meetings. As needed, methane monitoring will be conducted to identify any potential explosion hazards.

A packer will be set at a depth of approximately 5,500 feet BGL (5,514 feet KB) or deeper inside the 7" long string casing, and 4-½" OD, 12.6 lb/ft, J-55 LT&C tubing will be run from the packer to surface. As appropriate, coated or lined tubing and packer may be used to manage potential corrosion issues. A radioactive tracer survey (RAT) and a temperature log will then be conducted to establish baseline conditions and to demonstrate initial external mechanical integrity. A pressure transient test will also be conducted to derive estimates of formation pressure and properties (See Section A.14). A proposed schematic summarizing the proposed IW-1 well completion is presented as Figure A.11-1.

No over-pressured zones are anticipated during drilling of the IW-1 well; there are local oil and gas wells completed in the Traverse and other shallow formations above the Mt. Simon (see Section B.14), but well fields are approximately 2 miles to the south west and southeast and not expected to pose an issue with respect to over pressuring. If under-pressured zones are encountered, lost-circulation materials will be utilized to control fluid loss as necessary based on well conditions. Fresh water will be trucked to the site using local oilfield suppliers or a pre-existing water well already located on the property will be used to supply water during drilling and testing of this well. Fresh water will be used as the drilling fluid, and will be held in on-site tanks with no in-ground pits. Upon completion of drilling operations, remaining fluids and solids will be disposed of on-site or off-site by a licensed waste hauler or a suitable equivalent contractor.

The IW-1 well is expected to be installed and tested in the year 2019 or 2020 according to applicable regulations and permit requirements. Static pressure testing of the Mt. Simon will be performed, along with determination of various injection interval characteristics such as permeability-thickness that would be determined via pressure transient testing. Injection formation native brine chemistry and characteristics will be determined based by acquisition of a fluid sample. Characteristics of the injection interval will also be evaluated based on geophysical well logging results. Additional details regarding the well logging are presented in Table A.13-1 in Section A.13.

Based on equipment availability, prior to conducting any injection testing, injection interval fluid will be produced from a targeted injection formation using either a submersible pump or swabbing equipment. Based on fluid loss encountered during drilling and field conditions, target production volumes for obtaining representative samples will be adjusted in the field, based on conditions encountered. Field parameters including pH and conductivity will also be monitored at surface as fluid is recovered to determine when representative sampling is practical. Injection Zone formation fluid will be subjected to analysis for the following parameters:

- Alkalinity, Arsenic, Barium, Bicarbonate, Cadmium, Calcium, Carbonate, Chloride, Chromium, Conductivity, Copper, Hardness, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Nitrate, as (N), pH, Potassium, Radium 226, Radium 228, Selenium, Silica as SiO2, Sodium, Specific Gravity, Strontium, Sulfur, TDS, TSS, Zinc

Mechanical integrity and ambient monitoring will be conducted after well construction activities are complete. Annual Part I mechanical integrity testing (MIT) for the IW-1 well and 5-year Part II MIT are detailed below. WM will provide the agency a minimum of 30 days notice prior to annual testing. Although test procedures or methods may be changed based on approval by MDEQ staff, the following procedure will be used for the first such testing performed:

1. Conduct Wellsite Safety Meeting
   a. Prior to commencement of field activities, conduct safety meeting with contractors and personnel to be involved with field services and MIT testing. Ensure that all safety procedures are understood and review days' work activities.

2. Conduct Reservoir (Fall-Off or Static) Pressure Test
   a. For fall-off, record data regarding test well injection at typical operating conditions (constant rate). Rate versus time data will be recorded during the injection period. Cumulative injection volume will also be recorded. Continue injection for a minimum of approximately 8 hours. Note that significant rate variations may yield poor quality data or require more complicated analysis techniques.
   b. Rig-up pressure gauge and run in well to a depth likely not to exceed approximately 5,600 feet or other depth approved by MDEQ.
   c. For pressure transient fall-off, obtain final stabilized injection pressure for a minimum of 1 hour. For static test, collect a minimum of two pressure/temperature readings at depth. Ensure that the gauge temperature readings have also stabilized.
   d. After gauge recordings are stable, cease injection and monitor pressure fall-off. Continue monitoring pressure for a minimum of 8 hours or until a valid observation of fall-off curve is observed. For a static gradient survey, the well will be shut-in for a minimum of 48 hours before testing. Wellbore pressure gradients will be obtained to establish fluid gradient and bottomhole pressure data will be collected for a minimum of 4 hours for static testing.
   e. Stop test data acquisition, rig-down and release equipment.

3. Annulus Pressure Test
   a. Stabilize well pressure and temperature.
   b. As practical, arrangements will be made for a representative from the MDEQ to be present to witness testing.
   c. Install ball valve or similar type "bleed" valve on annulus gate valve. Pressurize annulus to a minimum of 100 psig above maximum permitted operating pressure and shut-in valve. Install certified gauge on "bleed" type valve. The annulus may need to be pressurized and bled off several

