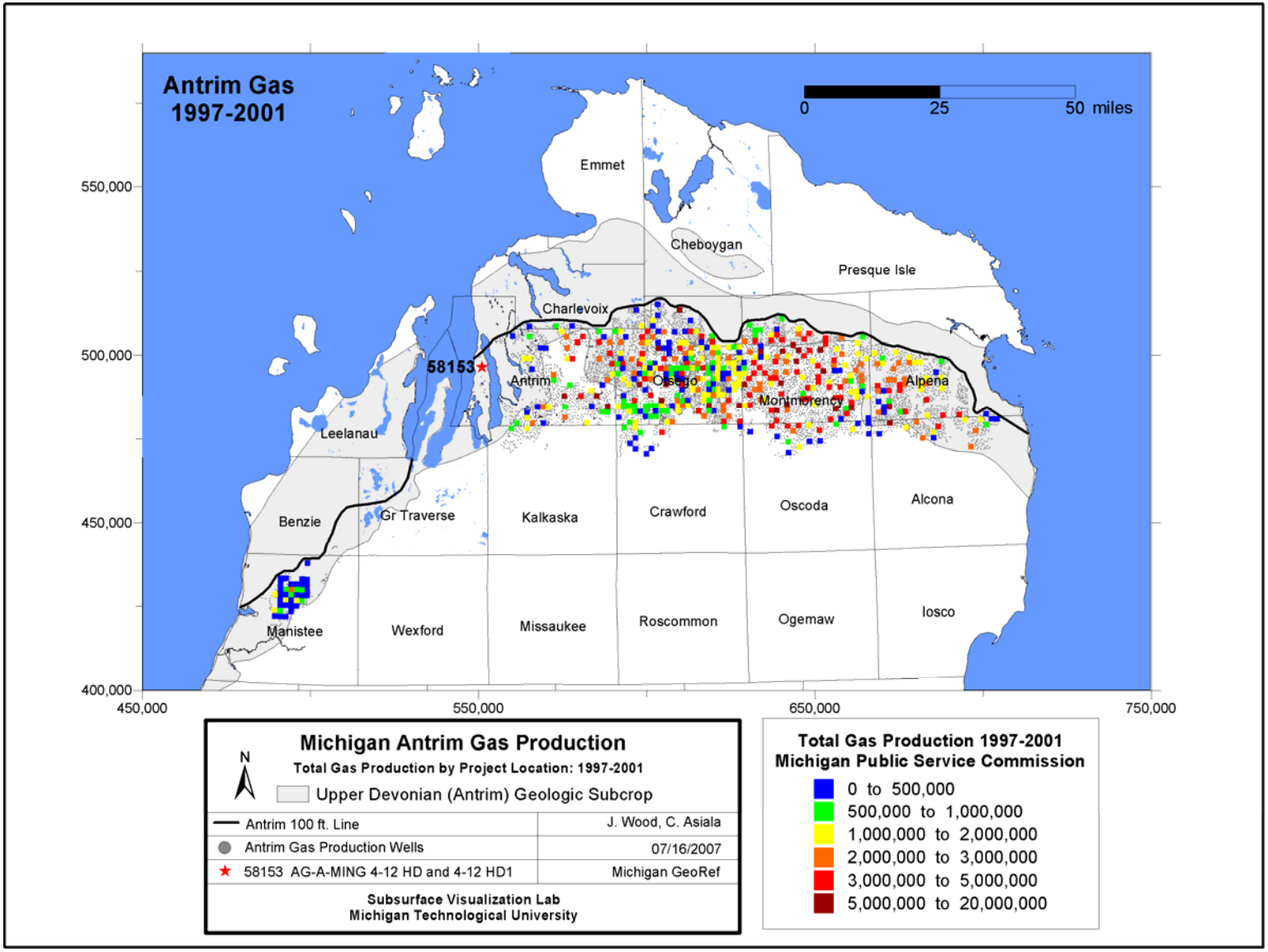
Appendix Figure 16-18. Michigan Bouguer Anomaly map created from data obtained from the University of Texas El Paso website for GeoNet – United States Gravity Data Repository System. (http://paces.geo.utep.edu/research/gravmag/gravmag.shtml)



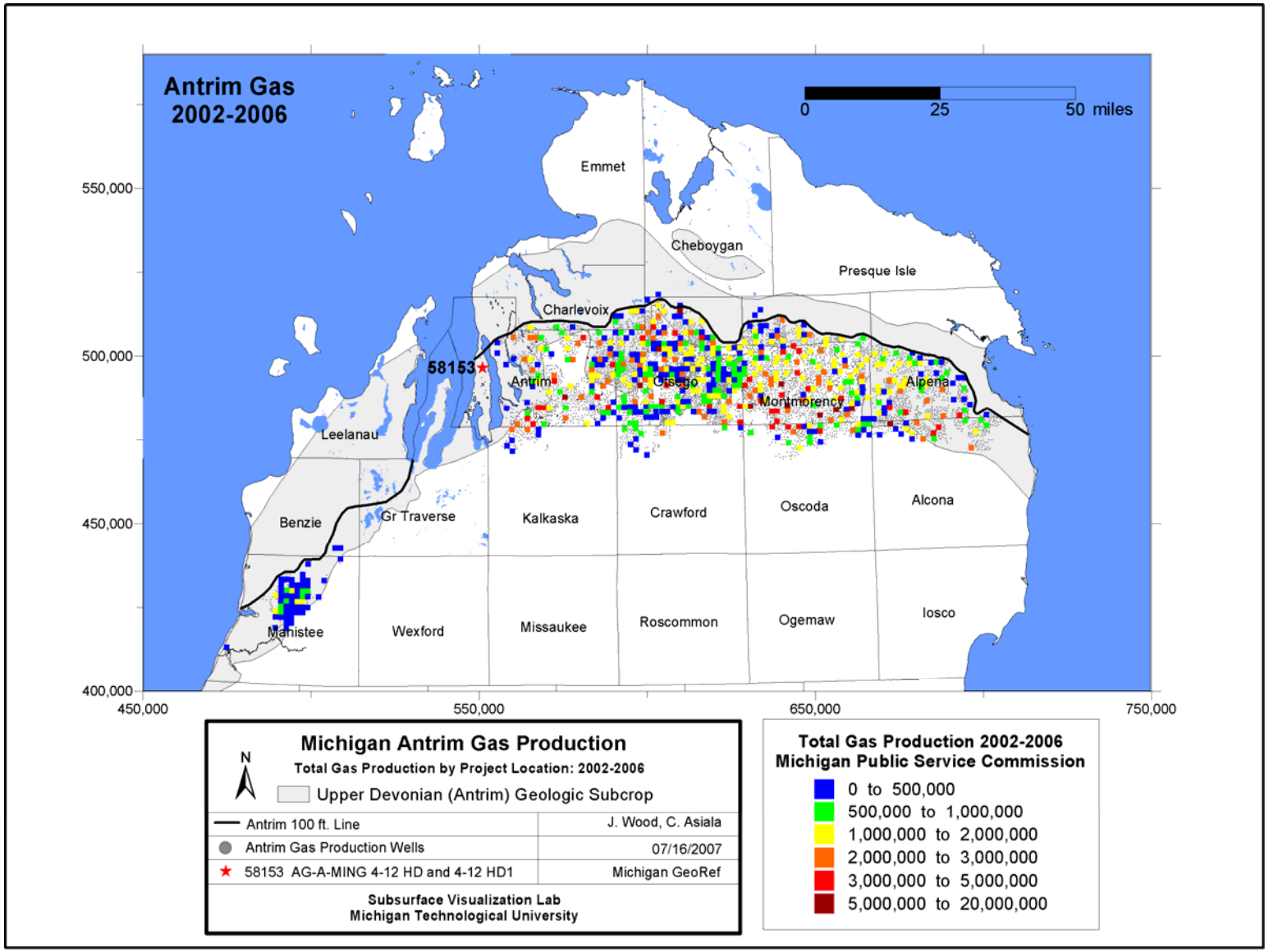
Appendix Figure 16-19. Michigan Bouguer Anomaly map zoomed to Antrim County, and created from data obtained from the University of Texas El Paso website for GeoNet – United States Gravity Data Repository System.



