May 2014
Updated October 2014

C-144 Permit Package for All Thorn Multi-Well Fluid Management Pit Section 36 of T17S, R27E, Eddy County

Volume 1

Transmittal Letter
C-144
Appendices D-F
Appendix G - Variances

View southwest from northeast corner of proposed site showing All Thorn trees

Prepared for:
Lime Rock Resources II-A, LP (LRRII)
Artesia, New Mexico

Prepared by:

R.T. Hicks Consultants, Ltd.
901 Rio Grande NW
F-142
Albuquerque, New Mexico

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

October 8, 2014

Mr. Mike Bratcher
NMOCD District 2
811 S. First Street
Artesia, New Mexico 88210
Via E-mail and US Mail

RE: Lime Rock Resources II-A, L.P. All Thorn MWFM Pit

Dear Mike:

Enclosed is a fully assembled C-144 permit application for a MWFM pit located at a proposed Lime Rock Resources II-A, L.P commercial surface lease from the SLO in Section 36, T17S R27E. This submission assembles all amendments, variances and various reports into a two volume document. Here is the guided tour of the document:

In Volume 1, the sections of the document that are NOT verbatim from the original submission are

1. Box 2 of the C-144
2. The discussion of stable v. unstable ground and karst in the siting criteria demonstration
3. Figure 8 (Karst Potential) of the site-specific figures
4. The list of wells with approved APDs
5. The addition of all variance requests to Appendix G
6. The addition of the geotechnical boring data as Appendix H
7. The E-mail concurrence of Pettigrew and Associates regarding the 8/22/14 geologic stability evaluation of R.T. Hicks Consultants is the last page of Appendix H.

In Volume 2, the sections of the document that are NOT verbatim from the original submission are

8. The last pages of Appendix A which show the revised footprint and depth of the MWFM Pit as a stamped engineering drawing from Pettigrew and Associates (
9. The Design/Construction Plan (Appendix B) is modified slightly to account for and include
    a. the new certified engineering drawings of Pettigrew and Associates shown in Appendix A
    b. The potential of using alternative liner media if approved by OCD
    c. The geotechnical recommendations of Pettigrew and Associates
    d. The Avian Protection Plan as an alternative to pit netting
10. Appendix C now includes specifications of proposed alternative LLDPE material for the secondary and primary liners (if approved by OCD)

There are also three important elements in the permit document that deserve your attention. They are described below.

Cave/Karst Potential and Earth Material Stability

Based upon my meeting with Scott Dawson and Jim Griswold last week, it is our understanding that OCD no longer equates cave/karst potential with the stability of the ground. However, high and critical cave/karst potential generally means the presence of void, fissures or other conduits between the surface and groundwater. Therefore, in these areas, extra care regarding the examination of unstable ground is required. Here is the resolution that I brought from the meeting

1. In low and medium cave/karst potential, the opinion of a professional geologist is sufficient to demonstrate the ground is stable.
2. In areas of high or critical cave/karst potential, a professional geologist and a professional engineer must certify that the ground is stable.

My signature on this letter certifies the opinions regarding ground stability presented in this application. The concurrence of Debra Hicks, PE in Appendix H regarding the stability of the ground satisfies the criteria that I understood from last week's meeting.

Primary Liner Variance Request

Please note that the Variance Request to employ 45-mil LLDPE as a primary liner for this MWFM Pit is included as part of this submission. While a preliminary denial of this request was generated in the OCD Santa Fe Office, the final decision of any variance comes from the District. While Lime Rock will begin harvesting of caliche under the mining lease as soon as the SLO lease is approved, ordering the primary liner material will not occur for several weeks. We urge the District to confer with OCD Santa Fe over the next few weeks before rendering a decision on the request.

Minor Modifications As Required by Field Conditions

All of our permit submissions contain the following language:

> Field conditions may create the need for minor modification of the pit design (e.g. changing the length, width or depth). If field conditions dictate the need to modify the design, the operator will notify NMOCD of the proposed changes and provide justification. Any design change that does not conform to the prescriptive mandates of NMOCD Rules or the approved permit will be the subject of a modification request submitted to the OCD for review and approval.

Provided that the total volume of a MWFM pit does not increase over that presented in the permit (120,000 bbls in the case of the All Thorn pit), such changes are a minor modification and require only notification to OCD not approval by OCD. This interpretation of the Rule is based upon the fact that the Rule speaks only of the volume of a pit (e.g. permanent pits are limited to 10 acre-feet total capacity) and the Rule does not impose limits on the surface footprint.

Please examine the revision to sheet C-101 on the last page of Appendix A. This drawing shows a 3- to 4-foot levee on the east side of the pit (uphill) and a 10-foot levee on the west side of the pit. This design is in conflict with item g. on page 3 of the Design/Construction plan. This conflict will be resolved through a minor modification and notification to OCD. Specifically we will:

1. modify item g. of the Design/Construction plan or
2. harvest more caliche on the east side of the pit to create a relatively level surface and lower the elevation of the bottom of the pit.

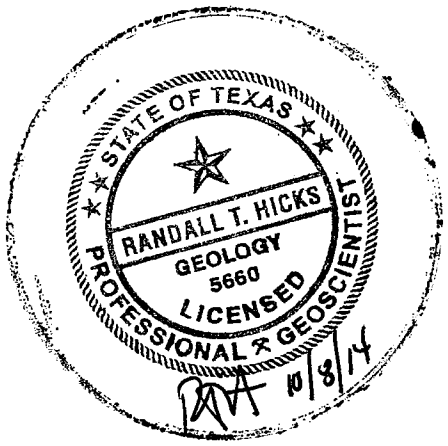
Implementation of option 2 will not change the surface footprint of the pit; rather it changes only the surface elevation of the land. The pit design remains the same except a 3 to 4-foot levee exists on all sides of the pit rather than the levee height shown in the drawing.

I believe the attached permit application is complete and meets all of the criteria for approval under NMOCD Rules. Please let us know if you need any additional information or clarification regarding the application.

Sincerely,
R.T. Hicks Consultants

Randall Hicks

Copy: Lime Rock Resources
Scott Dawson and Jim Griswold NMOCD Santa Fe
State Land Office (surface owner)



C-144 and
Site Specific Information for
Temporary Pit

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources
Department
Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-144
Revised June 6, 2013

For temporary pits, below-grade tanks, and multi-well fluid management pits, submit to the appropriate NMOCD District Office.
For permanent pits submit to the Santa Fe Environmental Bureau office and provide a copy to the appropriate NMOCD District Office.

Pit, Below-Grade Tank, or Proposed Alternative Method Permit or Closure Plan Application

Type of action:
- ☐ Below grade tank registration
- ☒ Permit of a pit or proposed alternative method
- ☐ Closure of a pit, below-grade tank, or proposed alternative method
- ☐ Modification to an existing permit/or registration
- ☐ Closure plan only submitted for an existing permitted or non-permitted pit, below-grade tank, or proposed alternative method

Instructions: Please submit one application (Form C-144) per individual pit, below-grade tank or alternative request

Please be advised that approval of this request does not relieve the operator of liability should operations result in pollution of surface water, ground water or the environment. Nor does approval relieve the operator of its responsibility to comply with any other applicable governmental authority's rules, regulations or ordinances.

1.

Operator: Lime Rock Resources ll–A, L.P. (LRRll) OGRID #: 277558

Address: 1111 Bagby Street, Suite 4600, Houston, TX 77002

Facility or well name: All Thorn MWFM Pit

API Number: _____ OCD Permit Number: _____

U/L or Qtr/Qtr NE/4 of SE/4 of____ Section 36 Township 17S Range 27E County: Eddy

Center of Proposed Design: Latitude 32.7875766 Longitude 104.2258098 NAD: ☒1927 ☐ 1983

Surface Owner: ☐ Federal ☒ State ☐ Private ☐ Tribal Trust or Indian Allotment

2.

☒ **Pit:** Subsection F, G or J of 19.15.17.11 NMAC

Temporary: ☐ Drilling ☐ Workover

☐ Permanent ☐ Emergency ☐ Cavitation ☐ P&A ☒ Multi-Well Fluid Management Low Chloride ~~Drilling~~ Fluid ☐ yes ☒ no

☒ Lined ☐ Unlined Liner type: Thickness 60* mil ☐ LLDPE ☒ HDPE ☐ PVC ☒ Other See Variance Request

☐ String-Reinforced * Or alternative material and thickness approved by OCD

Liner Seams: ☒ Welded ☐ Factory ☐ Other _____ Volume 160,500 bbl Dimensions: L 260 x W 260 x D 14 feet

3.

☐ **Below-grade tank:** Subsection I of 19.15.17.11 NMAC

Volume: _____bbl Type of fluid: _____

Tank Construction material: _____

☐ Secondary containment with leak detection ☐ Visible sidewalls, liner, 6-inch lift and automatic overflow shut-off

☐ Visible sidewalls and liner ☐ Visible sidewalls only ☐ Other _____

Liner type: Thickness _____mil ☐ HDPE ☐ PVC ☐ Other _____

4.

☐ **Alternative Method:**

Submittal of an exception request is required. Exceptions must be submitted to the Santa Fe Environmental Bureau office for consideration of approval.

5.

Fencing: Subsection D of 19.15.17.11 NMAC *(Applies to permanent pits, temporary pits, and below-grade tanks)*

☐ Chain link, six feet in height, two strands of barbed wire at top *(Required if located within 1000 feet of a permanent residence, school, hospital, institution or church)*

☒ Four foot height, four strands of barbed wire evenly spaced between one and four feet

☒ Alternate. Please specify____Game fence_____

6.

Netting: Subsection E of 19.15.17.11 NMAC *(Applies to permanent pits and permanent open top tanks)*

☐ Screen ☐ Netting ☒ Other_____ Operator will evaluate need for netting as described in Construction/Design Plan_____

☐ Monthly inspections (If netting or screening is not physically feasible)

7.

Signs: Subsection C of 19.15.17.11 NMAC

☒ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

☐ Signed in compliance with 19.15.16.8 NMAC

8.

Variances and Exceptions:

Justifications and/or demonstrations of equivalency are required. Please refer to 19.15.17 NMAC for guidance.

Please check a box if one or more of the following is requested, if not leave blank:

☒ Variance(s): Requests must be submitted to the appropriate division district for consideration of approval.

☐ Exception(s): Requests must be submitted to the Santa Fe Environmental Bureau office for consideration of approval.

9.

Siting Criteria (regarding permitting): 19.15.17.10 NMAC

Instructions: The applicant must demonstrate compliance for each siting criteria below in the application. Recommendations of acceptable source material are provided below. **Siting criteria does not apply to drying pads or above-grade tanks.**

General siting	
Ground water is less than 25 feet below the bottom of a low chloride temporary pit or below-grade tank. - ☐ NM Office of the State Engineer - iWATERS database search; ☐ USGS; ☐ Data obtained from nearby wells	☐ Yes ☐ No ☒ NA
Ground water is less than 50 feet below the bottom of a Temporary pit, permanent pit, or Multi-Well Fluid Management pit . NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells **See Figures 1 & 2**	☐ Yes ☒ No ☐ NA
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. **(Does not apply to below grade tanks) See Figure 5** - Written confirmation or verification from the municipality; Written approval obtained from the municipality	☐ Yes ☒ No
Within the area overlying a subsurface mine. **(Does not apply to below grade tanks) See Figure 7** - Written confirmation or verification or map from the NM EMNRD-Mining and Mineral Division	☐ Yes ☒ No
Within an unstable area. **(Does not apply to below grade tanks) See Figure 8 and discussion in application** - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; Topographic map	☐ Yes ☒ No
Within a 100-year floodplain. **(Does not apply to below grade tanks) See Figure 9** - FEMA map	☐ Yes ☒ No
Below Grade Tanks	
Within 100 feet of a continuously flowing watercourse, significant watercourse, lake bed, sinkhole, wetland or playa lake (measured from the ordinary high-water mark). - Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within 200 horizontal feet of a spring or a fresh water well used for public or livestock consumption;. - NM Office of the State Engineer - iWATERS database search; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Temporary Pit using Low Chloride Drilling Fluid (maximum chloride content 15,000 mg/liter) Within 100 feet of a continuously flowing watercourse, or any other significant watercourse or within 200 feet of any lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). (Applies to low chloride temporary pits.) - Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within 300 feet from a occupied permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; Aerial photo; Satellite image	☐ Yes ☐ No
Within 200 horizontal feet of a spring or a private, domestic fresh water well used by less than five households for domestic or stock watering purposes, or 300feet of any other fresh water well or spring, in existence at the time of the initial application. NM Office of the State Engineer - iWATERS database search; Visual inspection (certification) of the proposed site	☐ Yes ☐ No

Within 100 feet of a wetland. - US Fish and Wildlife Wetland Identification map; Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Temporary Pit Non-low chloride drilling fluid	
Within 300 feet of a continuously flowing watercourse, or any other significant watercourse, or within 200 feet of any lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within 300 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; Aerial photo; Satellite image.	☐ Yes ☐ No
Within 500 horizontal feet of a spring or a private, domestic fresh water well used by less than five households for domestic or stock watering purposes, or 1000 feet of any other fresh water well or spring, in the existence at the time of the initial application; - NM Office of the State Engineer - iWATERS database search; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within 300 feet of a wetland. - US Fish and Wildlife Wetland Identification map; Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Permanent Pit or Multi-Well Fluid Management Pit	
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; Visual inspection (certification) of the proposed site **See Figure 3**	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; Aerial photo; Satellite image **See Figure 4**	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database search; Visual inspection (certification) of the proposed site - **See Figures 1 & 2**	☐ Yes ☒ No
Within 500 feet of a wetland. - US Fish and Wildlife Wetland Identification map; Topographic map; Visual inspection (certification) of the proposed site **See Figure 6**	☐ Yes ☒ No

10.