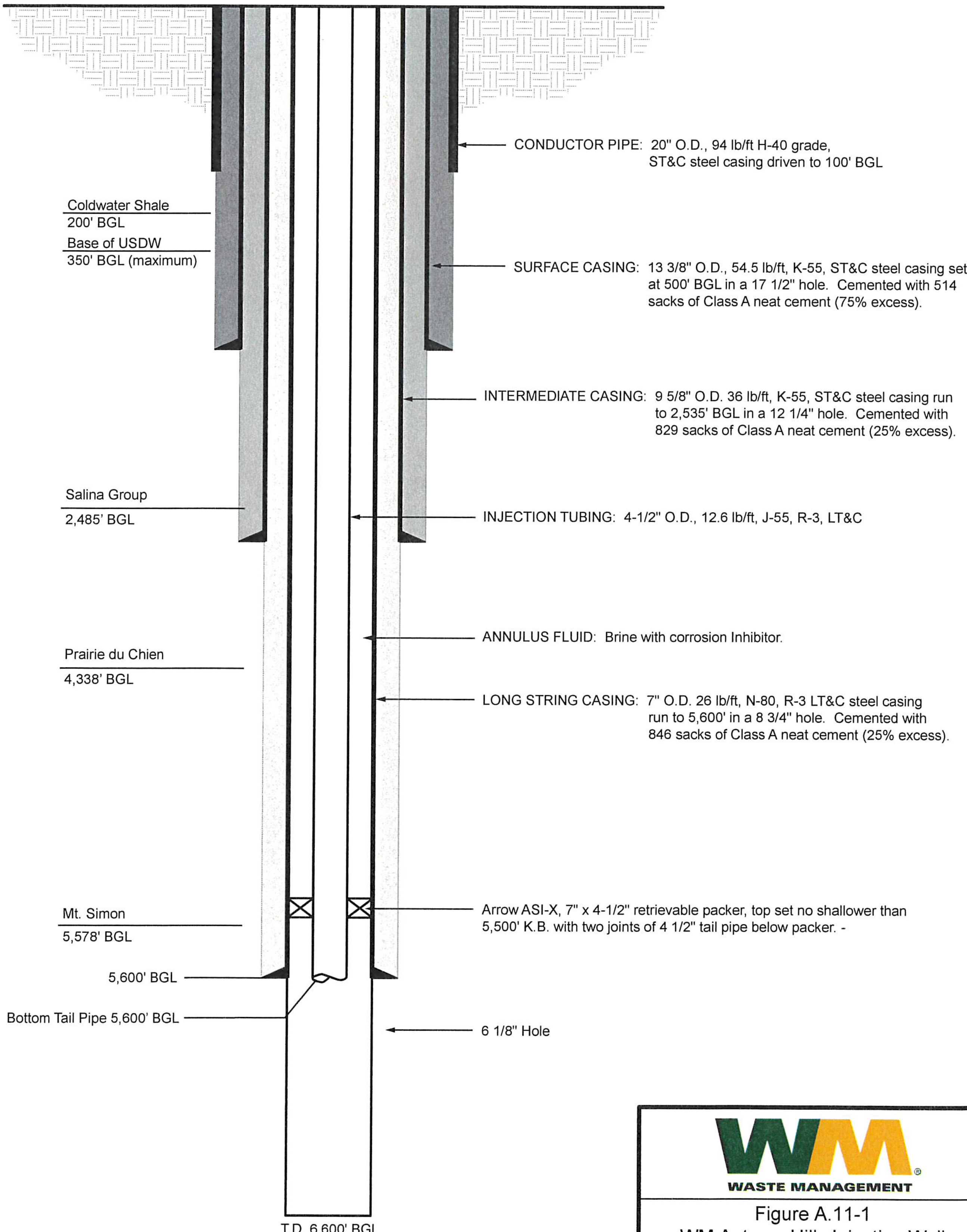
times to ensure an absence of air.

d. Monitor and record pressure for 1 hour. Pressure may not fluctuate more than 3% during the one-hour test.
e. Lower the annulus pressure to normal operating pressure at the end of the test.

Part II mechanical integrity demonstration, as required by the MDEQ, for the well will be accomplished via a minimum of one approved logging method such as temperature log, or radioactive tracer survey, or noise log, or oxygen activation log. WM will provide the agency with a minimum of a 30-day notice of Part II testing as practical to allow the agency an opportunity to witness data collection activities.

Although WM may utilize any acceptable method per MDEQ procedure approval, at this time it is proposed that temperature logging be utilized for 5-year Part II mechanical integrity testing. Static temperature logging is to be conducted as follows:

1. Conduct Temperature Log
   a. Shut-in well for stabilization (minimum of 36 hours, or as required by EPA/MDEQ) prior to running base temperature log.
   b. Rig-up temperature log and run base log from surface to total depth. Pull tool to surface and shut-in master valve.
   c. Rig-down equipment and return the well to normal operations.



NOTE:

- NOT TO SCALE

* - TD will be at the base of the Mt. Simon. 6,600 ft. is assumed to account for formation top variability.

WASTE MANAGEMENT

Figure A.11-1
WM Autumn Hills Injection Well
No. IW-1 Well Schematic

2018 Autumn Hills RDF - MDEQ Class I Permit

Scale: See Vertical Scale	Date: March 2019	
2019_WM_MDEQ_Fig_A.11-01_rev	By: KRS	Checked: AP

Petrotek
5935 South Zang Street, Suite 200
Littleton, Colorado 80127 USA
303-290-9414
www.petrotek.com

A.12 Description of the cementing program including the type, properties and compressive strength of cement to be used on each casing string. Indicate if DV tools will be used.

Figure A.11-1 presents the wellbore diagram for the proposed IW-1 well. The cement used for all cement jobs will be Michigan equivalent type A cement; 2% bentonite and 2% $CaCl_2$ may be required depending on field conditions. Assuming no bentonite or additives, the water requirements will be 5.2 gallons/sack with a slurry yield of 1.18 ft^3/sack. Any casing shoe tests (surface and long string casing only) will be run at values conservatively estimated to be below fracture pressure. At a depth of 500 feet (surface casing), assuming a bottomhole gradient not to exceed 0.7 psi/ft, and a normally pressured formation (0.433 psi/ft) at the shoe, a differential pressure (Δp) of less than 134 psi (500 ft * [0.7 – 0.433]) would be applied to the casing shoe. At a depth of 2,535 feet (intermediate casing) assuming a bottom hole gradient not to exceed 0.7 psi/ft, and a normally pressured formation (0.433 psi/ft) at the shoe, a differential pressure (Δp) of less than 677 psi (2,535 * [0.7 – 0.433]) would be applied at the casing shoe. At a depth of 5,600 feet (long string casing), assuming a bottomhole gradient not to exceed 0.7 psi/ft, and a normally pressured formation at the shoe, a Δp of less than 1,495 psi (5,600 * [0.7 – 0.433]) would be applied to the casing shoe. As noted by Bourgouyne et al. (1991) in Section 3.4.11 of his text, the exact amount of compressive strength needed before drilling activities can continue is difficult to determine, but a value of 500 psi is commonly used in field practice. Compressive strengths that exceed projected test pressures for the proposed cement blends over the range of temperatures expected (60 to 80 degrees Fahrenheit) conservatively referenced at atmospheric pressure are given in the following table:

Time (Hours)	Class A 60°F Compressive Strength (psi)	Class A 80°F Compressive Strength (psi)	2% Bentonite 60°F with 2% CaCl Compressive Strength (psi)	2% Bentonite 80°F with 2% CaCl Compressive Strength (psi)
8	20	265	135	620
12	80	580	255	1,150
24	615	1,905	765	1,820
36*	1,087*	2,823*	1,420*	--
72	2,050	4,125	--	--

*extrapolated

The cement volumes for each hole section up to and including the 7" casing cement job are summarized in the following table. Excess cement volumes may be increased depending on caliper logging.