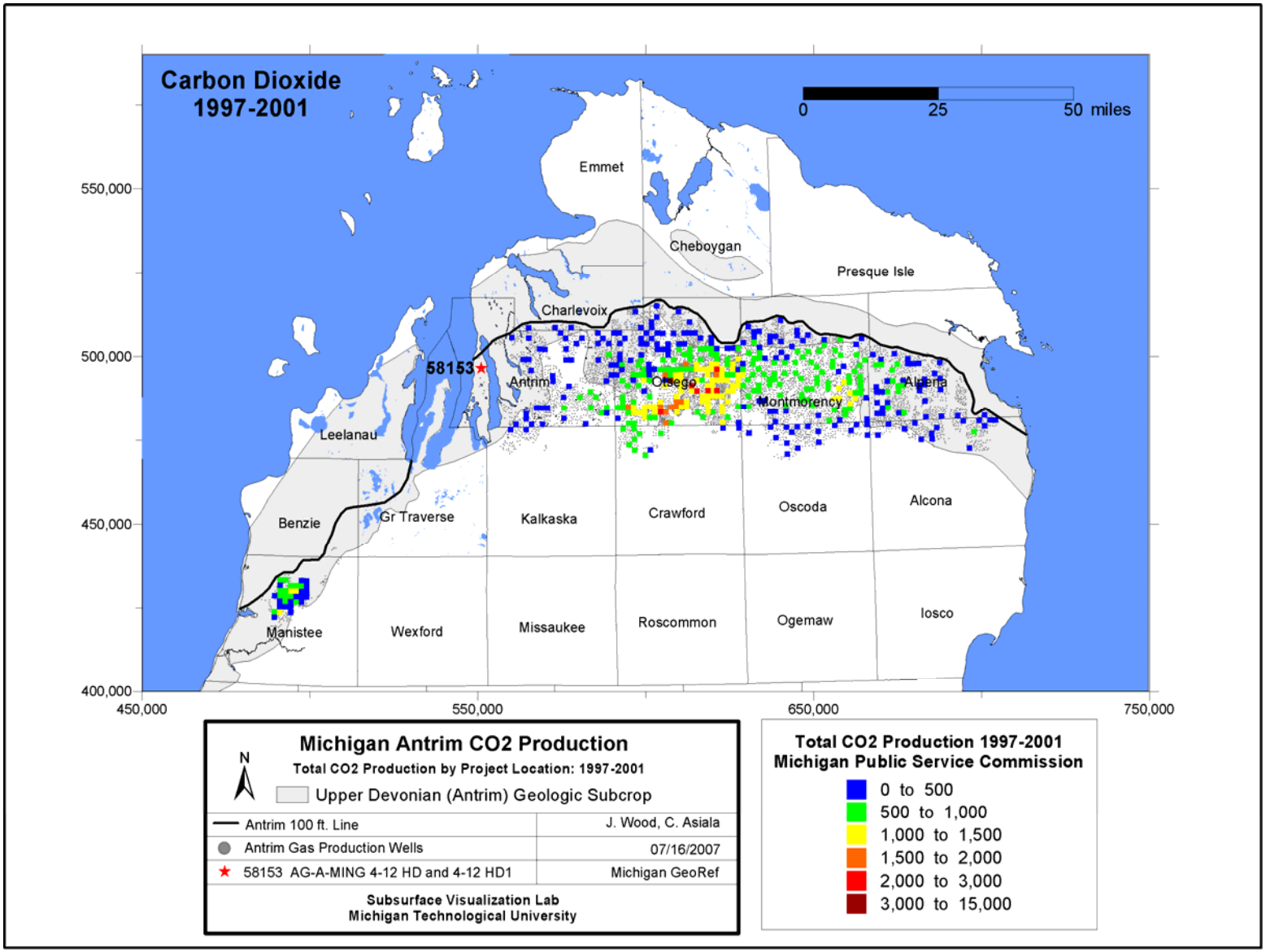
Appendix Figure 16-20. Summation of historic Antrim gas produced from 1992 through 1996 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



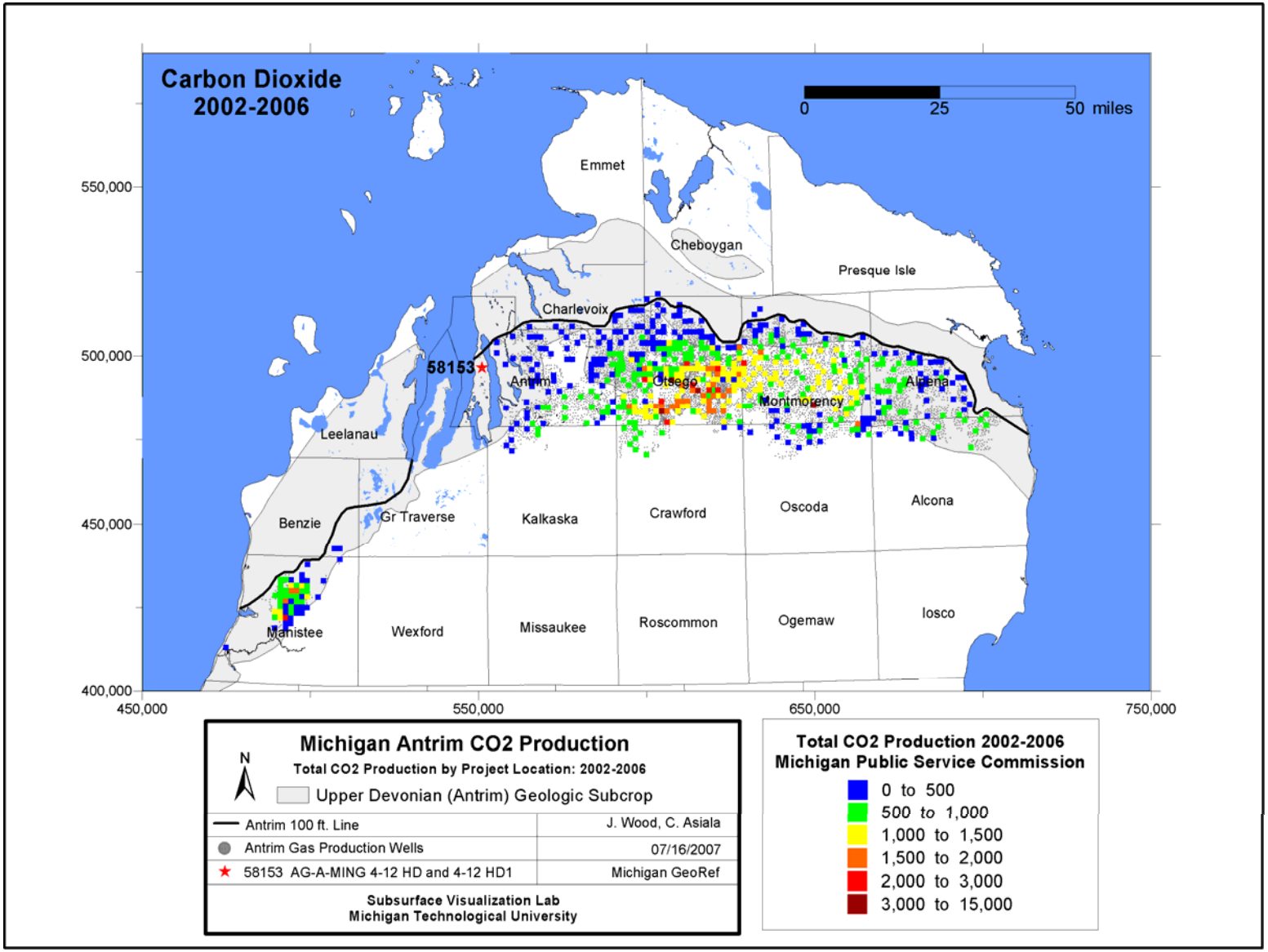
Appendix Figure 16-21. Summation of historic Antrim gas produced from 1997 through 2001 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