Temporary Pits, Emergency Pits, and Below-grade Tanks Permit Application Attachment Checklist: Subsection B of 19.15.17.9 NMAC

Instructions: Each of the following items must be attached to the application. Please indicate, by a check mark in the box, that the documents are attached.

☐ Hydrogeologic Report (Below-grade Tanks) - based upon the requirements of Paragraph (4) of Subsection B of 19.15.17.9 NMAC
☐ Hydrogeologic Data (Temporary and Emergency Pits) - based upon the requirements of Paragraph (2) of Subsection B of 19.15.17.9 NMAC
☐ Siting Criteria Compliance Demonstrations - based upon the appropriate requirements of 19.15.17.10 NMAC
☐ Design Plan - based upon the appropriate requirements of 19.15.17.11 NMAC
☐ Operating and Maintenance Plan - based upon the appropriate requirements of 19.15.17.12 NMAC
☐ Closure Plan (Please complete Boxes 14 through 18, if applicable) - based upon the appropriate requirements of Subsection C of 19.15.17.9 NMAC and 19.15.17.13 NMAC

☐ Previously Approved Design (attach copy of design) API Number: _____ or Permit Number: _____

11.

Multi-Well Fluid Management Pit Checklist: Subsection B of 19.15.17.9 NMAC

Instructions: Each of the following items must be attached to the application. Please indicate, by a check mark in the box, that the documents are attached.

☒ Design Plan - based upon the appropriate requirements of 19.15.17.11 NMAC Appendix A, B, and C
☒ Operating and Maintenance Plan - based upon the appropriate requirements of 19.15.17.12 NMAC Appendix D
☒ A List of wells with approved application for permit to drill associated with the pit. Appendix E
☒ Closure Plan (Please complete Boxes 14 through 18, if applicable) - based upon the appropriate requirements of Subsection C of 19.15.17.9 NMAC and 19.15.17.13 NMAC Appendix F
☒ Hydrogeologic Data - based upon the requirements of Paragraph (4) of Subsection B of 19.15.17.9 NMAC Attached
☒ Siting Criteria Compliance Demonstrations - based upon the appropriate requirements of 19.15.17.10 NMAC Attached

☐ Previously Approved Design (attach copy of design) API Number: _____ or Permit Number: _____

12.

Permanent Pits Permit Application Checklist: Subsection B of 19.15.17.9 NMAC

Instructions: Each of the following items must be attached to the application. Please indicate, by a check mark in the box, that the documents are attached.

- ☐ Hydrogeologic Report - based upon the requirements of Paragraph (1) of Subsection B of 19.15.17.9 NMAC
- ☐ Siting Criteria Compliance Demonstrations - based upon the appropriate requirements of 19.15.17.10 NMAC
- ☐ Climatological Factors Assessment
- ☐ Certified Engineering Design Plans - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Dike Protection and Structural Integrity Design - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Leak Detection Design - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Liner Specifications and Compatibility Assessment - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Quality Control/Quality Assurance Construction and Installation Plan
- ☐ Operating and Maintenance Plan - based upon the appropriate requirements of 19.15.17.12 NMAC
- ☐ Freeboard and Overtopping Prevention Plan - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Nuisance or Hazardous Odors, including H_2S, Prevention Plan
- ☐ Emergency Response Plan
- ☐ Oil Field Waste Stream Characterization
- ☐ Monitoring and Inspection Plan
- ☐ Erosion Control Plan
- ☐ Closure Plan - based upon the appropriate requirements of Subsection C of 19.15.17.9 NMAC and 19.15.17.13 NMAC

13.

Proposed Closure: 19.15.17.13 NMAC

Instructions: Please complete the applicable boxes, Boxes 14 through 18, in regards to the proposed closure plan.

Type: ☐ Drilling ☐ Workover ☐ Emergency ☐ Cavitation ☐ P&A ☐ Permanent Pit ☐ Below-grade Tank ☒ Multi-well Fluid Management Pit ☐ Alternative

Proposed Closure Method: ☒ Waste Excavation and Removal
☐ Waste Removal (Closed-loop systems only)
☐ On-site Closure Method (Only for temporary pits and closed-loop systems)
☐ In-place Burial ☐ On-site Trench Burial
☐ Alternative Closure Method

14.

Waste Excavation and Removal Closure Plan Checklist: (19.15.17.13 NMAC) ***Instructions: Each of the following items must be attached to the closure plan. Please indicate, by a check mark in the box, that the documents are attached.***

- ☒ Protocols and Procedures - based upon the appropriate requirements of 19.15.17.13 NMAC
- ☒ Confirmation Sampling Plan (if applicable) - based upon the appropriate requirements of Subsection C of 19.15.17.13 NMAC
- ☒ Disposal Facility Name and Permit Number (for liquids, drilling fluids and drill cuttings)
- ☒ Soil Backfill and Cover Design Specifications - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC
- ☒ Re-vegetation Plan - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC
- ☒ Site Reclamation Plan - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC

15.

Siting Criteria (regarding on-site closure methods only): 19.15.17.10 NMAC

Instructions: Each siting criteria requires a demonstration of compliance in the closure plan. Recommendations of acceptable source material are provided below. Requests regarding changes to certain siting criteria require justifications and/or demonstrations of equivalency. Please refer to 19.15.17.10 NMAC for guidance.

Ground water is less than 25 feet below the bottom of the buried waste. - NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☐ No ☐ NA
Ground water is between 25-50 feet below the bottom of the buried waste - NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☐ No ☐ NA
Ground water is more than 100 feet below the bottom of the buried waste. - NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☐ No ☐ NA
Within 100 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within 300 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; Aerial photo; Satellite image	☐ Yes ☐ No
Within 300 horizontal feet of a private, domestic fresh water well or spring used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Written confirmation or verification from the municipality; Written approval obtained from the municipality	☐ Yes ☐ No
Within 300 feet of a wetland. US Fish and Wildlife Wetland Identification map; Topographic map; Visual inspection (certification) of the proposed site	☐ Yes ☐ No
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance	

adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; Written approval obtained from the municipality	☐ Yes ☐ No
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Mineral Division	☐ Yes ☐ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; Topographic map	☐ Yes ☐ No
Within a 100-year floodplain. - FEMA map	☐ Yes ☐ No

16.
On-Site Closure Plan Checklist: (19.15.17.13 NMAC) ***Instructions: Each of the following items must be attached to the closure plan. Please indicate, by a check mark in the box, that the documents are attached.***

- ☐ Siting Criteria Compliance Demonstrations - based upon the appropriate requirements of 19.15.17.10 NMAC
- ☐ Proof of Surface Owner Notice - based upon the appropriate requirements of Subsection E of 19.15.17.13 NMAC
- ☐ Construction/Design Plan of Burial Trench (if applicable) based upon the appropriate requirements of Subsection K of 19.15.17.11 NMAC
- ☐ Construction/Design Plan of Temporary Pit (for in-place burial of a drying pad) - based upon the appropriate requirements of 19.15.17.11 NMAC
- ☐ Protocols and Procedures - based upon the appropriate requirements of 19.15.17.13 NMAC
- ☐ Confirmation Sampling Plan (if applicable) - based upon the appropriate requirements of 19.15.17.13 NMAC
- ☐ Waste Material Sampling Plan - based upon the appropriate requirements of 19.15.17.13 NMAC
- ☐ Disposal Facility Name and Permit Number (for liquids, drilling fluids and drill cuttings or in case on-site closure standards cannot be achieved)
- ☐ Soil Cover Design - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC
- ☐ Re-vegetation Plan - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC
- ☐ Site Reclamation Plan - based upon the appropriate requirements of Subsection H of 19.15.17.13 NMAC

17.
Operator Application Certification:

I hereby certify that the information submitted with this application is true, accurate and complete to the best of my knowledge and belief.

Name (Print): Spencer Cox Title: Production Engineer

Signature: Spencer Cox Date: 5/7/14

e-mail address: scox@limerockresources.com Telephone: 713-292-9528

18.
OCD Approval: ☐ Permit Application (including closure plan) ☐ Closure Plan (only) ☐ OCD Conditions (see attachment)

OCD Representative Signature: _____ **Approval Date:** _____

Title: _____ **OCD Permit Number:** _____

19.
Closure Report (required within 60 days of closure completion): 19.15.17.13 NMAC

Instructions: Operators are required to obtain an approved closure plan prior to implementing any closure activities and submitting the closure report. The closure report is required to be submitted to the division within 60 days of the completion of the closure activities. Please do not complete this section of the form until an approved closure plan has been obtained and the closure activities have been completed.

☐ **Closure Completion Date:** _____

20.
Closure Method:

☐ Waste Excavation and Removal ☐ On-Site Closure Method ☐ Alternative Closure Method ☐ Waste Removal (Closed-loop systems only)
☐ If different from approved plan, please explain.

21.
Closure Report Attachment Checklist: ***Instructions: Each of the following items must be attached to the closure report. Please indicate, by a check mark in the box, that the documents are attached.***

- ☐ Proof of Closure Notice (surface owner and division)
- ☐ Proof of Deed Notice (required for on-site closure for private land only)
- ☐ Plot Plan (for on-site closures and temporary pits)
- ☐ Confirmation Sampling Analytical Results (if applicable)
- ☐ Waste Material Sampling Analytical Results (required for on-site closure)
- ☐ Disposal Facility Name and Permit Number
- ☐ Soil Backfilling and Cover Installation
- ☐ Re-vegetation Application Rates and Seeding Technique
- ☐ Site Reclamation (Photo Documentation)

On-site Closure Location: Latitude _____ Longitude _____ NAD: ☐1927 ☐ 1983

22.

Operator Closure Certification:

I hereby certify that the information and attachments submitted with this closure report is true, accurate and complete to the best of my knowledge and belief. I also certify that the closure complies with all applicable closure requirements and conditions specified in the approved closure plan.

Name (Print): _____ Title: _____

Signature:_____ Date: _____

e-mail address:_____ Telephone: _____

Distance to Groundwater

Figure 1, Figure 2, and the discussion presented below demonstrates that groundwater (fresh water as defined by NMOCD Rules) at the location is greater than 270 feet beneath the Multi Wells Fluid Management (MWFM) Pit.

Figure 1 is an area geologic base map that depicts regional topography (metric contour units) and includes the water wells located nearest to the MWFM pit site for which information is available, regardless of how comprehensive or useful. It also shows:

1. The location of the MWFM pit as a solid blue rectangle
2. Water wells from the USGS database as a green triangle
3. Water wells from the New Mexico Office of the State Engineer (OSE) database as a small blue triangle inside a colored circle that indicates the well depth (see Legend). Please note, OSE wells are often miss-located in the WATERS database as older wells are plotted in the center of the quarter, quarter, quarter, of the Section Township and Range. Topographic maps and/or aerial photographs verified all of the OSE well locations included on this map.
4. Water wells, which are not documented in the public databases but were identified by field inspection or other published reports are shown as a dot inside a color-coded (depth) square. These wells are our internal Miscellaneous (Misc) database.
5. Depth to water and gauging dates from the most recent and reliable measurement for each well is provided adjacent to the well symbol. It should be noted that in most cases the depth to water provided by the OSE database are from drillers log notes estimated at the time of completion, rather than actual field measurements.

Figure 2 is a regional topographic base map (metric contour units) that depicts the potentiometric surface contours of the shallow-most aquifer at the MWFM pit site, labeled in feet above sea level (ASL). The water wells plotted include the USGS database water wells from Figure 1 and additional Misc database wells for which a reliable depth to water measurement has been recorded for the regional aquifer/water-bearing zone (Permian Rustler, Salado Formation and Artesia Group). Figure 2 also shows:

1. The location of the MWFM pit as a solid blue rectangle.
2. Groundwater elevations and gauging dates from the most recent available static water level measurement for each well.