Interval	Hole Size (in)	Casing Size (OD, in)	Depth (ft BGL)	Excess Cement (%)	Cement Required (with excess, sacks)	Cement Class (API)	Cement Yield (ft^3/sk)
Conductor	26.00	20.00	100	25%	*159**	A	1.18
Surface	17.5	13.375	500	75%	514	A	1.18
Intermediate	12.25	9.625	2,535	25%	829	A	1.18
Long String	8.75	7.000	5,600	25%	846	A	1.18

**optional if conductor casing is driven*

Unexpectedly high permeability or low reservoir pressure may require two cement stages for a particular cement job; in this case a DV tool may be utilized. It is anticipated that each cement job will be completed in a single stage unless conditions require a two-stage job. Any change to the procedure based on field conditions will be provided to MDEQ by email at least 24-hours in advance of cementing.

REFERENCES

Bourgouyne, A.T., Martin E. Chenevert, Keith K. Millheim, F.S Young Jr., 1991. Applied Drilling Engineering, SPE Textbook Series, Volume 2.

A.13 Description of the proposed wireline logging program.

The proposed wireline logging program is summarized in Table A.13-1, below.

TABLE A.13-1 LIST OF PROPOSED LOGS, AUTUMN HILLS WELL IW-1

Description	Estimated Depth Run
SP, Gamma Ray and Caliper Logs (Openhole before installing surface casing)	500 feet BGL – Surface
Dual LateroLog, SP, Gamma Ray, Formation Density, Compensated Neutron, and Caliper Log (Openhole before installing intermediate and long string casing)	2,535 - 500 feet BGL 5,600 – 2,535 feet BGL
Cement Bond Log (Surface,Intermediate casing)	Surface casing shoe to surface Intermediate casing shoe to surface casing shoe
Dual LateroLog, SP, Gamma Ray, Formation Density, Compensated Neutron, Fracture Finder ID Log (Openhole)	Mt. Simon injection interval (TD to 100 feet above injection interval)
Cement Bond Log, Casing Inspection Log and Directional Survey (Long-string casing)	Long string shoe to surface shoe

A.14 Description of the testing program, including pressure tests on casing strings, and any planned drill stem tests.

The IW-1 well is expected to be installed and tested in the year 2018 or 2019 according to applicable regulations and permit requirements. Static pressure testing of the Mt. Simon will be performed, along with determination of various injection interval characteristics such as permeability-thickness that would be determined via pressure transient testing. Injection formation native brine chemistry and characteristics will be determined based by acquisition of a fluid sample. Characteristics of the injection interval will also be evaluated based on geophysical well logging results. Additional details regarding the well logging are presented in Table A.13-1 in Section A.13. The following information is also presented in Section A.11 but is repeated to facilitate application review.

Based on equipment availability, prior to conducting any injection testing, injection interval fluid will be produced from a targeted injection formation using either a submersible pump or swabbing equipment. Based on fluid loss encountered during drilling and field conditions, target production volumes for obtaining representative samples will be adjusted in the field, based on conditions encountered. Field parameters including pH and conductivity will also be monitored at surface as fluid is recovered to determine when representative sampling is practical. Injection Zone formation fluid will be subjected to analysis for the following parameters:

- Alkalinity, Arsenic, Barium, Bicarbonate, Cadmium, Calcium, Carbonate, Chloride, Chromium, Conductivity, Copper, Hardness, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Nitrate, as (N), pH, Potassium, Radium 226, Radium 228, Selenium, Silica as SiO2, Sodium, Specific Gravity, Strontium, Sulfur, TDS, TSS, Zinc

Mechanical integrity and ambient monitoring will be conducted after well construction activities are complete. Annual Part I mechanical integrity testing (MIT) for the IW-1 well and 5-year Part II MIT are detailed below. WM will provide the agency a minimum of 30 days notice prior to annual testing. Although test procedures or methods may be changed based on approval by MDEQ staff, the following procedure will be used for the first such testing performed:

1. Conduct Wellsite Safety Meeting
    a. Prior to commencement of field activities, conduct safety meeting with contractors and personnel to be involved with field services and MIT testing. Ensure that all safety procedures are understood and review days' work activities.
2. Conduct Reservoir (Fall-Off or Static) Pressure Test
    a. For fall-off, record data regarding test well injection at typical operating conditions (constant rate). Rate versus time data will be recorded during the injection period. Cumulative injection volume will also be recorded. Continue injection for a minimum of approximately 8 hours. Note that

significant rate variations may yield poor quality data or require more complicated analysis techniques.

b. Rig-up pressure gauge and run in well to a depth likely not to exceed approximately 5,600 feet or other depth approved by MDEQ.
c. For pressure transient fall-off, obtain final stabilized injection pressure for a minimum of 1 hour. For static test, collect a minimum of two pressure/temperature readings at depth. Ensure that the gauge temperature readings have also stabilized.
d. After gauge recordings are stable, cease injection and monitor pressure fall-off. Continue monitoring pressure for a minimum of 8 hours or until a valid observation of fall-off curve is observed. For a static gradient survey, the well will be shut-in for a minimum of 48 hours before testing. Wellbore pressure gradients will be obtained to establish fluid gradient and bottomhole pressure data will be collected for a minimum of 4 hours for static testing.
e. Stop test data acquisition, rig-down and release equipment.

3. Annulus Pressure Test
   a. Stabilize well pressure and temperature.
   b. As practical, arrangements will be made for a representative from the MDEQ to be present to witness testing.
   c. Install ball valve or similar type "bleed" valve on annulus gate valve. Pressurize annulus to a minimum of 100 psig above maximum permitted operating pressure and shut-in valve. Install certified gauge on "bleed" type valve. The annulus may need to be pressurized and bled off several times to ensure an absence of air.
   d. Monitor and record pressure for 1 hour. Pressure may not fluctuate more than 3% during the one-hour test.
   e. Lower the annulus pressure to normal operating pressure at the end of the test.

Part II mechanical integrity demonstration, as required by the MDEQ, for the well will be accomplished via a minimum of one approved logging method such as temperature log, or radioactive tracer survey, or noise log, or oxygen activation log. WM will provide the agency with a minimum of a 30-day notice of Part II testing as practical to allow the agency an opportunity to witness data collection activities.