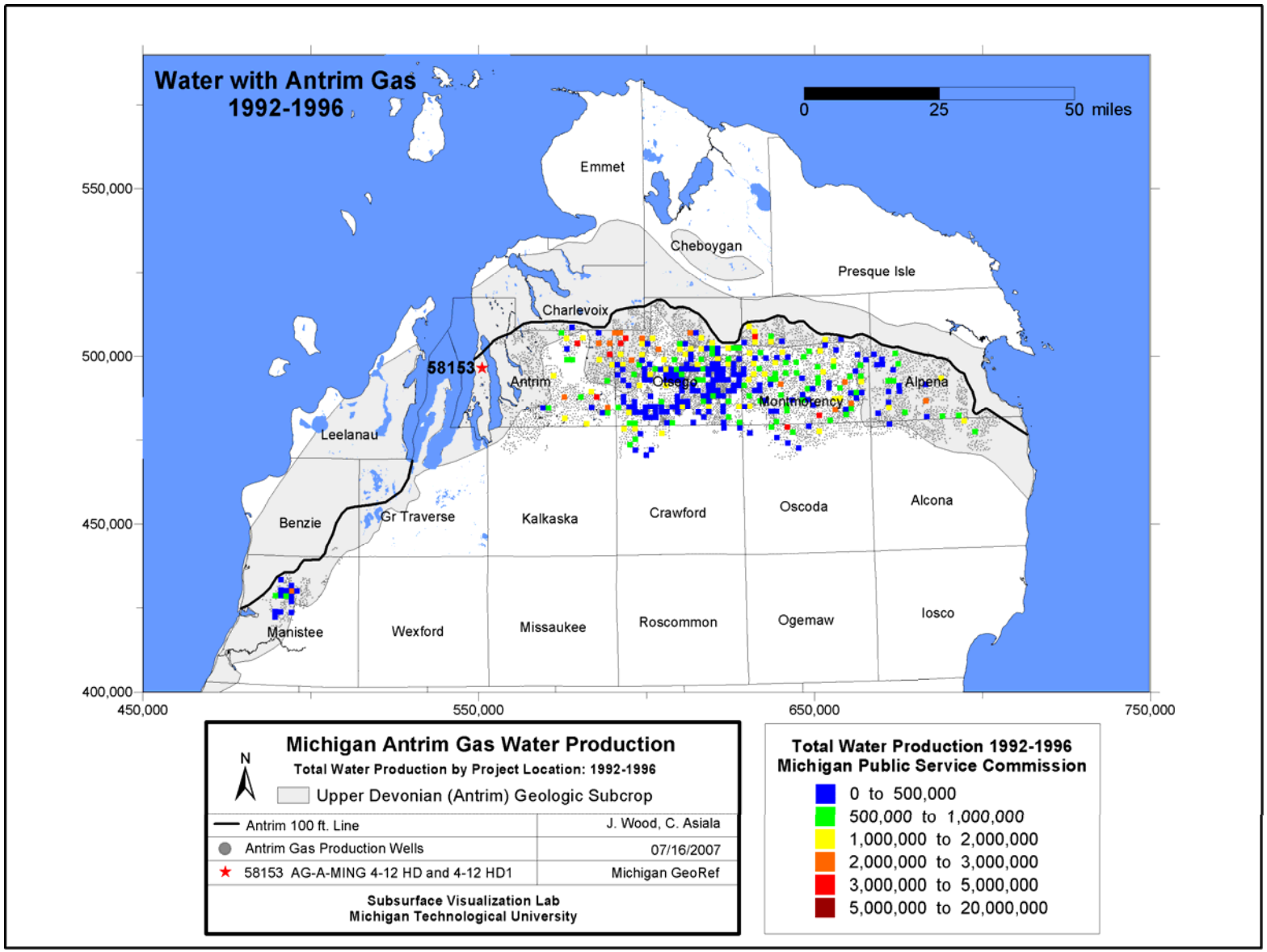
Appendix Figure 16-22. Summation of historic Antrim gas produced from 2002 through 2006 measured in MCF. Colored blocks represent the sum of gas produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



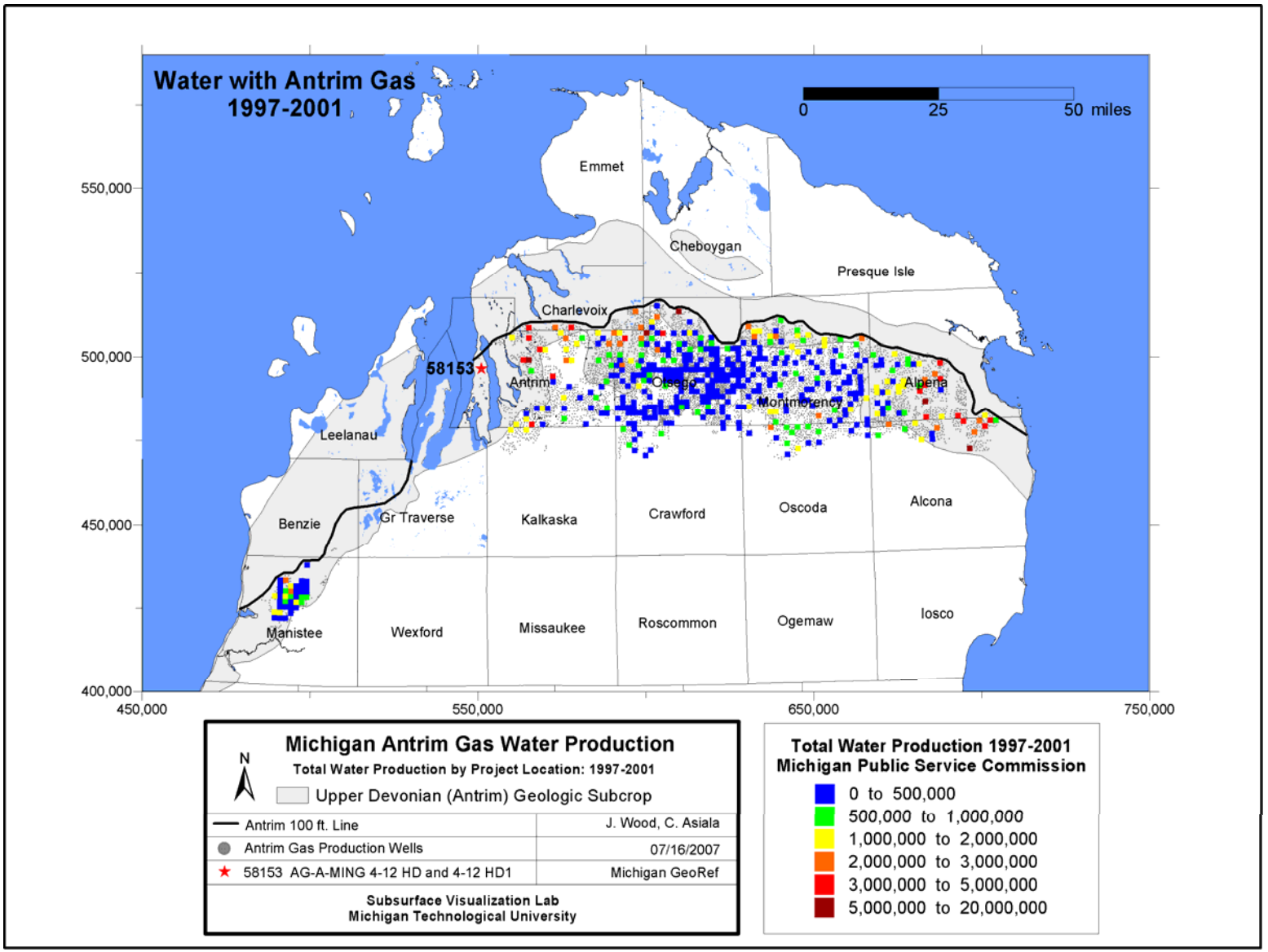
Appendix Figure 16-23. Summation of historic Antrim CO_2 produced from 1997 through 2001 measured in MCF. Colored blocks represent the sum of CO_2 produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