Hydrologic and Geologic Report

The proposed MWFM Pit is located in the Great Plains physiographic province. The Plains are considered a Cenozoic depositional feature composed of erosional materials derived from the eastern front of the Rocky Mountains and similarly aligned Basin and Range mountains to the south including the Sacramento and Guadalupe Mountains.

Much of the Plains material that comprises the surface was deposited between 40 and 50 million years ago (ma). With some uplift of the Plains, depositional rates slowed or ceased from 40 to 30 ma. Beginning 30 ma, additional deposition spreading from the north to the south and reworking of the earlier materials resulted in the deposition of the Ogallala formation. The later formation of the Pecos Valley by headward erosion due to either uplift to the west or solution/subsidence of the valley resulted in partial stripping of material from the fronts of the mountains (Reeves, 1972). This action has left the Great Plains isolated from the mountain fronts.

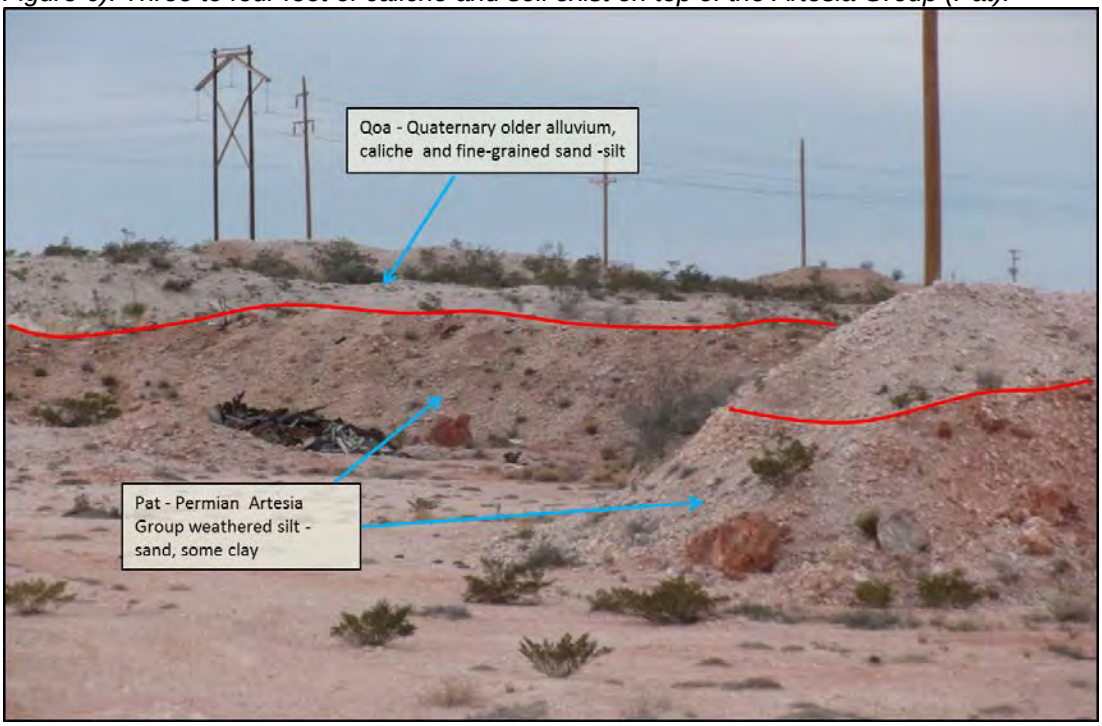
The MWFM Pit location is between the Mescalero rim, the western edge of the Great Plains (Ogallala Formation), and the Pecos River. The above mentioned development of the Pecos Drainage removed and reworked the remnants of the Ogallala formation between the Mescalero rim and the Pecos River. This surface is called the Mescalero Plain and is composed of relatively thin pediment deposits and alluvium of fluvial and eolian origins deposited on top of weathered Triassic and Permian formations.

The MWFM Pit location is mapped as Permian Salado Formation (Psl on Figure 1, see Graphic 1). About 200 feet south of the location is the mapped east-west contact between the Salado formation and Quaternary older alluvium (Qoa on Figure 1). Just west of the pit location, the mapped contact swings to the southwest. Hence, east to south of the location is Quaternary alluvium overlying the Salado Formation.

At the location and north and west of the location, at least several feet of caliche and soil exist on top of both the Permian Salado Formation and the underlying Artesia Group (Psl and Pat on Figure 1, see Graphic 2). The underlying Permian Artesia Group is exposed about 0.7 miles west-southwest of the pit location by the topography which slopes downwards to the Pecos River. The Permian Rustler Formation, overlying the Salado Formation, is a regional aquifer that is exposed to the north-northeast of the site and provides water to wells east of the site. The Rustler is not exposed at the proposed MWFM pit location.

Graphic 1: *Looking south at wall of caliche pit about 0.4 miles southwest of MWFM Pit location (see Figure 4). Three to four feet of caliche and alluvium (Qoa) is above the black contact line and thickens to the east (left).The western side of this caliche pit is mapped as Permian Salado Formation (Psl). The Salado Formation is below the black line. The dashed red contact is between the Salado formation and the Artesia Group. Some weathered limestone is exposed in the "red" layer on the lower pit walls and floor on the western side of the caliche pit. The proposed MWFM Pit will be excavated within this cross section.*

***Graphic 2**: Looking west at wall of caliche pit about 0.8 miles west-southwest of MWFM Pit location (see Figure 6). Three to four feet of caliche and soil exist on top of the Artesia Group (Pat).*



The site location is in the southeast corner of Section 36 along a topographic high at an elevation of about 3670 feet above sea level (asl). The western half of Section 36 is drained to the northwest by Logan Draw with a gradient of about 290 feet/mile (0.05 foot/foot). The western side of Section1 (immediately south of Section 36 and the site location) is drained by Scoggin Draw to the southwest with a gradient of about 310 feet/mile (0.06 foot/foot). Both Draws are tributaries of the Pecos River approximately six miles to the west

On the topographic high are several small, shallow depressions that are not sufficiently deep to register as closed topographic contours in Figure 3. These features are formed by the same mechanism proposed for similar depressions observed east of the Mescalero Rim, on the Ogallala Formation. According to Smith, (2003), small depressions initially form due to ancient collapse of solution voids, such as within the soluble evaporite beds in the underlying Permian Formations that lay deep below the Ogallala or, in the area of the MWFM Pit, within the Salado Formation and Artesia Group. As these surface irregularities/depressions collect surface water during precipitation events, infiltration is obviously greater than for the adjacent slopes or hilltops. Higher infiltration can result in dissolution of soluble material within the underlying material and resultant slumping of the overlying soils – increasing the depth of the depression and widening the area of impact. This deepening and enlarging process is limited by amount of rainfall and sediment inflow to the depression. Outside of these closed depressions, infiltration and subsequent solution of caliche or other soluble materials is negligible (Sabin, 1995).

Hydrogeology of the Pit Location

Figure 2 shows a potentiometric surface of the area. The western edge of the Mescalero Plain is a ground water divide between groundwater flowing west-southwest to the Pecos River and

ground water flowing south and southeast beneath the Mescalero Plain. Due to locally complicated geology, groundwater gradients can vary. Groundwater does not exist everywhere beneath the Mescalero Plain or everywhere within the Permian Formations exposed on the western edge of the Mescalero Plain. At the location of the MWFM Pit, the groundwater data suggests flow moves from east to west, toward the Pecos River. If groundwater exists at the site, it would occur in the Artesia Group evaporites.

Depth to Water

Data from the wells closest to the MWFM pit location are explained below:

- At the Empire Abo Gas Plant, 2.1 miles west of the MWFM Pit location (see Figure 2), groundwater monitoring wells at the Plant document a shallow, perched water body within the Artesia Group that is clearly a result of Plant Activities (known leakage of water lines). To the south of the Plant, shallow groundwater also exists in alluvium, within Scoggins Draw. A monitoring well immediately north of the plant was a dry hole to a depth of 200 feet.
- About 3 miles north of the site is Misc-21, a plugged and abandoned well observed in the field and probably completed within the Artesia Group. Figure 1 shows a measured depth to water of 115 feet and Figure 2 shows the water table elevation of 3357 (in 1954).
- About one mile west of Misc-21 is USGS-1520, an active windmill. This well is also probably completed in the Artesia Group, was monitored by the USGS in 2013 and shows a water table elevation of 3329.3. The data suggest a 28-foot decline in the water table over the 60-year time between the 1954 measurement of the nearby Misc-21. Adjacent to USGS-1520 is OSE well RA 07774 (Figure 1) with a depth to water of 50 feet in 1989. This suggests a 10-foot decline in the 24 year from 1989 to 2013, consistent with rate of decline noted above.
- The closest well to the north of the site is Misc.-17 about 2.25 miles to the northeast. Depth to water at Misc.-17 is recorded as more than 224.3 feet (ground water elevation of 3366.7). Misc.-17 is no longer a well as we field verified on our site visit of March 4, 2014. The windmill and some of the stock tank and plumbing are still present. The casing could not be located. Misc-17 is on an exposure of Rustler Formation and could have drawn water from this unit or from the underlying Artesia Group. We believe it unlikely that this well draws water from the poor-quality Salado Formation.
- About 4.35 miles to the northeast and 4.0 miles to the southeast are two USGS wells, USGS-1393 and USGS-1108. Ground water elevation at these two sites is 3499 asl (1999) and 3355 asl (1999). Both of these wells draw water from the Rustler and are up gradient of the MWFM Pit location as shown on the water table surface on Figure 1. Resultant depths to water are 78.55 feet and 225.24 feet respectively.
- Misc-18 is mapped as being slightly east of USGS-1393. We believe this well is the same well as USGS-1393. If this is true, the data record a 33 foot decline in the water table elevation – which is consistent with the estimated water table decline near Misc-21 to the northwest.
- Closest wells to the south are Misc.-59 and Misc.-60 located just east and west of the Pecos Diamond Gas Plant, and are 2.35 miles and 1.95 miles away respectively. Ground water elevation at Misc-59 is reported as 3517 with a depth to water of 81 feet (1948). Ground water elevation at Misc-60 is reported as 3550 (1989) with a depth to water of 55

feet. These wells are pumped by windmills. Due to the pump construction, it was not possible to obtain a measurement from these wells during our site visit of March 4, 2014. We believe these wells are most likely completed in the Rustler Formation, like the nearby USGS 1108 well.

As explained above, much of the data employed to create Figure 2 relies upon wells completed in the Rustler Formation. The only documented wells with reasonable depth to water measurements within the Artesia Group are at the Empire Abo Gas Plant, Misc-21 and USGS-1520. We found no wells completed within the Salado Formation, which underlies the MWFM Pit location. Although the projection of the water table elevation from these wells to the Salado Formation beneath the MWFM Pit would benefit from more data, the available data do suggest that the water table elevation map of Figure 2 is relatively accurate at the proposed pit site.

The MWFM Pit location is at an altitude of 3670 feet and is on a topographic high area along the western rim of the Mescalero Plain. The water table surface shown in Figure 2 suggests a water table elevation of about 3380, resulting in a calculated depth to water of 290 feet at the MWFM Pit location.

Distance to Surface Water

Figure 3 and the site visit demonstrates that the location is not within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark).

- The nearest stream (intermittent) is a branch of Hart Canyon, more than 2000 feet north-northeast of the pit location. Logan Draw is more than 2200 feet west of the pit location. Other nearest streams (intermittent) include Logan Draw, and various tributaries. All are at greater distances from the pit location (see Figure 2).
- There are no water bodies within 1.5 miles of the pit location.

Distance to Permanent Residence or Structures

Figure 4 and the site visit demonstrates that the location is not within 300 feet from a permanent residence, school, hospital, institution, church, or other structure in existence at the time of initial application.

- There is a gas pipeline facility more than 750 feet southwest of the pit location.
- All structures in the area are oil field infrastructure.

Distance to Non-Public Water Supply

Figures 1 and Figure 2 demonstrates that the location is not within 500 horizontal feet of a private, domestic fresh water well or spring that less than five households use for domestic or stock watering purposes, or within 1000 horizontal feet of any other fresh water well or spring, in existence at the time of initial application.

- Figure 1 and 2 show the locations of all area water wells, active or plugged/abandoned
- The nearest active well is Misc.-59 located more than 2 miles southeast of the location.
- There are no known domestic water wells located within 1000 feet of the location.
- No springs were identified within the mapping area (see Figure 3).