Although WM may utilize any acceptable method per MDEQ procedure approval, at this time it is proposed that temperature logging be utilized for 5-year Part II mechanical integrity testing. Static temperature logging is to be conducted as follows:

1. Conduct Temperature Log
   a. Shut-in well for stabilization (minimum of 36 hours, or as required by EPA/MDEQ) prior to running base temperature log.
   b. Rig-up temperature log and run base log from surface to total depth. Pull tool to surface and shut-in master valve.
   c. Rig-down equipment and return the well to normal operations.

A.15 Description of any planned coring program.

No coring program is currently planned during the drilling of the IW-1 well.

B. Additional information required for an application for a permit to drill and operate a disposal well or to convert a previously drilled well to such a well:

B.1 Form EQP 7200-14, Injection Well Data.

Disposal well data is presented on form EQP 7200-14, which is attached at the end of this Section (B.1).

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY - OIL, GAS, AND MINERALS DIVISION

INJECTION WELL DATA

Supplemental information for drilling or converting to an injection well

By authority of Part 615 or Part 625 of Act 451 PA 1994, as amended.
Non-submission and/or falsification of this information may result in fines and/or imprisonment.

Applicant: Waste Management of Michigan, Inc.
Autumn Hills Recycling and Disposal Facility

Well name and number: IW-1

INSTRUCTIONS: Complete all portions of form which apply to this well. **Attach supplemental documents as needed.**

1. File a separate plat which identifies the depth and location of this proposed well and all producing, abandoned, or drilling wells within 1320 feet of it. Also identify the permittee of each producing well within 1320 feet of this proposed well.
2. Enclose a copy of the completion reports for all wells and the plugging records for all plugged wells shown on the plat. Identify what steps will be necessary to prevent injected fluids from migrating up or into inadequately plugged or completed wells.
3. Provide information demonstrating that construction of the well will prevent the movement of fluid containing any contaminant into an underground source of drinking water.
4. If this is an existing well to be converted to an injection well, enclose this form with an Application To Change Well Status (form EQP 7200-06). Also enclose a copy of the completion report and geologic description and electric logs for this well.
5. Injection wells (except for gas storage) must receive a mechanical integrity test every 5 years pursuant to Rule 324.805.

6. Type of fluids to be injected
☐ Brine ☐ Natural Gas (omit #8 & #13)
☐ Fresh Water (omit #13) ☒ Other Landfill Leachate

7. Maximum expected injection rate: 150 gpm

8. Specific gravity of injected fluid: 1.1 (1.05 plus 0.05 safety margin)

9. Maximum expected injection pressure: 944 psig (Top Injection Zone); 1,493 psig (Top Mt Simon inj. interval)

10. Maximum bottom hole injection pressure: 4,150 psig (Top Inj. Interval); 2,779 psig(Top Inj. Zone)
Show calculations 1,493 + (5,578 x 0.433 x 1.1) [Top Injection Interval]
944 + (3,853' x 0.433 x 1.1) [Top Injection Zone];both include safety margin

11. Fracture pressure of confining formation: Utica Shale base 2,793 psig; top 2,656 psig
Show calculations (Top of Confining Fm)
0.725 x 3,853' = 2,793 (base); 0.725 x 3,663' = 2,656 (top)

12. Fracture pressure of injection formation: 4,044 (top Injection Interval); 2,793 (top Injection Zone)
Show calculations (Top of Injection Fm)
0.725 x 5,578 = 4,044 (top Mt. Simon injection interval), 0.725 x 4,893 = 3,547 (top Inj. Zone)

13. Chemical analysis of representative samples of injected fluid
Specific conductance 9,580 umhos/cm (field)

Cation (mg/l)		Anions (mg/l)	
Calcium	140 mg/l	Chloride	3,100 mg/l
Sodium	2,800 mg/l	Sulfate	615 mg/l
Magnesium	160 mg/l	Bicarbonate	9,500 mg/l
Potassium	890 mg/l		

What was the source of this representative sample? leachate and gas condensate

14. Is this well to be completed in a potential or previous oil or gas producing formation? ☐ Yes ☒ No
If yes, provide a list of all offset permittees and proof of service of notification of this application to all permittees by certified mail.

15. Attach proposed plugging and abandonment plan (EQP 7200-6), along with a schematic detailing the depths, volumes, and types of cement and mechanical plugs, and depths where casing will be recovered.

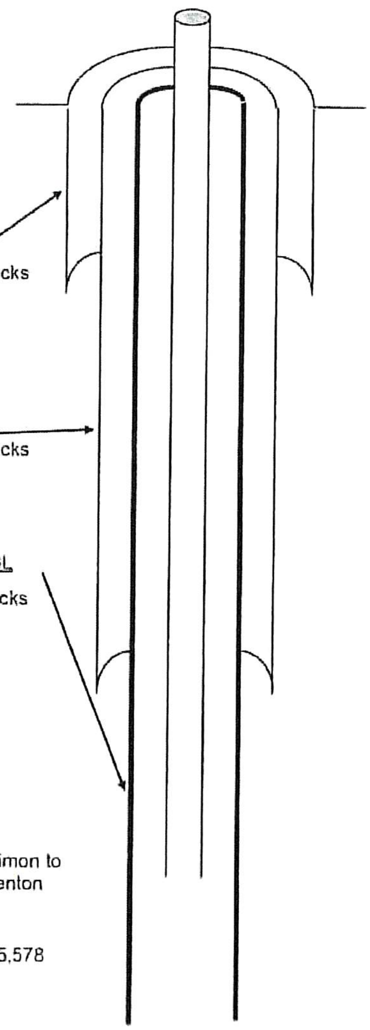
The Plugging and Abandonment Plan is included in Section B.15 of the Permit Application.

Schematic of wellbore construction

Complete bottom of diagram as needed to conform with proposed construction (e.g. show rat hole below casing, open hole completion, packer loc. etc.)