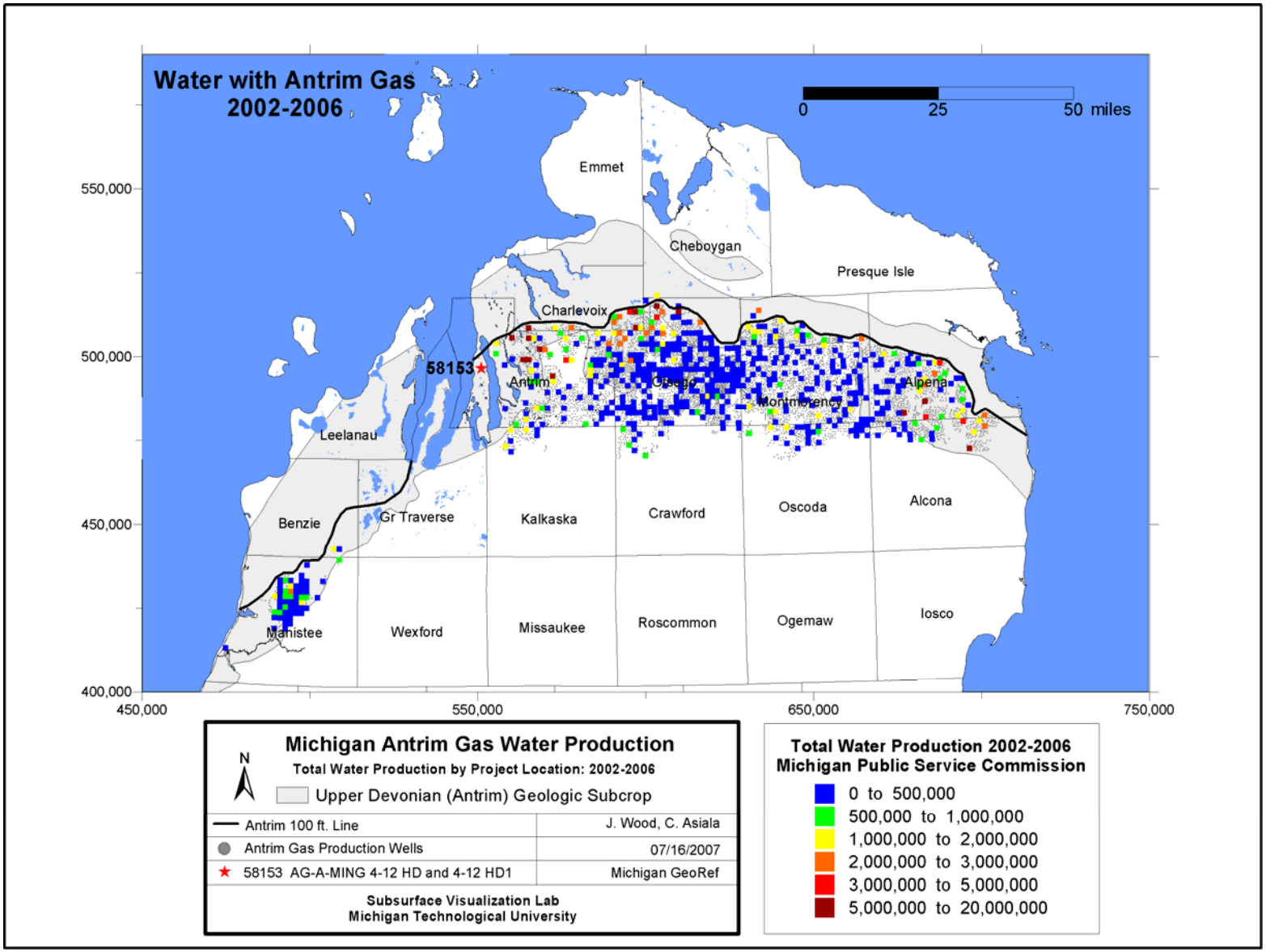
Appendix Figure 16-24. Summation of historic Antrim CO2 produced from 2002 through 2006 measured in MCF. Colored blocks represent the sum of CO2 produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



Appendix Figure 16-25. Summation of historic water produced with Antrim gas from 1992 through 1996 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



Appendix Figure 16-26. Summation of historic water produced with Antrim gas from 1997 through 2001 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.



Appendix Figure 16-27. Summation of historic water produced with Antrim gas from 2002 through 2006 measured in barrels. Colored blocks represent the sum of water produced by Section. PRroduction Units (PRU) are associated with the Section where most of PRU's wells are located.

17. APPENDIX IV. Antrim Shale Play

From presentation by Dr. William B. Harrison, III, Western Michigan University presented during the Annual DOE project meeting in March 2007.

Appendix Figure 17-1. Core photo of Lachine member of Antrim Formation in Welch-St. Chester #18, Otsego Co. (photo courtesy of WMU Core Repository).

Appendix Figure 17-2. Thin section of Lachine member in Welch-St. Chester #18, Otsego Co. (1486ft. 100X, photo courtesy of WMU Core Repository).

Appendix Figure 17-3. Annual and cumulative Antrim Shale gas production from data provided by the Michigan Public Service Commission.

17.1 Antrim Shale Timeline

Late 1920's: Michigan's commercial production begins in Devonian strata (Saginaw area). Drillers regularly note shows in Antrim.

1940: Rinehart & Hickok complete an Antrim test in Otsego County (34-30N-3W); it produces minor gas for 2 yr.

1965: Independent Murrell Welch proves economic viability of Antrim gas with successful pool development in south Chester twp., Otsego County (29N-2W).

1969: First Niagaran pinnacle discoveries in N. Michigan. Antrim shows recorded in essentially all Niagaran wells as the play grows - labeled "nuisance shows".

1975: Northern Michigan land & oil develops successful Antrim projects in Otsego County (29N-3W, 30N-2W).

1987: Underutilized Niagaran infrastructure, improved completion techniques, concept of Antrim "projects" with many wells feeding a central production facility (CPF), and non- conventional fuels tax incentives trigger modern play levels and production growth.

1992: Antrim wells must be completed or in progress by 01/01/93 to qualify for NCF section 29 tax credits, which expired 12/31/02. Drilling reaches peak in1992 with 1189 completed wells. Industry and regulatory agencies agree to voluntary 80-acre Antrim spacing on all new projects.

1995: Establishment of uniform spacing plan (USP) option for Antrim projects allows greater operator discretion in locating individual wells within a project. 80-acre spacing is mandated play-wide.

17.2 Antrim Completions and Project Operations

1. After drilling and logging, selected high interest zone(s) in the Lachine Member (core and thin section photos are shown in Appendix Figures 18-1 and 18-2) and Norwood Member pays are identified for stimulation.
2. The optimal pay in the thinner (15-22' thick), lower Norwood Member pay is selectively perforated and stimulated with a light sand-nitrogen frac. Two sand sizes are typically used.
3. Optimal intervals in the higher Lachine pay (overall thickness 55-80') are selectively perforated; either a single or multistage sand-nitrogen frac of the Lachine is performed, with frac size(s) larger than for the Norwood.
4. Wells are flowed back to the project's Central Production Facility (CPF) via PVC flowlines, either single (all fluids commingled) or dual phase (some gas/water separation at the wellhead).
5. At the CPF, dewatering of the gas is accomplished, typically via glycol treatment at dehy towers. Gas is compressed to sales line pressure (typically around 1300 PSIA) via a 4-stage compressor and sent out via stainless steel sales lines. (In areas lacking electricity, some of the dewatered, compressed gas is returned to the well via pipeline to power for drillstring gas lift systems.)
6. Each Antrim project typically injects formation water into a single salt water disposal (SWD) well, in underlying Devonian carbonates of the Dundee Formation or upper Detroit River Formation. SWD's are typically located at the CPF facility and controlled by Federal EPA regulations.
7. Gas is sent via the sales lines to large CO_2 removal facilities to reduce the 5-30% CO_2 content of Antrim gas to sales quality. It is sent to common carrier residential and commercial use lines from the CO_2 facility.

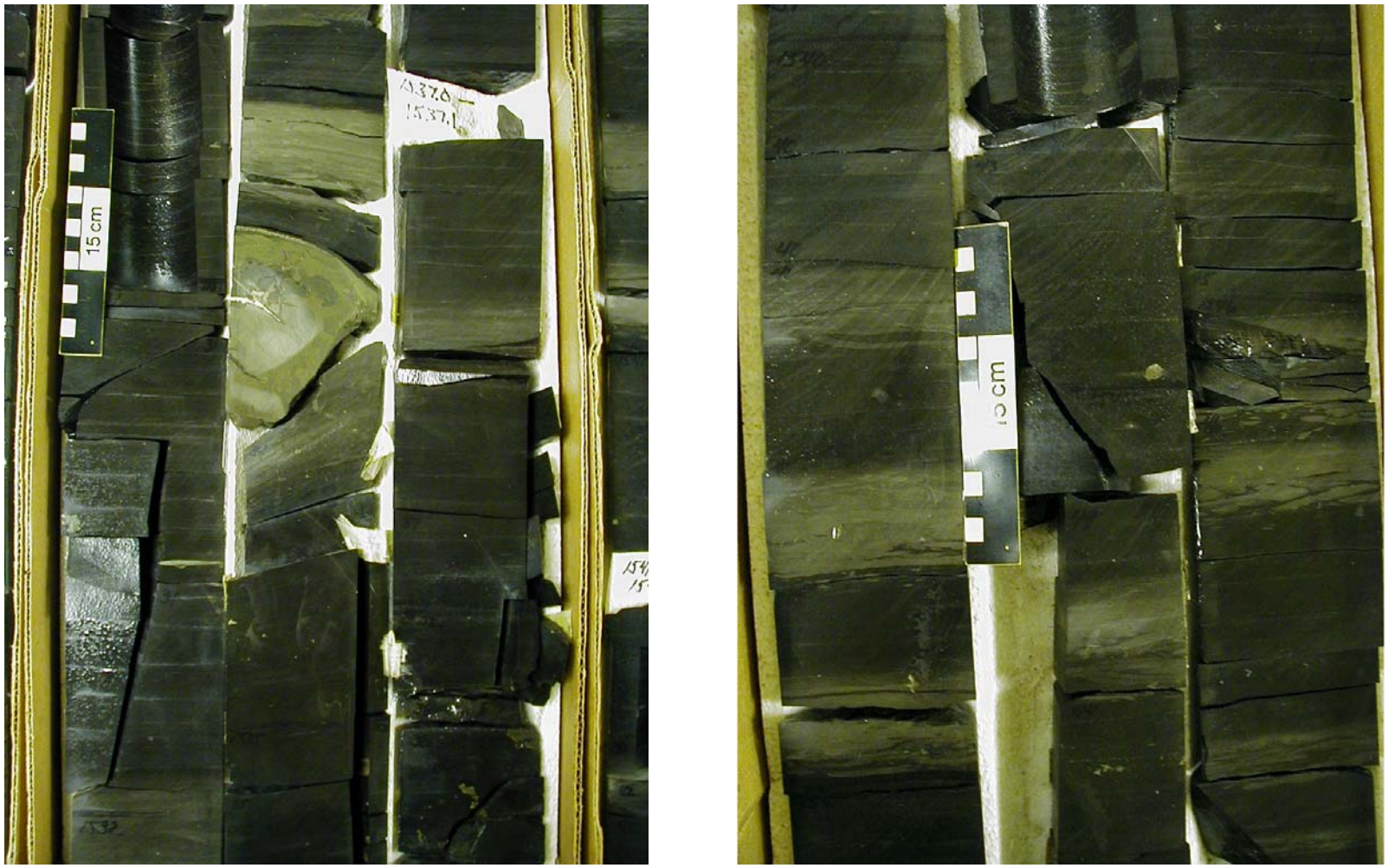
17.3 Antrim Drilling, Logging, and Evaluation