Distance to Municipal Boundaries and Fresh Water Fields

Figure 5 demonstrates that the location is not within incorporated municipal boundaries or defined municipal fresh water well fields covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended.

- The closest municipality is Artesia, NM approximately 10.5 miles to the northwest.
- The City of Carlsbad's Double Eagle Wellfield is more than 23 miles to the northeast.

Distance to Wetlands

Figure 6 demonstrates the location is not within 500 feet of wetlands. This also qualifies the location for in-place closure.

- The nearest designated wetland is a "freshwater pond" located 1.7 miles southeast of the pit location.

Distance to Subsurface Mines

Figure 7 and our general reconnaissance of the area demonstrate that the nearest mines are caliche pits. The location is not within an area overlying a subsurface mine.

- The nearest mapped caliche pit is located about 1.0 miles to the northeast.
- There is an active caliche pit whose northeastern corner is about 1600 feet to the southwest of the pit location and is not part of the government database of mines.
- There are no subsurface mines in the area.

Stability of Pit Area and Distance High or Critical Karst Areas

Figure 8a shows the location of the MWFM Pit with respect to BLM Karst areas using the 2014 map and Figure 1 shows the regional geology.

- The proposed MWFM pit location is currently mapped in a "High Potential" karst area.
- .
- No evidence of surface solution voids were observed within or near the chosen pit location during the field inspection.
- No surface evidence of unstable ground was observed within or near the chosen pit location.
- Solution slump features are observed about ½ mile north of the proposed pit location where stormwater temporarily flows or accumulates.
- The subsurface investigation showed no evidence of unstable ground

In areas that collect storm water, subsidence is common if near-surface gypsum or anhydrite (soluble material) is present. About ½ mile north of the All Thorn MWFM pit, we observed obvious subsidence in a small depression due to solution of the underlying gypsum/anhydrite within the underlying Rustler Formation. More than 1000 feet south of the pit site, we observed what may be collapse features in depressions – but subsequent examination showed these depressions to be man-made and what appeared as subsidence was very old digging. Our observations and research allowed us to conclude that the 2-3 square mile area around the All Thorn location has "high karst potential" due to the presence of relatively near-surface soluble rocks; and certain areas are unstable. At the All Thorn pit location, Hicks Consultants concludes

that this particular area is an island of stability due to its location on a topographic high and the presence of massive caliche beneath the surface.

Graphic 1 is a photograph of the caliche pit wall located 0.4 miles southwest of the MWFM Pit location (see Graphic 3). The proposed MWFM Pit will be excavated into material equivalent to the upper eight feet of the caliche pit wall in Graphic 1. We also examined a more distant caliche pit, located about 1 mile west of the proposed MWFM Pit location.

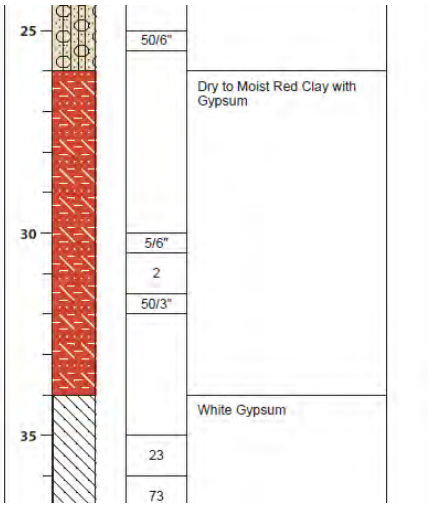
At both caliche pits, we examined the pit floors. The closer pit (Graphic 1) is actively being worked, and therefore the floor surface is covered with freshly, loosened material. At the more distant caliche pit to the west (Graphic 2), vegetation is present on the pit floor indicating that it has not been worked since before the mesquite and grass began growing. At neither location was there evidence of subsidence features or instability.

As mentioned above, a geotechnical study comprised of 3-4 borings was conducted at the site. The results of this investigation are presented in Appendix H and are summarized below. .

Subsurface Boring Investigation

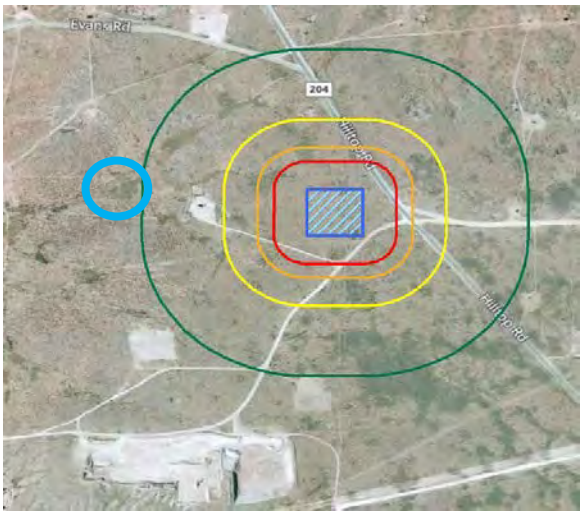
From ground surface to a depth of at least 20 feet at all boring locations, competent caliche is present. As presented in the attached Pettigrew and Associates report (Appendix H), blow counts document a bearing capacity in excess of 3,000 pounds per square foot for the caliche at depths below 2-4 feet.

Below the caliche is the Rustler Formation, which is comprised of red claystone and gypsum. In these boreholes, the gypsum layers were generally 1-inch to 1-foot thick and were encased in many feet of red claystone. In Borehole 3 (see map attached to the Pettigrew Report), cores and cuttings revealed a 3-foot thick horizon of gypsum at a depth of 34 feet below grade. While the blow counts in this gypsum horizon were significantly lower than in the surrounding claystone (23-73 counts/foot versus 50 counts/6-inches or 100 counts/foot), the bearing capacity of the gypsum still exceeds the 3,000 pounds per square foot criteria (see Pettigrew Report).



In Borehole #3, we encountered a void at a depth of approximately 30-31.5 feet. As shown in the reproduction of the boring log at this depth, the blow counts were 2 counts/foot; clearly less than the 18 counts/foot that represent competent material. However, immediately below the void, the stability of the Rustler bedrock meets all design criteria. Within the overlying caliche, the sample at 25 feet shows 50 blows with the 140 pound hammer were required to advance the split spoon sampler 6 inches.

We also conducted a foot survey of several small depressions that collect storm water west-northwest of the proposed pit location; from the turquoise circle on the adjacent aerial photograph (see Figure 4 of the C-144 Application) to Borehole #3. The small depression within the turquoise circle is at an elevation of about 3630 feet asl (see Figure 3 of the C-144 Application) and the elevation of Borehole #3 (NW corner of the proposed pit location) is 3682, about 50 feet higher. Thus, as we walked the small drainage that led to Borehole #3, we were able to observe the complete stratigraphic section penetrated by the boring. In several small depressions between the turquoise circle and the pit area, we found no evidence of subsidence or instability.



Pettigrew and Associates agree with this stability evaluation as originally submitted to OCD on 8/22/2014 and their e-mail substantiating their agreement is part of Appendix H.

Although a professional geotechnical engineer and a professional geologist agree that the ground of the area is stable, Pettigrew has developed a set of engineering recommendations for the pit foundation. These recommendations are included in Appendix B.

Distance to 100-Year Floodplain

Figure 9 demonstrates that the location is within an area that has not yet been mapped by the Federal Emergency Management Agency with respect to the Flood Insurance Rate 100-Year Floodplain.

- Areas that are not mapped are generally considered minimal flood risk
- Our field inspection and examination of the topography permits a conclusion that the location is not within any floodplain

References

Reeves, C.C., Jr., 1972, Tertiary-Quaternary Stratigraphy and Geomorphology of West Texas and Southeastern New Mexico, In Guidebook, East-Central New Mexico, ed. V.C. Kelley and F. D. Trauger, 103-17, New Mexico Geological Society 23

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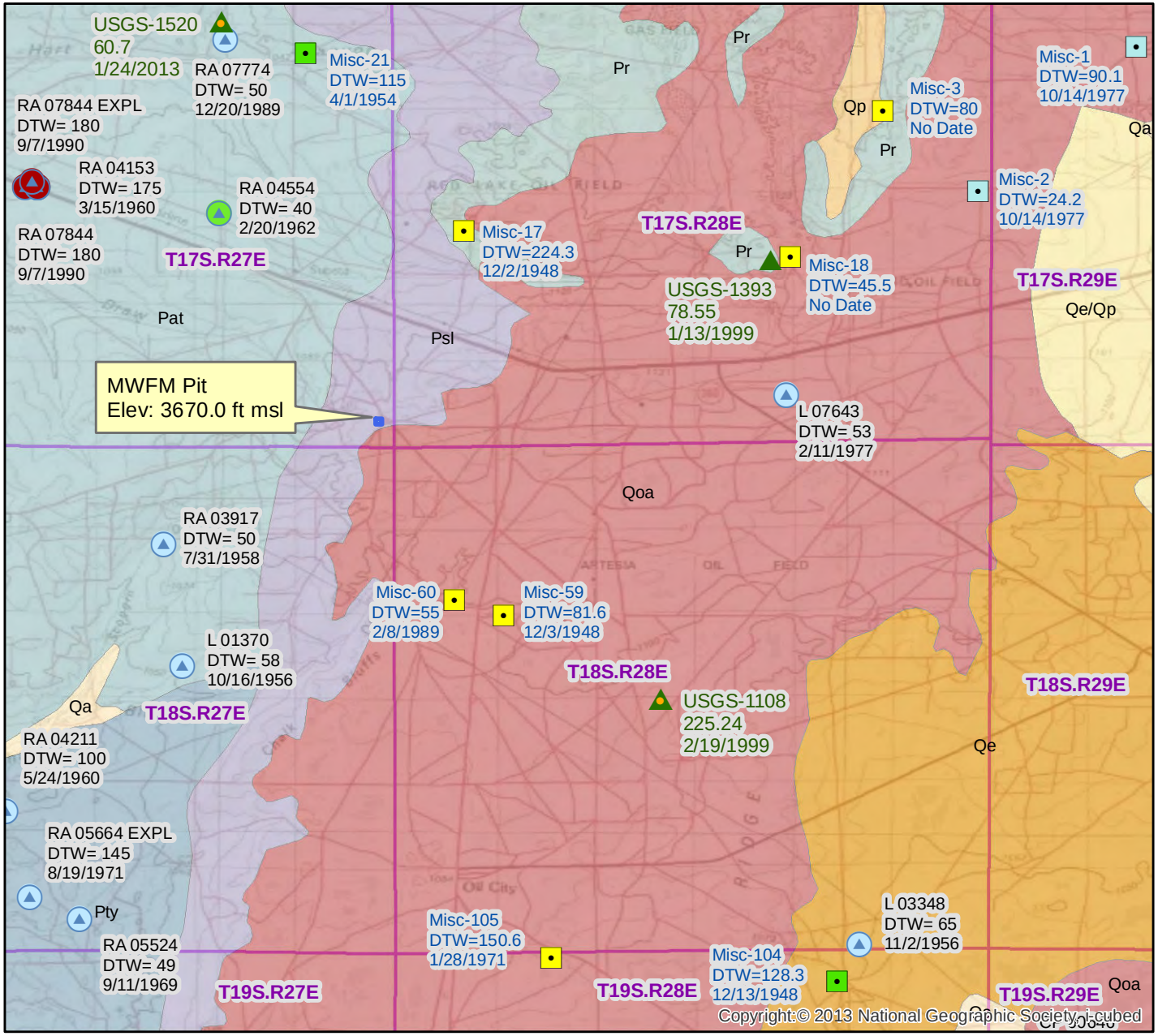
Sabin,T.J. and Holiday, V.T., Playas and Lunettes on the Southern High Plains, Morphometric and Spatial Relationships, Anals of the Association of American Geographers, Vol 85, No.2.(Jun,1995), pp 286-305

http://www.argonaut.arizona.edu/articles/sabin_holliday1995.pdf

Smith, L. M., 2003, Playas of the Great Plains, University of Texas Press, pp 31-39