Underground source(s) of drinking water (formation name(s) & depth(s)): Glacial till to base of Marshall Fm/top of Coldwater estimated at ~220 ft BGL

Base of deepest underground source of drinking water, name & depth: Base of Marshall Sandstone: 220 ft BGL



Surface casing 13 3/8 "x 500' BGL
Amount of cement 514 sacks
T.O.C. 0

Intermediate casing (if applicable) N/A
9 5/8 "x 2,535' BGL
Amount of cement 829 sacks
T.O.C. 0

Long string casing 7 "x 5,600' BGL
Amount of cement 846 sacks
T.O.C. 0

Confining formation(s) Utica Shale
Depth to top 3,663' BGL
Depth to base 3,853' BGL

Injection formation(s) Munsing Group, Mt. Simon to Trenton
Depth to top 3,853' BGL
Depth to base 6,600' BGL
Note: Mt. Simon is injection interval, top at 5,578

Tubing 4 1/2 " x 5,500' BGL
Packer Depth 5,514" KB

Bottom TD or PBTD 6,600' BGL ft. → 6,600' BGL

16. Application prepared by (print or type): Denise Gretz
Signature: Denise Gretz
Date: 3/25/19

EQP 7200-14 (rev. 2/2017) Enclose with *APPLICATION FOR PERMIT TO DRILL* or *APPLICATION TO CHANGE WELL STATUS*

B.2 A calculation of the area of review in the injection interval over the anticipated life of the well. "Area of review" means either of the following:

A. For a well disposing of non-hazardous waste, that area the radius of which is the greater of 1/4 mile or the lateral distance in which the pressures in the injection zone are sufficient to increase hydrostatic head in the injection zone above the base of the lowermost underground source of drinking water, but not more than 2 miles.

B. For a well disposing of hazardous waste that area the radius of which is the greater of 2 miles or the lateral distance in which the pressures in the injection zone are sufficient to increase hydrostatic head in the injection zone above the base of the lowermost underground source of drinking water.

The IW-1 well will be used for the injection of non-hazardous liquid waste generated on-site. To be conservative, a 2-mile area of review (AOR) is adopted for this permit as allowed by regulation. The cone of influence is anticipated to be smaller than the statutory value of 2-miles. A conservative fixed radius of 1/4-mile has been defined for the evaluation of freshwater artificial penetrations. These AOR radii have both been applied from the property boundary of the Autumn Hills RDF. Freshwater well data for penetrations located within the area defined by a 1/4-mile radius have been identified from state files and submitted. See Figure A.4-6 at the end of Section A.4 for a summary of shallow freshwater penetrations. Figure B.4-1 at the end of Section B.4 provides a summary of all deep non-freshwater penetrations. As noted in Section B.4, only one of these deep wells penetrates the confining zone and uppermost injection zone, but not the injection interval, within the two-mile AOR. This well is located approximately 1.74 miles from the proposed IW-1 well. The nearest wells that penetrate the injection zone are the two Class I UIC non-hazardous wells at the Consumers Energy Generating Station in Section 17, T5N, R14W, located approximately 4.5 miles to the northwest. Deep well data are included as Attachment C (CD-ROM).

B.3 A discussion of the affect of injection on the present and potential mineral resources in the area of review.

As shown on Figure B.4-1 and detailed in Section B.4, one deep well penetrates to the Black River formation and through the confining zone, but does not extend to the injection interval. All of the remaining 57 identified artificial penetrations in the two-mile AOR were not drilled below the top of the upper confining zone. As such, there are no potential mineral resources projected to be present in the proposed injection zone.

B.4 A plat which shows the location and total depth of the proposed well, shows each abandoned, producing, or dry hole within the area of influence, and each operator of a mineral or oil and gas well within the area of influence.

Figure B.4-1 shows the locations of the proposed well and all non-freshwater artificial penetrations within and around the two-mile AOR. Records available at the Michigan Department of Environmental Quality (MDEQ) as of November 2017, were examined. Table B.4-1 presents a summary of the identified non-freshwater artificial penetrations within the two-mile AOR that includes pertinent well information, formations, and depths.

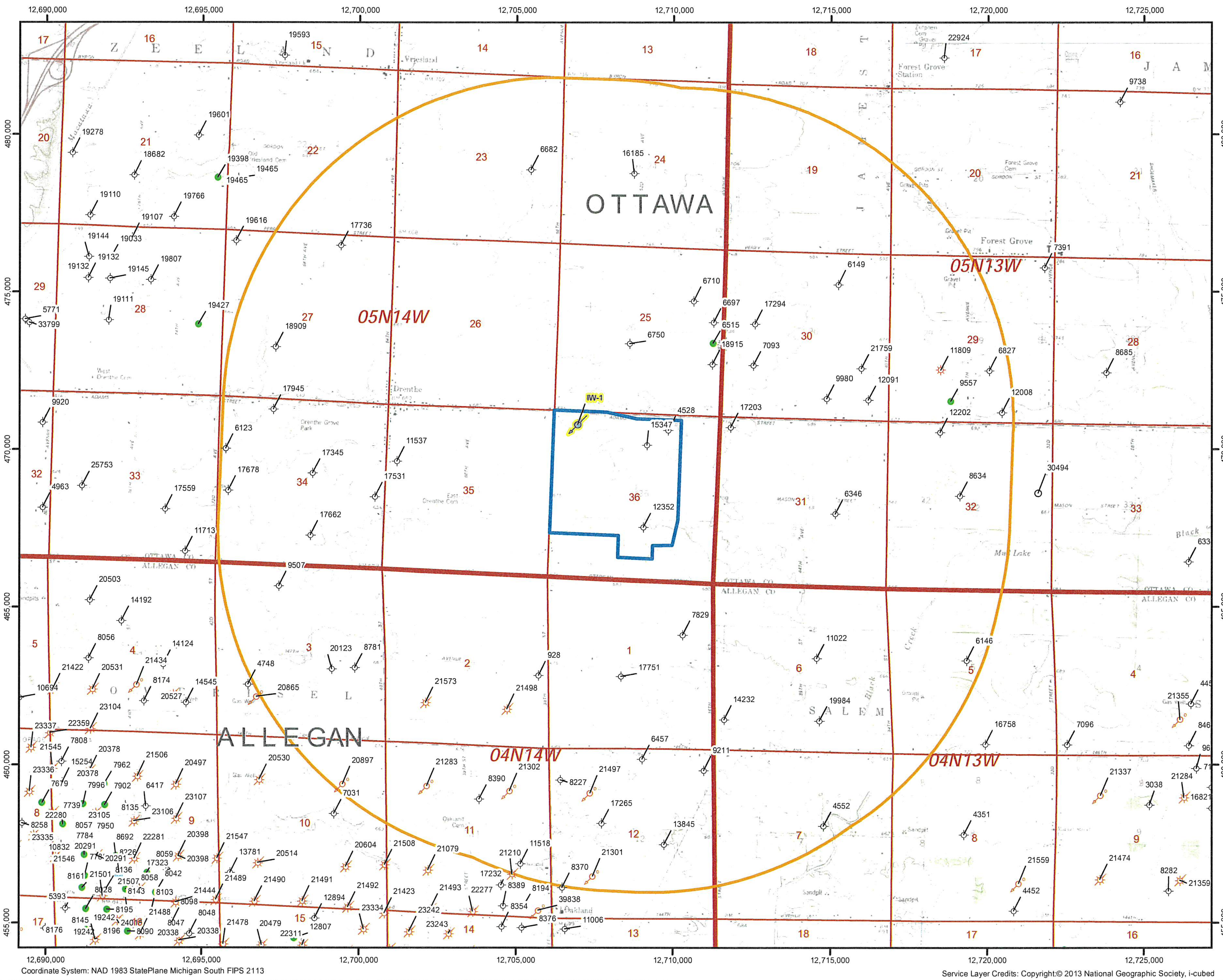
There are 58 deep non-freshwater artificial penetrations identified in the area of review as presented on Figure B.4-1. Data for these wells, including depth and formation information is provided in Table B.4-1. One of the 58 wells permitted and/or drilled in the vicinity of the facility within the two-mile AOR penetrates 425 feet below the base of the confining zone, which is composed of the Utica Shale. Wells completed above the confining zone were drilled to explore for oil and gas, and primarily targeted (in order of increasing depth) the Ellsworth Shale, Traverse Formation, Dundee Limestone, and a single well to the Black River Formation. There are also wells utilized for gas storage (GS) in the Detroit River Group, Bass Islands Group, and Salina Group. The deepest artificial penetration within the AOR which penetrates the confinging zone (Utica Shale) is the W. Van Koevering 1 oil and gas test well (Permit #21759), which was drilled into the Black River Formation to a total depth of 4,308 feet RKB (4,290 feet BGS). This well was drilled 126 feet into the Black River Formation, approximately 60 feet above the top of the Prairie du Chien Group. Wells drilled above the Utica Shale (top of the upper confining zone) are not potential pathways for fluid migration out of the permitted injection zone, since they do not penetrate through the confining zone or injection zone. Section B.6 addresses the plugging record and other information pertaining to the Winnie Van Koevering 1 well which demonstrates this well poses no issue with respect to migration of fluid from the injection interval. Therefore no wells have any potential to serve as a pathway from the proposed injection interval.