1. Antrim wells in Northern Michigan are drilled to depths ranging from 600-2000' (true vertical). Horizontal wells comprise about 1% of all wells to date, with varying commercial success. Directional drilling has been an effective means to reach drainage areas with restricted surface accessibility. Antrim tests are conventionally drilled with a water-based mud system—air drilling has not become a practice in the play.
2. By State statute, surface casing is required to a depth 100' (vertical) below the base of the Glacial Drift, the regional fresh water aquifer. (Drift depth range in the play area: 300-1100.')
3. Production casing is typically run through the entire Antrim pay section and into a varying amount of "rathole" drilled into the Traverse Group. (Many wells drilled into the early 1990's were open-hole completions, this is very uncommon today.)

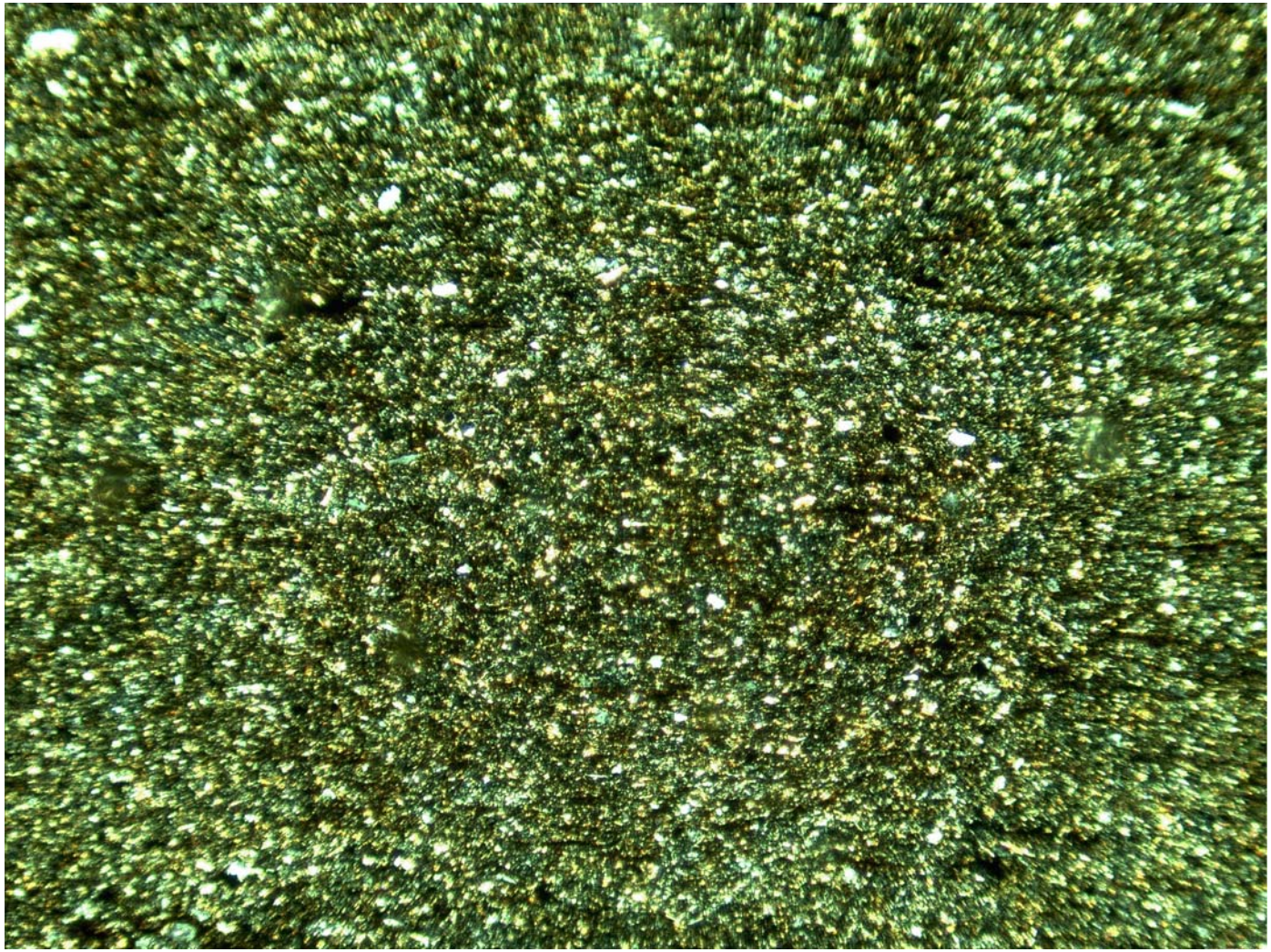
4. In early 1990's, many wells were not open hole logged. Evaluation and completion was defined by sample logs, ROP logs or cased hole gamma ray/collar correlation logs that identified the "hot" zones.
5. Many operators continue to use open hole logging in only a limited fashion, relying chiefly on mudlogs, ROP logs, and cased hole GR logs. Others evaluate the quality of Antrim pay by induction logs and porosity logs akin to the evaluation used in "conventional" reservoirs.
6. The advent of open hole fracture indicator logs has made their use both widespread and effective in Antrim evaluation. This includes such tools as the UBI (Schlumberger), CAST (Halliburton), and CBIL (Baker).
7. Coring and use of core data is extremely limited. No new cores in the main play area since the mid 1990's.