Site Specific Information
Figures

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104



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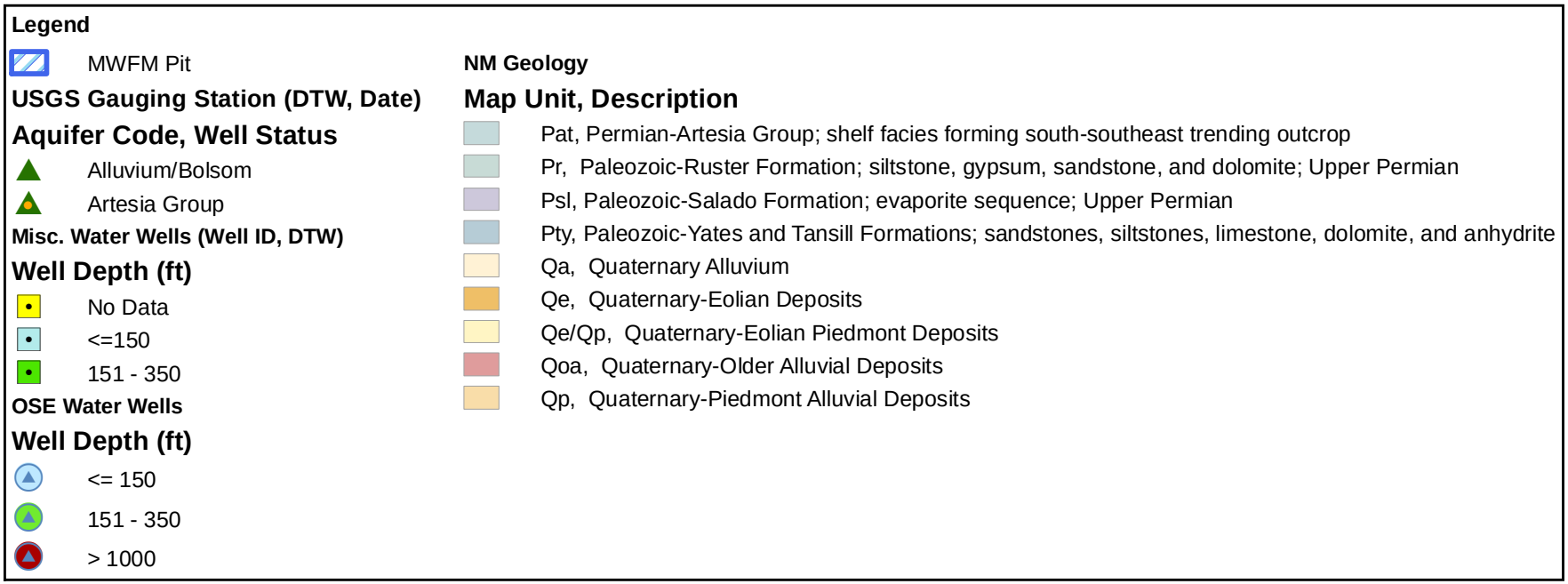
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Depth To Water and Geology

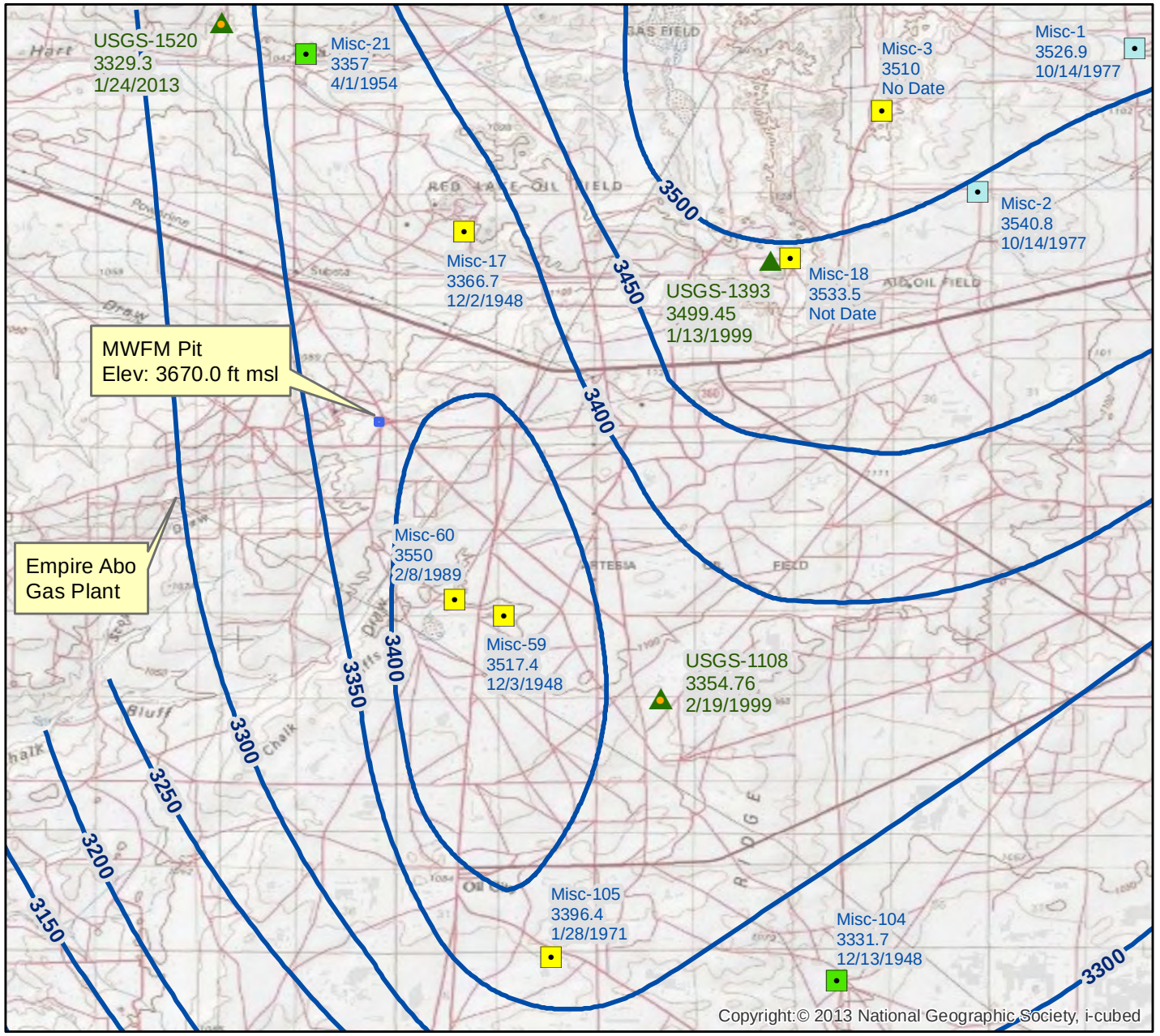
Figure 1

Lime Rock Resources: All Thorn MWFM Pit

April 2014



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Legend for Figure 1	Figure 1 Legend
	Lime Rock Resources: All Thorn MWFM Pit	April 2014



Legend

USGS Gauging Station (GW Elev, Date)

Aquifer Code, Well Status

- Alluvium/Bolsom
- Artesia Group

Misc. Water Wells (Well ID, GW Elev)

Well Depth (ft)

- No Data
- <=150
- 151 - 350

Potentiometric Surface (ft msl)

Type

- Isocontour

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901 Rio Grande Blvd NW Suite F-142
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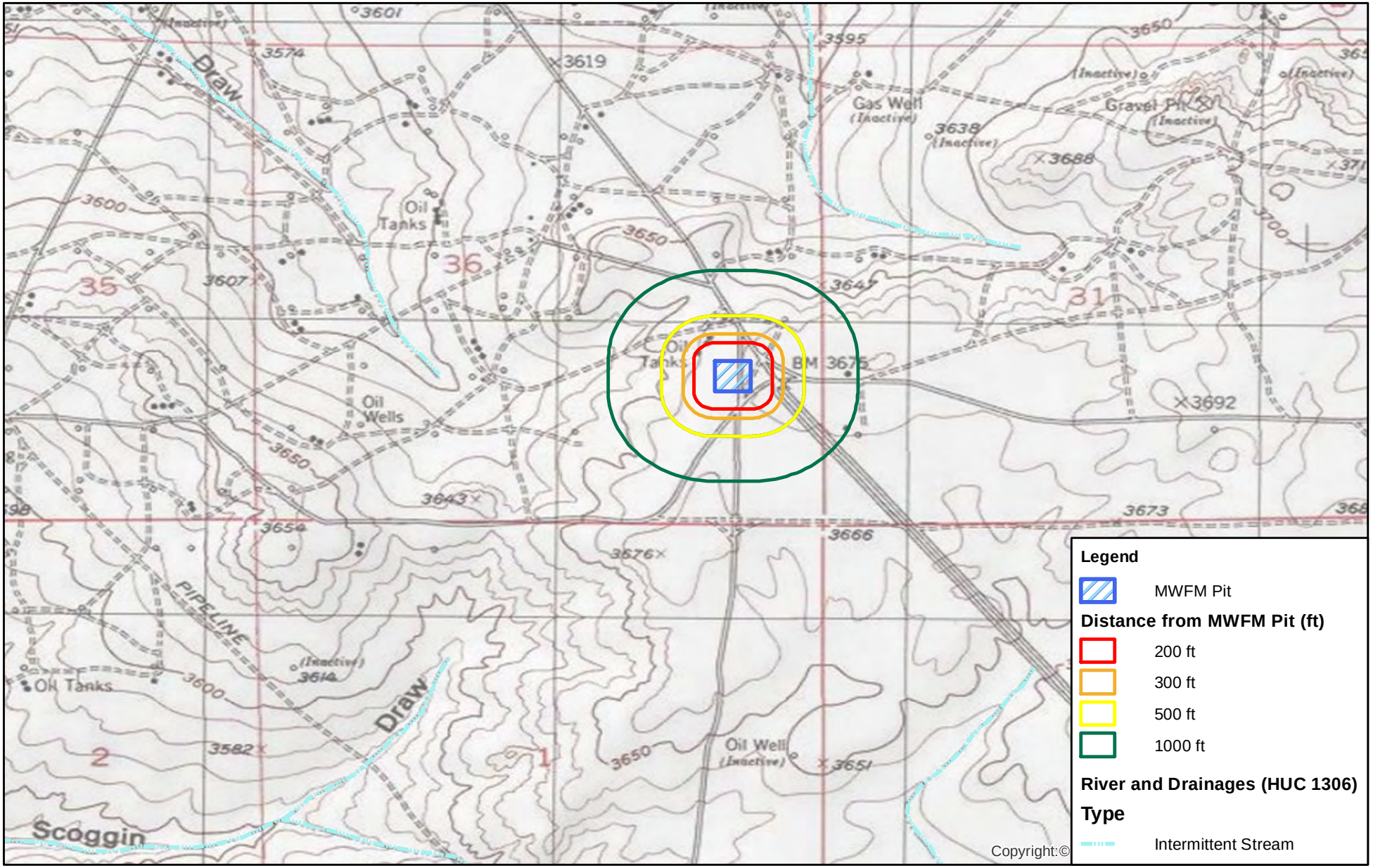
Ph: 505.266.5004

Potentiometric Surface and Groundwater Elevation at Nearby Water Wells

Figure 2

Lime Rock Resources: All Thorn MWFM Pit

April 2014



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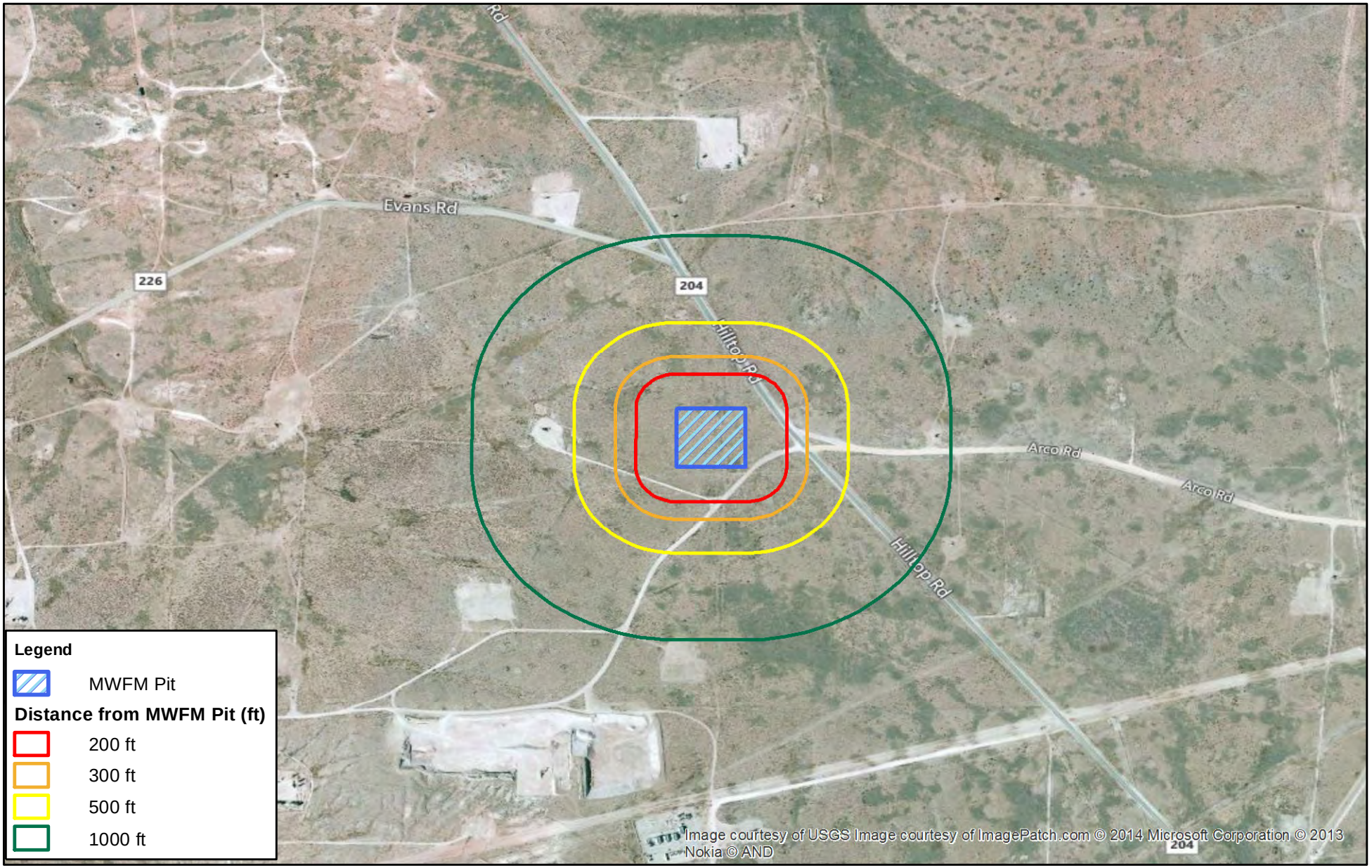
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Surface Water and Topography	Figure 3
Lime Rock Resources: All Thorn MWFM Pit	April 2014