Freshwater wells are shown on Figure A.4-6, as presented in Section A.4.

Table B.4-1. Non-Freshwater Artificial Penetrations within the Area of Review

API Well No.	Permit No.	Well Type	Well Status*	DTW	Deep Formation	Field Name	Prod Fm	Field Type	Lease Name	Co Name	T-R-S	qqqs	qqs	qs
21005061460000	6146	DH	PA	1648	TRAVERSE FM				LOEW, M. S.	WILSON VIC R & THE GORDON OIL CO	4N-13W-5	SE	SE	NW
21005110220000	11022	DH	PA	1633	TRAVERSE LS				TIMMER, WILLIAM G	WAGENAAR NEIL	4N-13W-6	SW	SW	NE
21005142320000	14232	DH	PA	1645	TRAVERSE LS				KLOMP, GEORGE	FORD OIL CO	4N-13W-6	NW	SW	SW
21005199840000	19984	DH	PA	1577	TRAVERSE LS				VERBEEK	HENRY FORD	4N-13W-6	NW	SW	SE
21005045520000	4552	DH	PA	1604	TRAVERSE LS				CAMPAGNER, W.	REGAL DUTCH PETROLEUM CO	4N-13W-7	SW	SW	NE
21005212830000	21283	GSO	Active	2714	DETROIT RIVER	Overisel GS	SALINA(GS)	GS	ARENDSEN & BROEKHUIS & BROEKHUIS	CONSUMERS ENERGY CO	4N-14W-11		CN	NW
21005213020000	21302	GSO	Active	2735	SALINA E	Overisel GS	SALINA(GS)	GS	DOZEMAN, ED J & JOHN J & CHESTER & HOEVE,	CONSUMERS ENERGY CO	4N-14W-11		CN	NE
21005214970000	21497	GSO	Active	2771	SALINA E	Overisel GS	SALINA(GS)	GS	COMPAGNER, ALMER & BOESKOOK, JANE & HULST	CONSUMERS ENERGY CO	4N-14W-12	NE	SW	NW
21005078290000	7829	DH	PA	1633	TRAVERSE LS				LANKHEET, HARRY & HATTIE	WELLER C E & DAPAR OIL CO & BAKKE W E	4N-14W-1	NW	SE	NE
21005083900000	8390	DH	PA	1600	TRAVERSE LS				DOZEMAN, ED.	KENT DRILLING CO	4N-14W-11	NW	SW	NE
21005115180000	11518	DH	PA	1575	TRAVERSE LS				VAN KLOMPENBERG, A & K	WINCHESTER ALAN W	4N-14W-11	SW	NE	SE
21005138450000	13845	DH	PA	1642	TRAVERSE LS				DOZEMAN, JOHN SR	FORD OIL CO	4N-14W-12	NE	NW	SE
21005177510000	17751	DH	PA	0	TRAVERSE LS				HULST, HAROLD E.	CHOLETTE PAUL E TRUSTEE	4N-14W-1	NE	NE	SW
21005064570000	6457	DH	PA	1670	TRAVERSE FM				VANDERWIEDE, A. & R. AND BOESKOOL, H.	REGAL DUTCH PETROLEUM CO	4N-14W-12	NW	NW	NE
21005082270000	8227	DH	PA	1613	TRAVERSE FM				HULST, BERT	NELSON H C	4N-14W-12	SW	NW	NW
21005092110000	9211	DH	PA	1603	TRAVERSE FM				NIERS, LENA	REGAL DUTCH PETROLEUM CO	4N-14W-12	E2	NE	NE
21005172650000	17265	DH	PA	0	TRAVERSE FM				BROWER, ANNA	SMITH PETROLEUM CO	4N-14W-12	SW	SE	NW
21005208970000	20897	GSO	Active	2704	BASS ISLANDS	Overisel GS	SALINA(GS)	GS	BOERMAN & HOLLEMAN & JANSEN	CONSUMERS ENERGY CO	4N-14W-10		CN	NE
21005213010000	21301	GSO	Active	2776	BASS ISLANDS	Overisel GS	SALINA(GS)	GS	VANDAM, OBBIE & MYAARD, MELVIN & VANDERHO	CONSUMERS ENERGY CO	4N-14W-12		CN	SW
21005214980000	21498	GS	Active	2754	BASS ISLANDS	Overisel GS	SALINA(GS)	GS	COMPAGNER, ALMER & HULST, HATTIE & HOEVE	CONSUMERS ENERGY CO	4N-14W-2	NE	SW	SE
21005215730000	21573	GS	Active	2754	BASS ISLANDS	Overisel GS	SALINA(GS)	GS	DOZEMAN, JAMES J & KAMPS, HENRY J & NYKAMP	CONSUMERS ENERGY CO	4N-14W-2		CN	SW
21005009280000	928	DH	PA	2600	DUNDEE				HOEVE	UNION OIL CO OF CALIFORNIA	4N-14W-2	NE	NE	SE
21005201230000	20123	DH	PA	900	ELLSWORTH				VAN RHEE, A	HENRY FORD	4N-14W-3	NE	NW	SE
21005087810000	8781	DH	PA	1601	TRAVERSE LS				VAN RHEE, DICK	MCCLANAHAN W L	4N-14W-3	NW	NE	SE
21005095070000	9507	DH	PA	1564	TRAVERSE LS				VAN RHEE & VAN DAM	HOYT ANDREW S AGENT	4N-14W-3	CN	NE	NW
21139120080000	12008	DH	PA	955	ELLSWORTH				LA DENA BOS, JOHN	CLAWSON DEVELOPMENT CO	5N-13W-29	SE	SW	SE
21139095570000	9557	OIL	PA	2017	MONROE	Jamestown	TRAV GR (G)	G	VAN SPYKER, RALPH & KIEKOVER, ALBERT	FISHER MCCALL OIL & GAS INC & KEELER M BLISS	5N-13W-29	CN	SE	SW