17.4 Conclusions

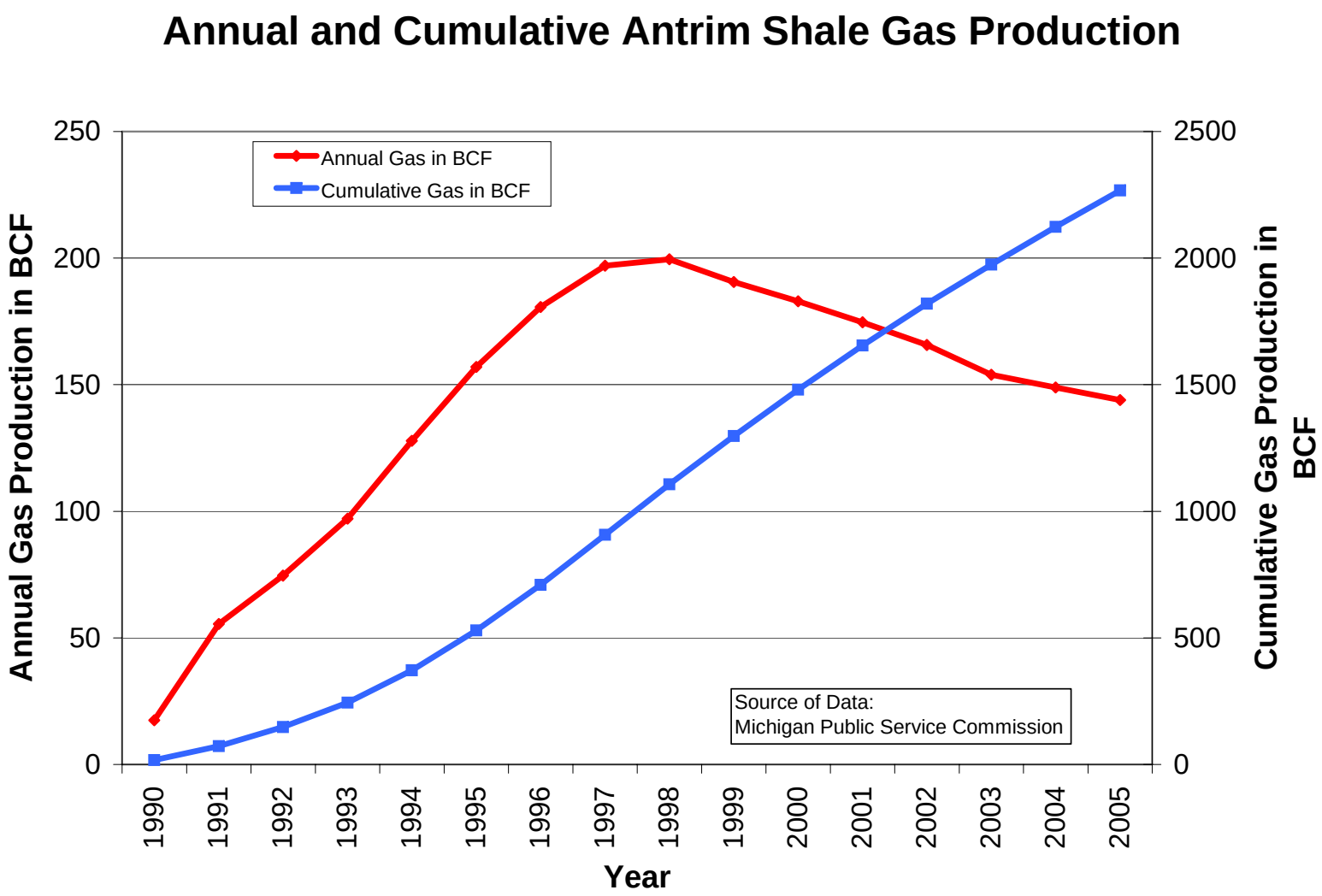
1. The Upper Devonian Antrim Shale is a major gas producer in the Michigan Basin (Appendix Figure 18-3).
2. The Antrim Shale is classic black shale that produces natural gas by desorption processes into a complex network of fractures.
3. The distribution of high total organic carbon and natural fractures are keys to good productivity.
4. Gas in place can be measured by geochemical rock analyses and suggest 0.5 to 1.0 BCF per 40 acres in the northern part of the basin.
5. Variable production history of project areas can be explained by reservoir rock properties measurable from core, logs and drill cuttings.



Appendix Figure 17-1. Core photo of Lachine member of Antrim Formation in Welch-St. Chester #18, Otsego Co. (photo courtesy of WMU Core Repository).



Appendix Figure 17-2. Thin section of Lachine member in Welch-St. Chester #18, Otsego Co. (1486ft. 100X, photo courtesy of WMU Core Repository).



Appendix Figure 17-3. Annual and cumulative Antrim Shale gas production from data provided by the Michigan Public Service Commission.

18. Appendix V. DeWard-Clever Project Data

The DeWard-Clever project is of interest to this DOE LINGO project because it is using the “J” well configuration of horizontal wells in south-east Antrim County, Michigan.

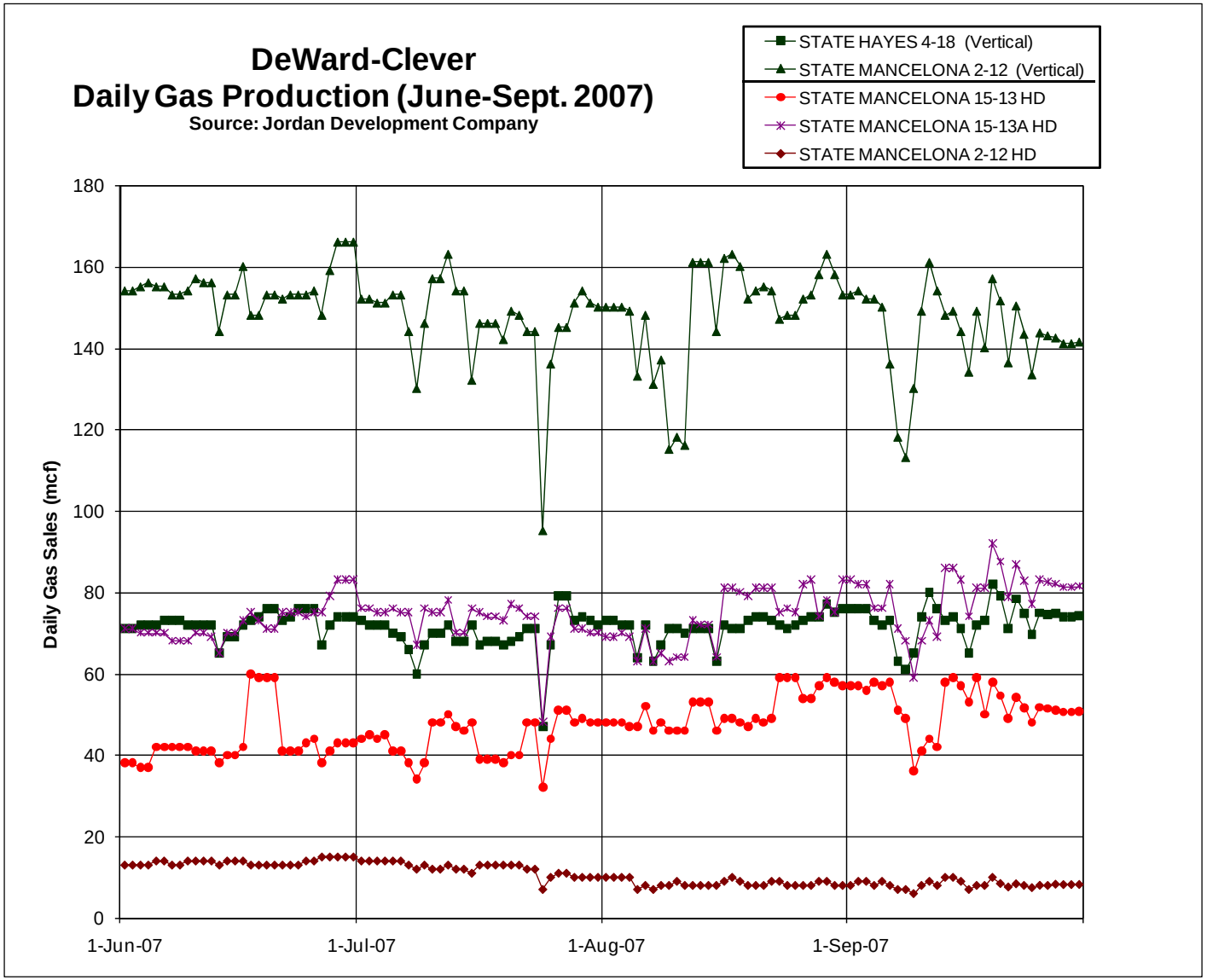
Appendix Figure 18-1. Daily Antrim gas production for the DeWard-Clever project wells located in southeast Antrim County. The horizontal wells are using the “J” well configuration planned for the LINGO project demonstration well.

Appendix Figure 18-2. Comparison of cumulative Antrim gas production for the DeWard-Clever project wells located in southeast Antrim County. The horizontal wells are using the “J” well configuration planned for the LINGO project demonstration well.