(aerial image c.2013)

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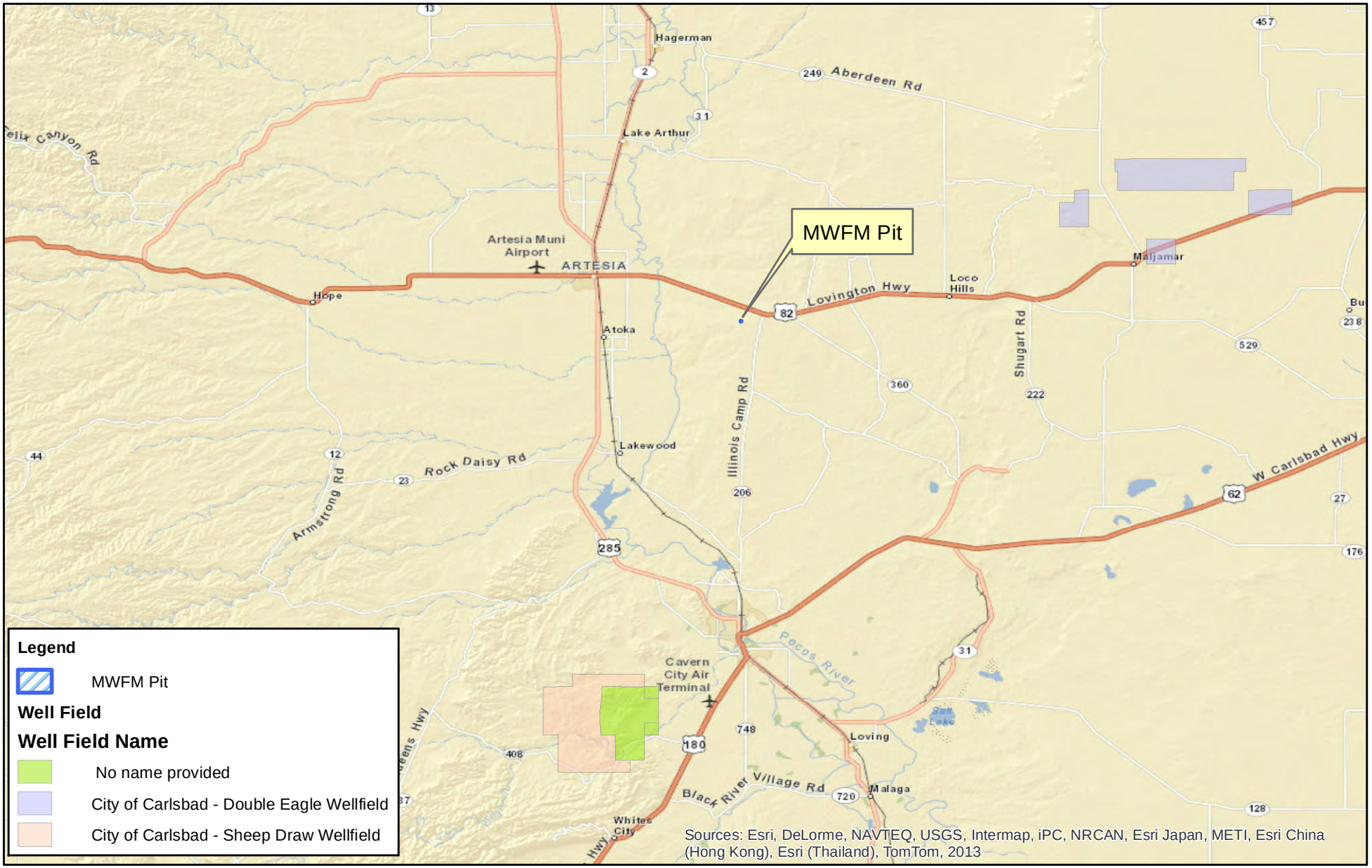
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Nearby Structures	Figure 4
Lime Rock Resources: All Thorn MWFM Pit	April 2014



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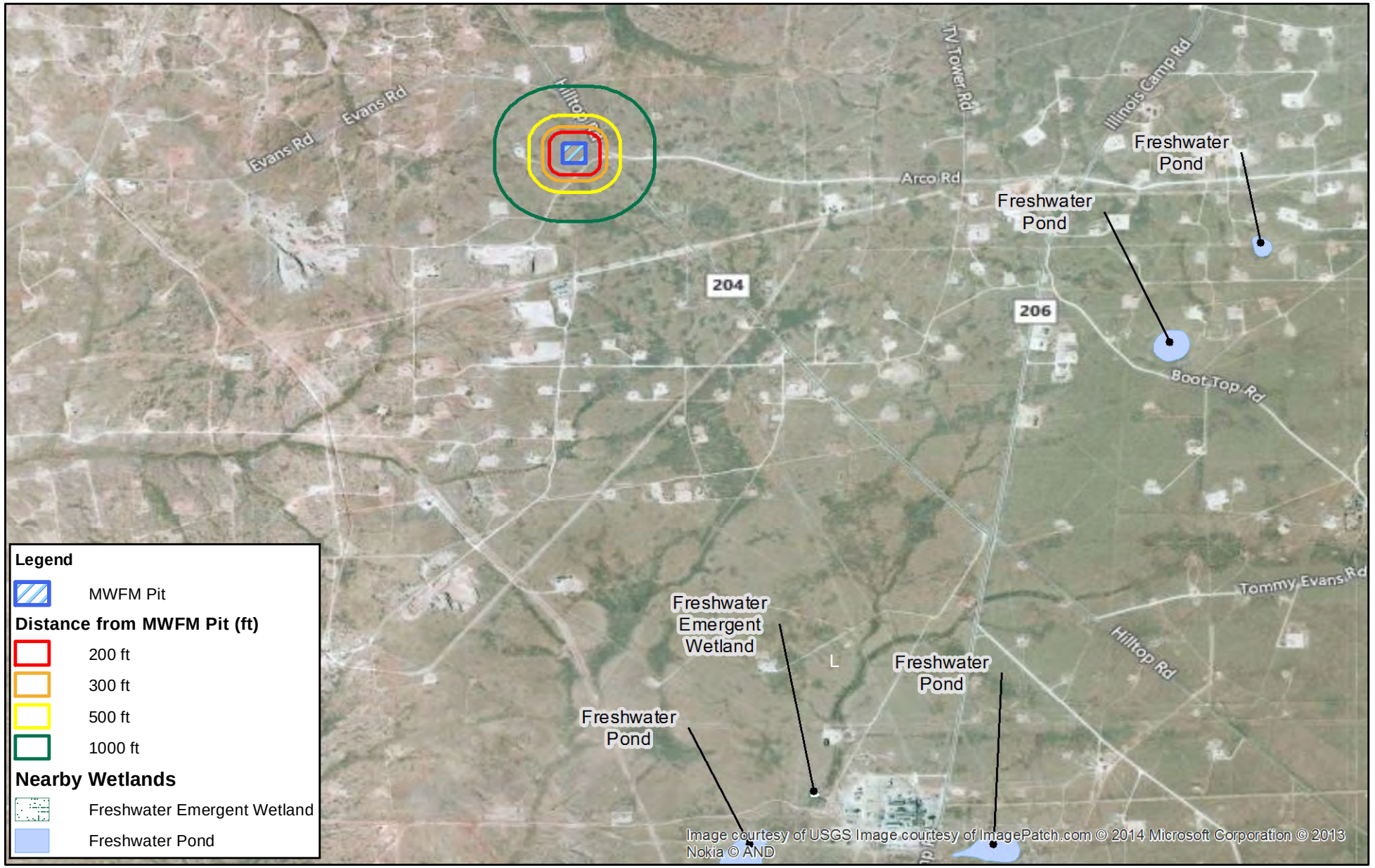
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Nearby Municipalities and Well Fields

Figure 5

Lime Rock Resources: All Thorn MWFM Pit

April 2014



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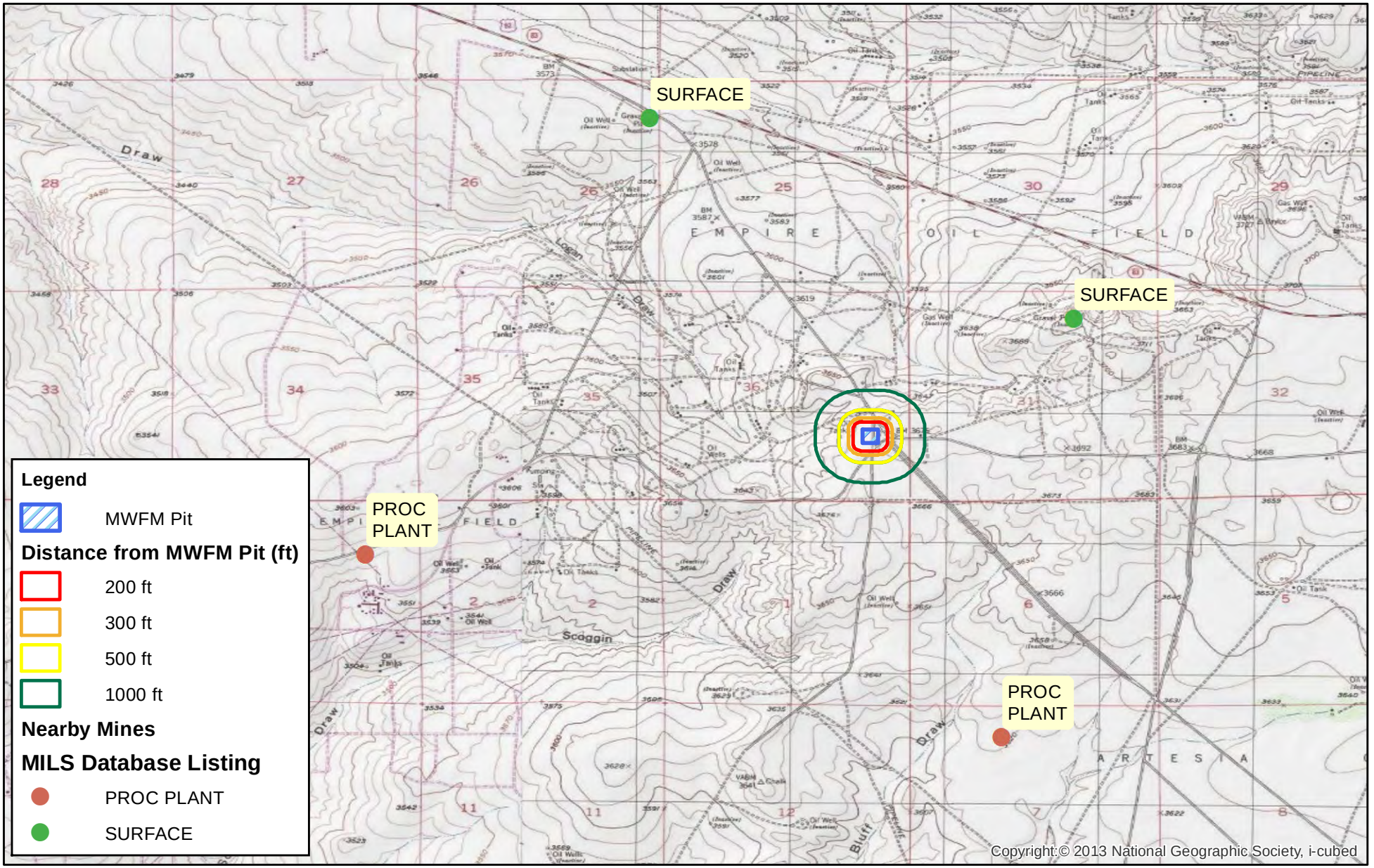
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Nearby Wetlands	Figure 6
Lime Rock Resources: All Thorn MWFM Pit	April 2014