21139118090000	11809	GAS	PA	1645	TRAVERSE LS	Jamestown	BEREA SS (G)	G	VAN BRONKHORST, RAYNOLD A & HENRIETTA	TRI COUNTY DEVELOPMENT CO	5N-13W-29	SW	NE	SW
21139068270000	6827	DH	PA	1712	TRAVERSE FM				STRICK, MARGARET H.	LEONARD VESTER OIL CO INC	5N-13W-29	SW	NW	SE
21139217590000	21759	DH	PA	4308	BLACK RIVER				VAN KOEVERING, WINNIE	STRAKE G W	5N-13W-30	SW	NE	SE
21139061490000	6149	DH	PA	1646	TRAVERSE LS				WALTERS, PETER & DONA	FORTNEY OIL CO	5N-13W-30	SE	NW	NE
21139063460000	6346	DH	PA	1840	TRAVERSE LS				VAN DAM	FREEMAN OIL CO	5N-13W-31	NE	NW	SE
21139099800000	9980	DH	PA	1612	TRAVERSE LS				BRANDT & VANKOVERING (COMM.)	FISHER MCCALL OIL & GAS INC & HARRIS OIL CO	5N-13W-30	CN	SW	SE
21139120910000	12091	DH	PA	1612	TRAVERSE LS				HOEVE, GERRITT J. & VAN KOEVERING, CHRIS	CLAWSON DEVELOPMENT CO	5N-13W-30	CN	SE	SE
21139122020000	12202	DH	PA	1651	TRAVERSE LS				KIEKOVER, NICHOLAS	CLAWSON DEVELOPMENT CO	5N-13W-32	NW	NE	NW
21139172030000	17203	DH	PA	1683	TRAVERSE LS				KLINE, J.	STRICKLER W H & FORD OIL CO	5N-13W-31	NW	NW	NW
21139070930000	7093	DH	PA	1658	TRAVERSE FM				LANNING, ALBERT H.	FREEMAN OIL CO	5N-13W-30	SE	NW	SW
21139086340000	8634	DH	PA	1641	TRAVERSE FM				KIEKOVER, JOHN	MCCLANAHAN W L	5N-13W-32	SE	SE	NW
21139172940000	17294	DH	PA	1672					DEKLEINE, B	FORD OIL CO	5N-13W-30	SE	SW	NW
21139161850000	16185	DH	PA	2839	BASS ISLANDS				DE WITT, MARTIN	TRI COUNTY DEVELOPMENT CO	5N-14W-24	NE	NE	SW
21139189090000	18909	DH	PA	1553	TRAVERSE				BRUMMEL, GERRIT & BESSIE	STEVENS NORMAN L	5N-14W-27	SW	NE	SW
21139065150000	6515	OIL	PA	1700	TRAVERSE LS	Zeeland	TRAVGR (O)	O	DEKLEINE ET AL	CHAPMAN OIL CO	5N-14W-25	NE	NE	SE
21139066820000	6682	DH	PA	1642	TRAVERSE LS				MAATMAN, JAMES	VANEENENAAM GORDON F	5N-14W-23	NW	NE	SE
21139066970000	6697	DH	PA	1668	TRAVERSE FM				YNTEMA, HENRY	FREEMAN OIL CO	5N-14W-25	SE	SE	NE
21139067100000	6710	DH	PA	1709	TRAVERSE FM				YNTEMA, HENRY	BATTJES D D & BATTJES HAROLD A	5N-14W-25	NW	SE	NE
21139067500000	6750	DH	PA	1744	TRAVERSE FM				ESSING, JOHN AND SEAN	FORTNEY OIL CO & CRYDEN PETROLEUM CORP	5N-14W-25	NE	NE	SW
21139177360000	17736	DH	PA	1586					TER HAAR, SYBIL	CHOLETTE PAUL E TRUSTEE	5N-14W-27	NE	NW	NE
21139189150000	18915	DH	PA	1700					DE KLEINE, BERT & JOSIE	BREHM E EDWIN & SCRIBNER ARTHUR E	5N-14W-25	SE	NE	SE
21139045280000	4528	DH	PA	1712	TRAVERSE				BRANDT, MARINUS	MORRIS SUTHERLAND DRILLING CO	5N-14W-36	NE	NW	NE
21139061230000	6123	DH	PA	1535	TRAVERSE				BROUWER, KLAAS L.	SANDERS ROBERT L	5N-14W-34	NW	SW	NW
21139115370000	11537	DH	PA	1600	TRAVERSE LS				BOERMAN, JENNIE	DEGENTHER P K	5N-14W-35	NW	SW	NW
21139123520000	12352	DH	PA	1650	TRAVERSE LS				STELLKAMP & BRANDT COMM	BOEVE ARTHUR	5N-14W-36	SW	NW	SE
21139153470000	15347	DH	PA	1675	TRAVERSE LS				MYAARD, JOHN	OTTAWA DEVELOPING CO	5N-14W-36	SW	NW	NE
21139173450000	17345	DH	PA	1532	TRAVERSE LS				KOERT, PETER & ANNA	SMITH PETROLEUM CO	5N-14W-34	SW	SW	NE
21139175310000	17531	DH	PA	1585	TRAVERSE LS				DE VRIES, DICK & CLARA	DEGENTHER P K	5N-14W-34	NE	NE	SE
21139176620000	17662	DH	PA	1542	TRAVERSE LS				KOERT, PETER	FORD OIL CO	5N-14W-34	NW	SW	SE
21139176780000	17678	DH	PA	1558	TRAVERSE LS				WALCOTT-KOERT	TRAVERSE OIL PRODUCERS	5N-14W-34	NW	NW	SW
21139179450000	17945	DH	PA	1541	TRAVERSE LS				DOZEMAN, HENRY H.	CHOLETTE PAUL E TRUSTEE	5N-14W-34	NW	NE	NW