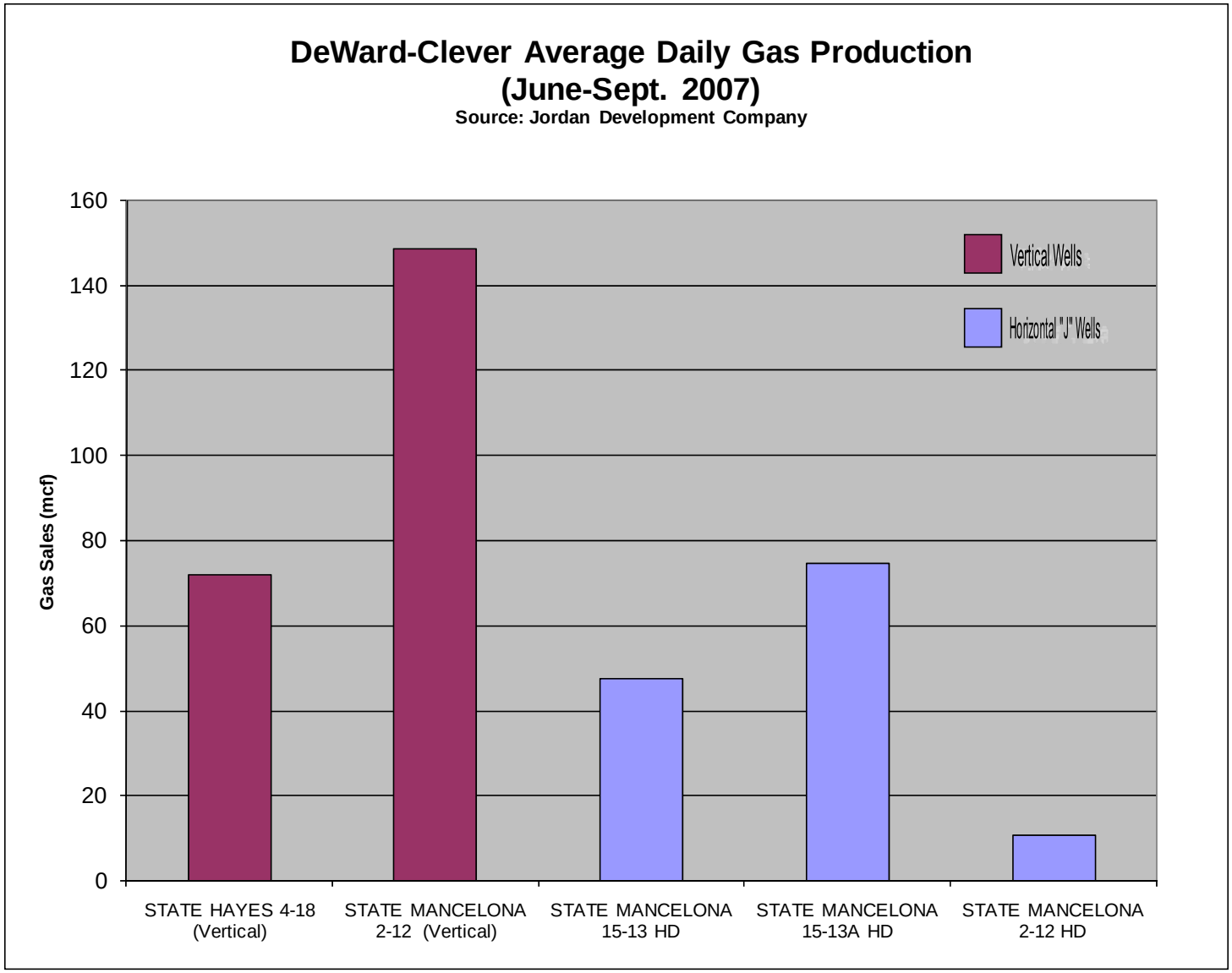
Appendix Figure 18-3. Well bore schematic of the "J" well configuration of the State Mancelona #15-13A HD1 & HD2 (Permit 57452) horizontal wells in the DeWard-Clever project in southeast Antrim County, MI.

Appendix Figure 18-4. Well bore schematic of the "J" well configuration of the State Mancelona #15-13 HD2 (Permit 57451) horizontal well in the DeWard-Clever project in southeast Antrim County, MI.

Appendix Figure 18-5. Well bore schematic of the "J" well configuration of the State Mancelona #2-12 HD3 (Permit 57450) horizontal well in the DeWard-Clever project in southeast Antrim County, MI.

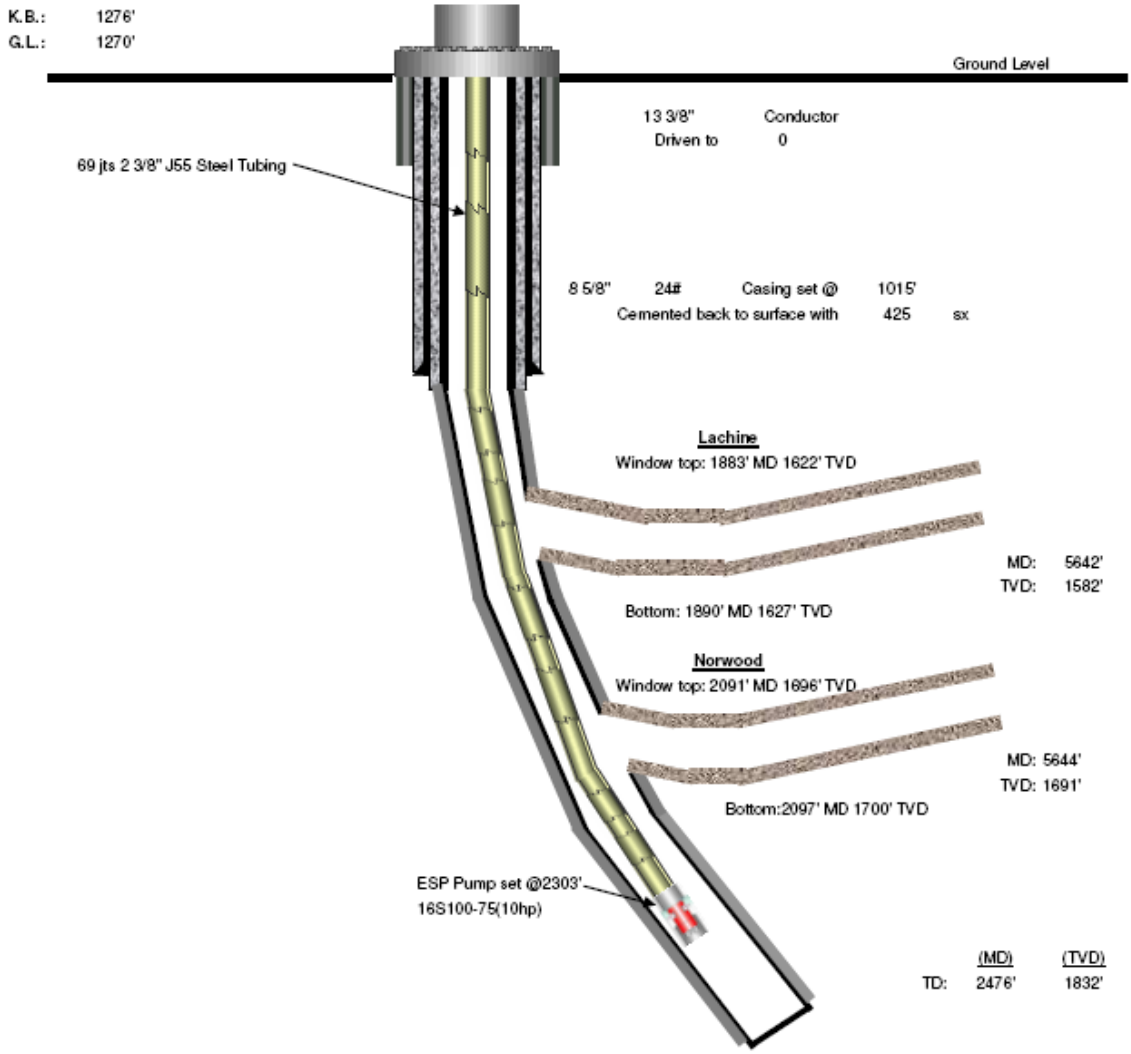


Appendix Figure 18-1. Daily Antrim gas production for the DeWard-Clever project wells located in southeast Antrim County. The horizontal wells are using the "J" well configuration planned for the LINGO project demonstration well.



Appendix Figure 18-2. Comparison of cumulative Antrim gas production for the DeWard-Clever project wells located in southeast Antrim County. The horizontal wells are using the "J" well configuration planned for the LINGO project demonstration well.