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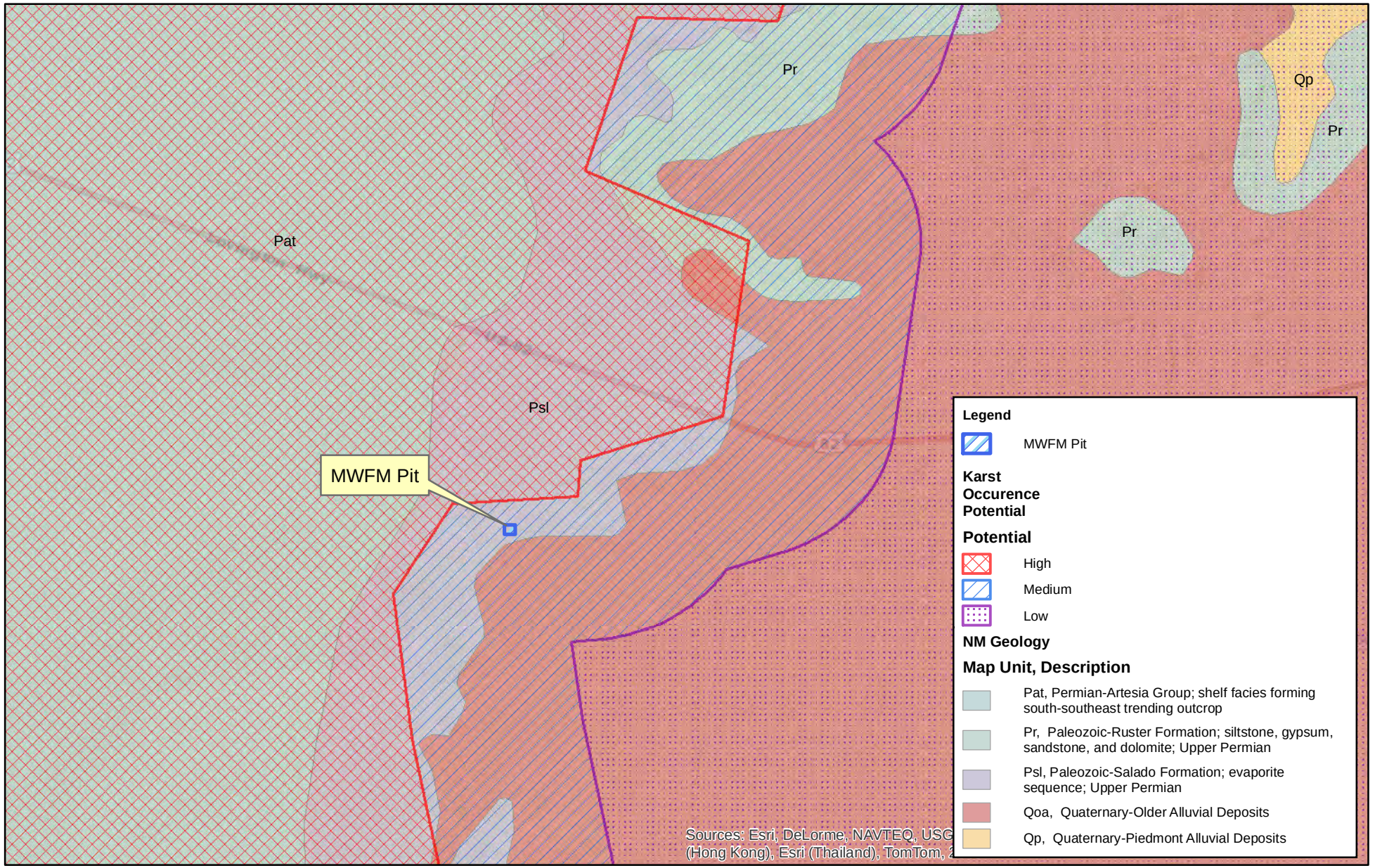
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Nearby Mines and Minerals

Figure 7

Lime Rock Resources: All Thorn MWFM Pit

April 2014



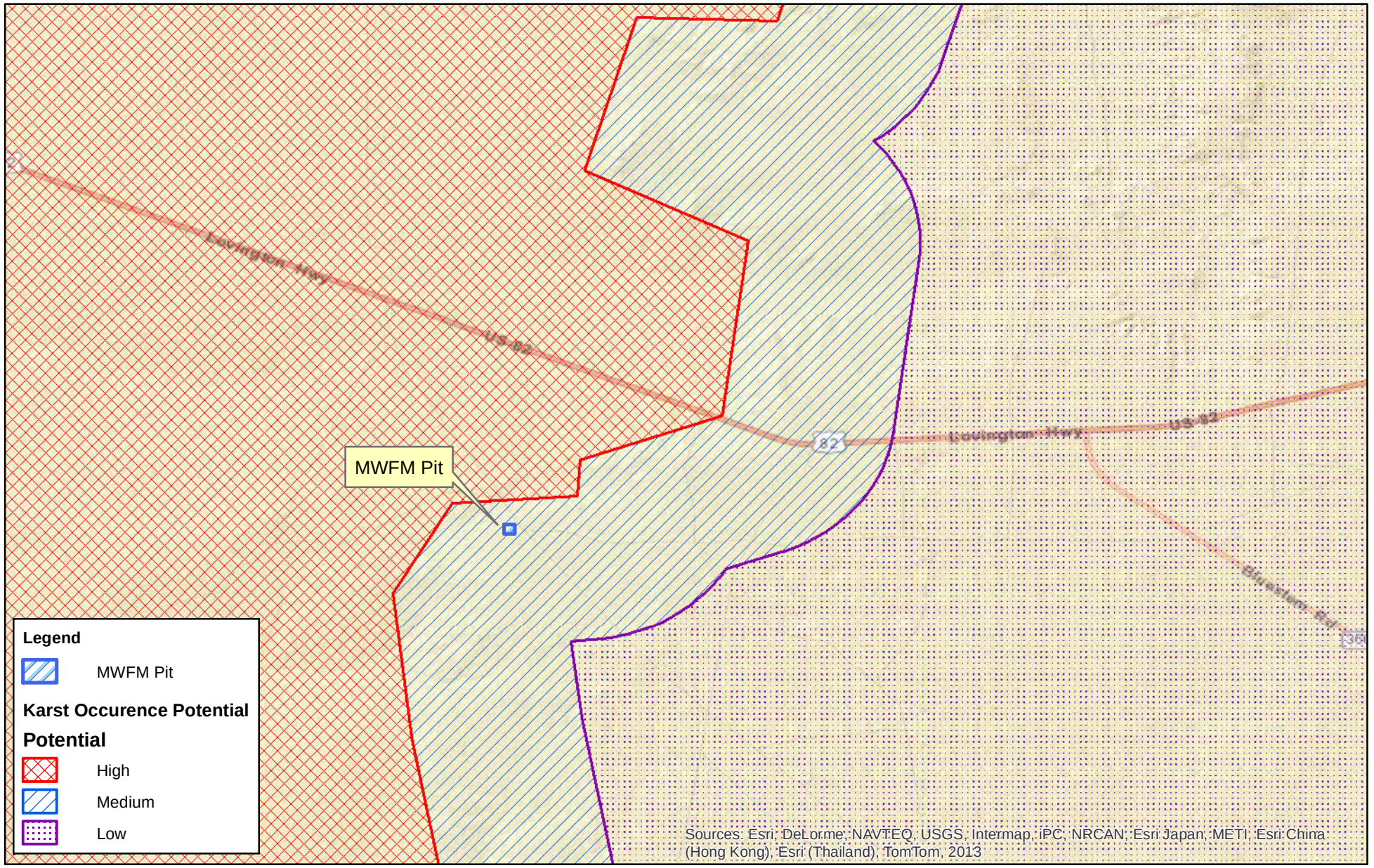
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Karst Potential and Geology

Figure 8b

Lime Rock Resources: All Thorn MWFM Pit

October 2014



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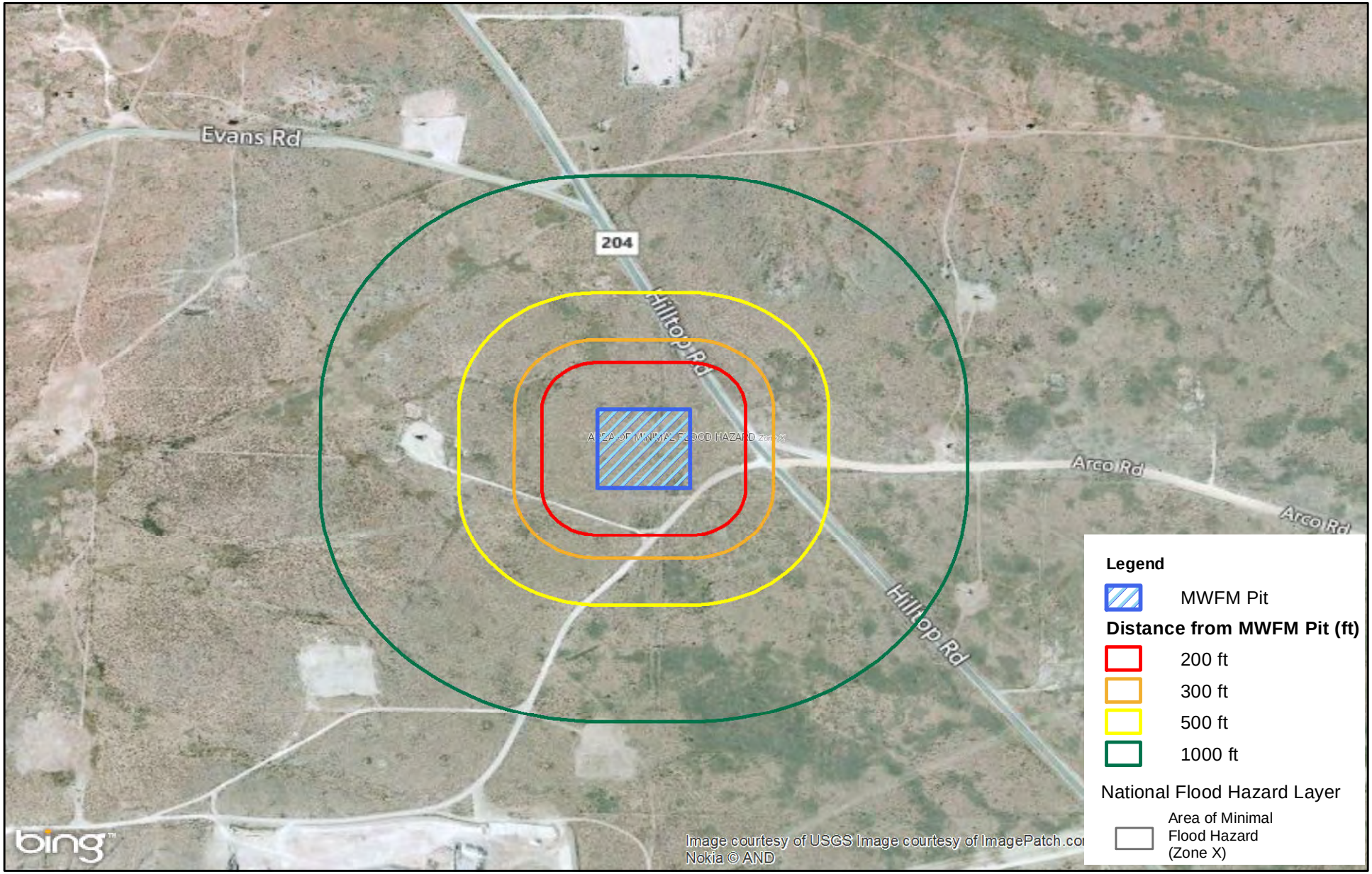
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Karst Potential

Figure 8a

Lime Rock Resources: All Thorn MWFM Pit

October 2014



FEMA Source: https://hazards.fema.gov/gis/nfhl/services/public/NFHLWMS/MapServer/WMSServer

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R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

FEMA Flood Map	Figure 9
Lime Rock Resources: All Thorn MWFM Pit	April 2014

Appendix D

Operating and Maintenance Plan

Operating and Maintenance Procedures

Lime Rock Resources ll-A, L.P. (Lime Rock) will operate and maintain the MWFM Pit to contain liquids and solids (blow sand and minimal precipitates from the treated produced water) and maintain the integrity of the liner system in a manner that prevents contamination of fresh water and protects public health and the environment as described below. The purpose of the MWFM pit is to facilitate recycling, reuse and reclamation of produced water derived from nearby oil and gas wells listed in Appendix E. During periods when water for E&P operations is not needed, produced water will discharge to one of the injection wells in the Lime Rock SWD system, which is also listed in Appendix E.