* PA - Plugging Approved



Legend

- IW-1 - Proposed Location
- Location only (1)
- Oil Well (31)
- Gas Well (1)
- Gas Storage (62)
- Brine Disposal Well (1)
- Dry Hole (122)
- Gas Storage Observation Well (12)
- Autumn Hills RDF
- Autumn Hills RDF - 2 Mile AOR

N

0 3,000 6,000 Feet

1 in = 3,000 ft

WASTE MANAGEMENT

Figure B.4-1
Non-Freshwater Penetration Well
Location Map and AOR, Autumn Hills RDF

2018 Autumn Hills RDF - MDEQ Class I Permit

Scale: 1:36,000	Date: September 2018	
2018_WM_MDEQ_Fig_B.4-01	By: KRS	Checked: AP

Petrotek
5935 South Zang Street, Suite 200
Littleton, Colorado 80127 USA
303-290-9414
www.petrotek.com

B.5 If a well is proposed to be converted to a disposal well, a copy of the completion report, together with the written geologic description log or record and borehole and stratum evaluation logs for the well.

Conversion of an existing well is not proposed. Upon installation of the new well, copies of the written geologic description and all log data collected from the well will be submitted to MDEQ.

B.6 Plugging records of all abandoned wells and casing, sealing, and completion records of all other wells and artificial penetrations within the area of influence of the proposed well location and a map identifying all such artificial penetrations. An applicant shall also submit a plan reflecting the steps or modifications believed necessary to prevent proposed injected waste products from migrating up, into, or through inadequately plugged, sealed, or completed wells.

Topographic Map

A copy of the USGS Topographic map available from the area of review with the outline of the conservative maximum two-mile radius area of review and a disposal well symbol representing the facility superimposed on the map is included as Figure A.4-4. (See Section A.4). This topographic map extends in excess of two miles beyond the Autumn Hills RDF boundary.

The Autumn Hills RDF property encompasses a portion of Section 36, T5N, R14W Figure A.4-4 shows the location of all known surface bodies of water and roads within two miles. There are no known springs, mines, or quarries within the two-mile radius. Residences are not shown on Figure A.4-4, but as shown on Figure A.4-9 there are no residences within more than 600 feet of the proposed well. A listing of property owners within a ¼-mile radius of the Autumn Hills RDF is provided as Table B.6-1 at the end of this section, and these parcels are shown on Figure B.6-1. No known hazardous waste treatment storage or disposal facilities are present within the AOR based on available state of Michigan permit information.

Artificial Penetrations

Figure B.4-1 (Section B.4) shows the location of all non-freshwater artificial penetrations within the two-mile radius and surrounding areas, based on data provided from MDEQ as of November 2017. State Permit numbers are shown at each well symbol. General geographic features and the outline of the required two-mile AOR are also shown on the map. Note that only one of these wells within the two-mile AOR penetrate the confining zone and none penetrate the injection zone to the injection interval. Data associated with these wells is provided in Table B.4-1 and further discussed in Section B.4. Table B.6-2 summarizes information about this single well that is located approximately 1.74 miles from the proposed IW-1 well. Plugging records for this well are included at the end of this section.

Table B.6-2
Artificial Penetrations: MDEQ Oil and Gas Permits Active Permits Penetrating the Confining Zone within 2 Miles AOR

MDEQ Permit #	Well Location			Total Depth (ft. BGS)	Date of Completion or P&A	Permit Data	Casing	
	Twn	Rng	Sec				Depth	Plug
21759	5N	13W	30	4,308	P/A: 8/21/1959	O&G	4,308-1,680'	Heavy mud
							Traverse Pay Zone (1,680'-1,539')	50 sx cement
							Top Taverse to base surface pipe (1,539'-294')	Heavy mud
							Base surface pipe to 20' (294'-20')	5 sx cement, followed with mud
							20'- surface	5 sx

Notes:
P&A = dry hole, plugged
O&G = Oil/Gas Well

Figure A.4-6 (Section A.4) presents the location of all local freshwater well penetrations in the state water well database (as of December 2017) as well as water wells identified by Autumn Hills RDF personnel that were not listed in the well database. Note that fresh water penetrations in the area of review are no deeper than 238 feet BGS and, as such, are not critical with regard to the safety of fluid injection at the Autumn Hills RDF site because none come close to penetrating the confining zone. Copies of selected water well records for freshwater penetrations are submitted at the end of this section in Attachment C (CD-ROM) and a summary table presenting water well information is also in Table B.6-2.

Figure B.6-2 shows the location of monitoring wells associated with the Autumn Hills RDF. These wells are shallow completions to the Glacial Drift interval and do not extend past the Coldwater Shale.

Corrective Action

As shown in Table B.6-2, there is a single well, the Winnie Van Koevering #1 (PN 21759, Figure B.4-1), that penetrates the confining zone within the two mile AOR. Well construction and abandonment information for this well are included at the end of this Section (B.6). The well was drilled in 1959 to the Trenton/Black River and was abandoned the same year in accordance with requirements in place at the time:

- The wellbore and casing was filled with mud from TD (4308 ft BGL) to the Traverse Pay zone (app. 1680'), and 141 feet (50 sacks) of cement were spotted through the Traverse Pay zone from 1680 ft BGL to 1539 feet BGL.

Petrotek