State Mancelona #15-13A HD1 & HD2

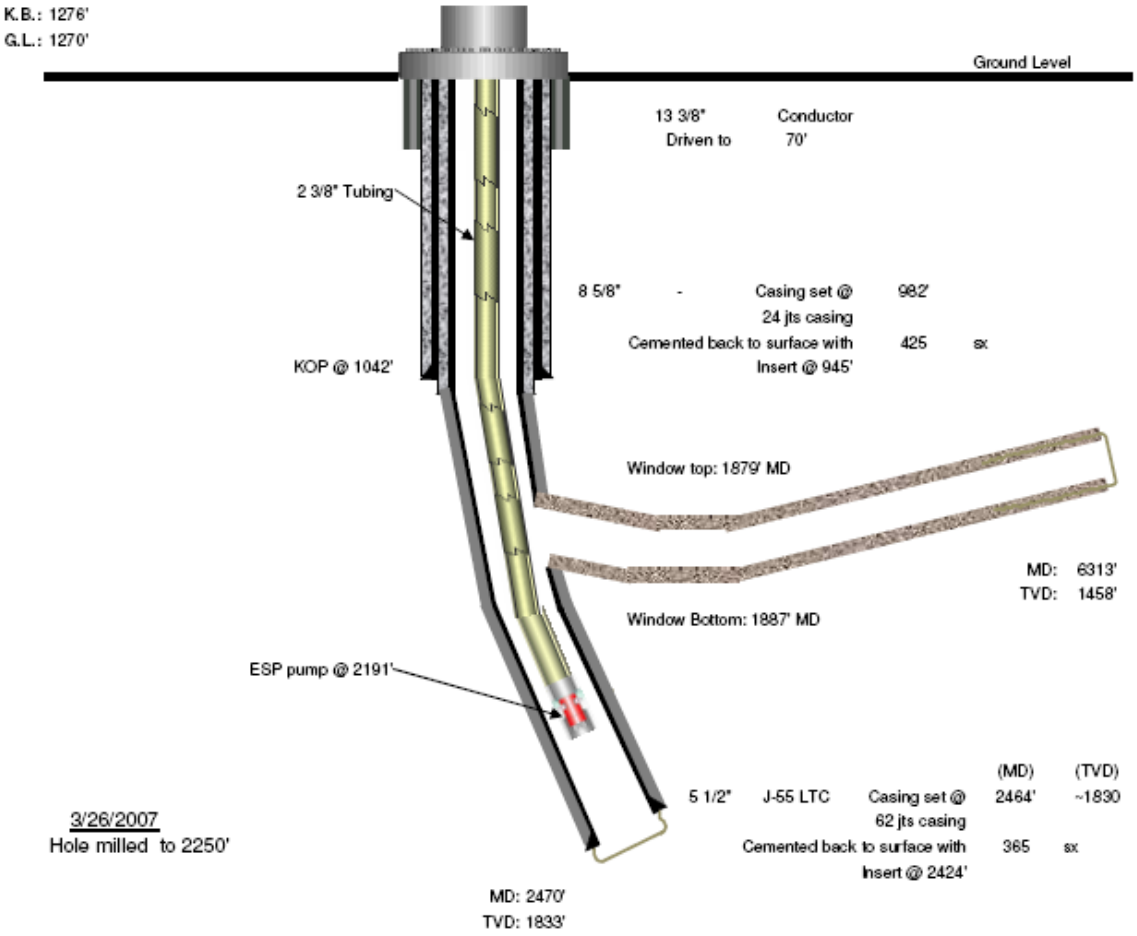


HD SHL:	SW SW SE	500' from S & 2212' from E, Sec 13, T29N R5W
HD BHL:	SE SW SE	512' from S & 1137' from E, Sec 13, T29N R5W
HD1 SHL:	SW SW SE	500' from S & 2212' from E, Sec 13, T29N R5W
HD1 BHL:	SE SE SW	522' from S & 2052' from W, Sec 18, T29N R4W
HD2 SHL:	SW SW SE	500' from S & 2212' from E, Sec 13, T29N R5W
HD2 SHL:	SE SE SW	513' from S & 2064' from W, Sec 18, T29N R4W

Well Name & Number:	State Mancelona #15-13A HD1 & HD2			MDEQ#	57452	**Spud Date:**	6-13-06
Section:	13	**Township:**	T29N	**Range:**	R5W	**Prepared By:**	Benjamin J. Nieto
County:	Antrim			**State:**	Michigan	**Last Revision Date:**	02/28/07
Township:	Mancelona			**Country:**	United States		

Appendix Figure 18-3. Well bore schematic of the "J" well configuration of the State Mancelona #15-13A HD1 & HD2 (Permit 57452) horizontal wells in the DeWard-Clever project in southeast Antrim County, MI.

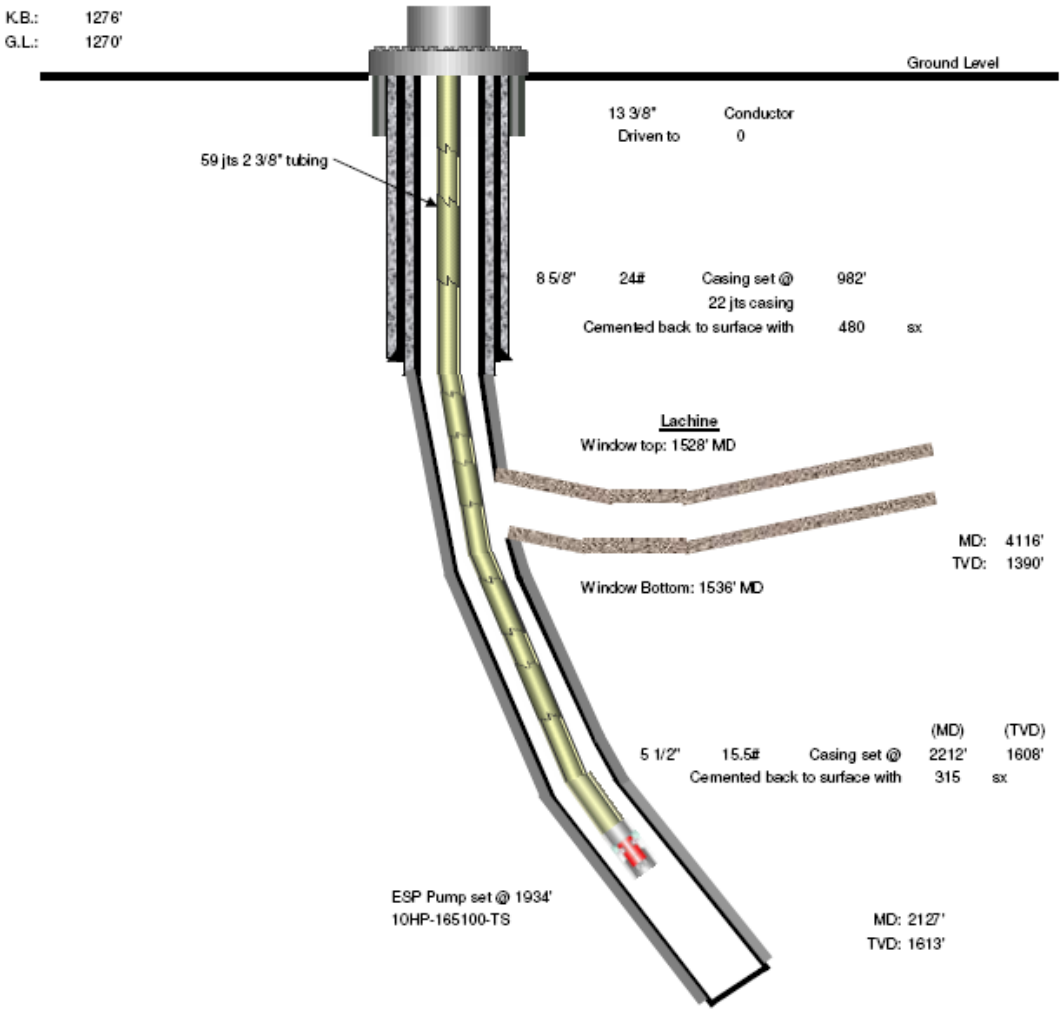
State Mancelona #15-13 HD2



Well Name & Number:	State Mancelona #15-13 HD2			**MDEQ#**	57451				
Sections:	12 & 13	**Township:**	T29N	**Range:**	R5W		**SHL, Sec 13:**	SW SW SE	
County:	Antrim			**State:**	Michigan		**BHL, Sec 12:**	NW NW NW	
Township:	Mancelona			**Country:**	United States				
Spud Date:	2-27-2007								
Prepared By:	Benjamin J. Nieto			**Last Revision Date:**	3-28-2007				

Appendix Figure 18-4. Well bore schematic of the "J" well configuration of the State Mancelona #15-13 HD2 (Permit 57451) horizontal well in the DeWard-Clever project in southeast Antrim County, MI.

State Mancelona #2-12 HD3



Well Name & Number:	State Mancelona #2-12 HD3			**MDEQ#**	57450		
Section:	12	**Township:**	T29N	**Range:**	R5W	**Surface Hole Location:**	NW NW NE
County:	Antrim			**State:**	Michigan		
Township:	Mancelona			**Country:**	United States		
Spud Date:	2-12-2007						
Prepared By:	Benjamin J. Nieto			**Last Revision Date:**	03/19/07		

Appendix Figure 18-5. Well bore schematic of the "J" well configuration of the State Mancelona #2-12 HD3 (Permit 57450) horizontal well in the DeWard-Clever project in southeast Antrim County, MI.