The operation of the MWFM pit is summarized below.

A. Via pipeline, produced water generated from nearby oil and gas wells is delivered to a treatment system located within the perimeter fence on the north side of the MWFM pit. The treatment capacity of the proposed unit is about 8,000 bbls/day.
B. After initial treatment, the produced water flows into frac tanks which provide the required residence time after treatment to remove H2S and certain other constituents, then discharges into the pit
C. When required, treated produced water is removed from the pit for E&P operations. At this time, treated produced water will be used for drilling beneath the fresh water zones (beneath surface casing), for well stimulation (e.g. hydraulic fracturing) and other E&P uses as approved by OCD.
D. Typically, one well will be stimulated during the same contractor mobilization event. Each simulation requires about 120,000 bbls and each stimulation event occurs over a several day period (set up-fracturing-demobilization). Because the pit cannot be 100% evacuated of fluid and the treated produced water serves other E&P uses (e.g. drilling), the pit must hold more than 120,000 bbls prior to each stimulation event.
E. A treatment rate of 8,000 bbl/day allows stimulation of two wells per month.
F. Whenever the maximum fluid capacity of the pit is reached, treatment and discharge to the pit ceases (see Freeboard and Overtopping Plan, below)

The operation of the MWFM pit will follow the mandates listed below:

1. The operator will not discharge into or store any hazardous waste (as defined by 40CFR 261 and NMAC 19.15.2.7.H.3) in the pits.
2. If the pit liner's integrity is compromised above the water line, then the operator will repair the damage within 48 hours of discovery.
3. If any penetration of the pit liner is visually identified below the normal high water mark of the pit, then The operator will suspend operations of the pit, remove all liquid above the damage or leak within 48 hours, notify the district office within 48 hours (phone or email) of the discovery and repair the damage or replace the pit liner.
4. If any penetration of the pit liner is confirmed by sampling of fluid in the leak detection system (see Inspection and monitoring plan), The operator will
    a. Begin and maintain fluid removal from the leak detection/pump-back system
    b. notify the district office within 48 hours (phone or email) of the discovery
    c. Schedule a shut-down of produced water treatment/re-use, then
        i. remove all liquids
        ii. identify the location of the leak and
        iii. repair the damage or replace the pit liner prior to continuing operation
5. The operator will report releases of fluid to the subsurface in a manner consistent with NMAC 19.15.29

6. As shown in the engineering drawings (Appendix A), the injection and withdrawal or treated and untreated produced water is accomplished through a piping system to prevent liner damage.
7. Appendix A also demonstrates that the elevation and slopes of the pit prevent the collection of surface water run-on.
8. No oil or floating hydrocarbon shall be present in the MWFM pit. In the on-site storage building, the operator will maintain an oil absorbent boom to contain and remove oil from the pit's surface.
9. The operator will maintain the pit free of miscellaneous solid waste or debris.
10. The operator will maintain at least three feet of freeboard for the permanent pit and will use a free-standing staff gauge to allow easy determination of the required 3-foot of freeboard.
11. The operator will ensure that all gates associated with the fence are closed and locked when responsible personnel are not on-site.

Monitoring, Inspection, and Reporting Plan

When the pit holds fluid, the operator will inspect the pit daily and document such inspections until the pit is closed. Daily inspections consist of

a. reading and recording the fluid height of staff gauges
b. recording any evidence that the pond surface shows visible oil
c. visually inspecting the pit's exposed liners.

If a liner's integrity is compromised, or if any penetration of the liner occurs above the water surface, then the operator will notify the Artesia district office within 48 hours (phone or email).

After back-to-back stimulation of two wells, the fluid level in the pit should be relatively low and the nature (e.g. jetting) of water that is actively leaving and/or entering the pit should be visible. At this time, the daily inspection includes:

1. a thorough examination of the liner (e.g. with binoculars) for any possible loss of integrity.
2. Watching the movement of fluid into and/or out of the pit to monitor any liner damage due to fluid jets, vibration or other problems with the manifold system (see Design and Construction Plan for data relating to this equipment).

Monthly, the operator will

A. Inspect diversion ditches and berms around the pit to check for erosion and collection of surface water run-on.
B. For the first year, measure H_2S concentrations on the down-wind side of the pit.
C. Inspect the leak detection system for evidence of damage or malfunction and monitor for leakage (see Design and Construction Plan for data relating to this system).
D. inspect the pit for dead migratory birds and other wildlife. Within 30 days of discovery, the operator will report such findings to the USFWS and to the Artesia Division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

The operator will maintain a log of all inspections and make the log available for the appropriate Division district office's review upon request. An example of the log is attached to this section of the permit application.

- On a quarterly basis the operator will report the following information:
- Any reports of bird or wildlife mortality
- The location (UL, S, T, R), identifier (e.g. well/ API number and volume of treated produced water used for each hydraulic fracturing event

- The volume of fresh water, if any, used for hydraulic fracturing
- The total volume of treated produced water and fresh water used in the quarter.

Freeboard and Overtopping Prevention Plan

The method of operation of the pit allows for maintaining freeboard with very few potential problems. When the capacity of the pit is reached (3-feet of freeboard), the discharge of treated produced water ceases and the produced water generated by nearby oil and gas wells is managed by one of the injection wells identified in Appendix E.

If rising water levels suggest that 3-feet of freeboard will not be maintained, the operator will implement one or more of the following options

I. Cease discharging produced water scheduled for recycling to the pit
II. Accelerate re-use of the treated produced water for purposes approved by the Division
III. Transfer treated produced water from the pit to one of the injection wells listed in Appendix E

The reading of the staff gauge occurs daily. In order for the MWFM Pit to rise 1-foot above the required 3-feet of freeboard (thus creating only 2-feet of freeboard) a total volume of at least 15,000 bbls of treated must enter the pit. At a treatment rate of 8,000 bbls/day, this 1-foot rise requires 2 days of discharge. Overtopping the pit would require six days of inattention, which is essentially impossible, given the need to maintain the treatment unit.

Protocol for Leak Detection Monitoring, Fluid Removal and Reporting

As shown in Appendix A, the leak detection system includes a monitoring system. Any fluid released from the primary liner will flow to the collection sump where fluid level monitoring is possible at the monitoring riser pipe associated with the leak detection system (see Appendix A). Lime Rock personnel will employ a portable electronic water level meter to determine if fluid exists in the monitoring riser pipe. Obtaining accurate readings of water levels in a sloped pipe beneath a pit can be a challenge. An electrician's wire snake may be required to push the probe to the bottom of the port and the probe may be fixed in a 2-inch PVC pipe "dry housing" to avoid false readings due to water condensation on the pipe. There are many techniques to determine the existence of water in the sumps – including low flow pumps.

If seepage from the pit into the leak detection system is suspected by a positive fluid level measurement, the operator will

1. Re-measure fluid levels in the monitoring riser pipe on a daily basis for one week to determine the rate of seepage.
2. Collect a water sample from the monitoring riser pipe to confirm the seepage is treated produced water from the pit via field conductivity and chloride measurements.
3. Notify NMOCD of a confirmed positive detection in the system within 48-hours of sampling (initial notification).
4. Install a pump into the monitoring riser pipe sump to continually (manually on a daily basis or via automatic timers) remove fluids from the leak detection system into the pit until the liner is repaired or replaced.
5. Dispatch a liner professional to inspect the portion of the pit suspected of leakage during a "low water" monitoring event.
6. Provide NMOCD a second report describing the inspection and/or repair within 20 days of the initial notification

If the point of release is obvious from the low water inspection, the liner professional will repair the loss of integrity. If the point of release cannot be determined by the inspection, the liner professional will develop a more robust plan to identify the point(s) of release. The inspection plan and schedule will be submitted to OCD with the second report. The operator will implement the plan upon OCD approval.

Pit Inspection Form All Thorn MWFM Pit

Month Oct-14

Day	Weekly	Low Water	Activity	Monthly	Staff Gauge	Comments
1 - Wed						
2	x				8.75	Gate unlocked upon arrival - notified Jerry Smith, no birds in pit
3					10	
4					12	
5			x			Water transfer to frac - pipes are good
6			x			Water transfer to frac - pipes are good
7		x			2.5	No visible liner problems
8					3	
9	x				4	All OK - no oil on surface, no birds in pit
10					5	
11					5	
12					6	
13					7	
14					7.5	
15				x	8	No fluid in leak detection, outer berm and stormater diversion OK, H2S - no alarm,
16					9	
17					9	
18					9.5	
19	x				10	All OK
20					11	
21					12	
22			x			Water transfer to frac - no problems
23			x			Water transfer to frac - no problems
24		x			1.75	No visible liner problems
25					2.25	
26	x				3.75	High wind -liner is good, no birds
27					4.75	
28					5.5	
29					6.75	
30					7.75	
31					8.5	

Appendix E

List of Wells with Approved APDs

List of Wells with Approved APD's.

Well Name	API #	
ANTHONEY STATE #1	30-015	37691
ANTHONEY STATE #2	30-015	38234
CHALK BLUFF FEDERAL #4	30-015	41509
COMPTON 8G FEDERAL #6	30-015	42344
COMPTON 5 P FEDERAL #4	30-015	41439
EAGLE 26N FEDERAL #6	30-015	39564
EAGLE 26I FEDERAL #7	30-015	42301
EAGLE 26M FEDERAL #8	30-015	42373
EAGLE 33G FEDERAL #27	30-015	41226
EAGLE 33J FEDERAL #25	30-015	41264
EAGLE 33N FEDERAL #31	30-015	42263
EAGLE 33O FEDERAL #19	30-015	39459
EAGLE 34D FEDERAL #72	30-015	41216
EAGLE 34F FEDERAL #69	30-015	41287
EAGLE 34G FEDERAL #67	30-015	41432
EAGLE 34I FEDERAL #62	30-015	41285
EAGLE 34J FEDERAL #63	30-015	41446
EAGLE 34K FEDERAL #65	30-015	41433
EAGLE 34L FEDERAL #79	30-015	42522
EAGLE 34N FEDERAL #64	30-015	41213
EAGLE 34N FEDERAL #76	30-015	42523
EAGLE 35 A FEDERAL #21	30-015	40810
EAGLE 35 H FEDERAL #25	30-015	41697
EAGLE 35E FEDERAL #20	30-015	40809
EAGLE 35E FEDERAL #29	30-015	42302
EAGLE 35F FEDERAL #24	30-015	41751
EAGLE 35F FEDERAL #31	30-015	42454
EAGLE 35L FEDERAL #23	30-015	41441
ENRON STATE #15	30-015	36978
ENRON STATE #16	30-015	38512
ENRON STATE #21	30-015	42156
ENRON STATE #4	30-015	32162
ENRON FEDERAL #19	30-015	41321
FALCON 3G FEDERAL #32	30-015	41466
FALCON 3K FEDERAL #28	30-015	39948
GANT 7G FEDERAL #2	30-015	42447
HONDO 4 K FEDERAL #50	30-015	41510
JEFFERS 36 STATE #3	30-015	31541
JEFFERS 36 STATE #4	30-015	34626
KERSEY STATE #7	30-015	42612

KERSEY STATE #8	30-015	42613
KITE 5I FEDERAL #4	30-015	41718
LOGAN 2C STATE #4	30-015	40783
LOGAN 35I FEDERAL #17	30-015	41370
LOGAN 35J FEDERAL #20	30-015	42247
LOGAN 35F FEDERAL #25	30-015	42573
LOGAN B 35O FEDERAL #10	30-015	41435
MALCO B 6 P FEDERAL #11	30-015	42319
MATTHEWS 25 FEDERAL #2	30-015	41712
MATTHEWS 25 FEDERAL #3	30-015	41698
NO BLUFF STATE COM #1	30-015	30907
RESTLER STATE #1	30-015	31283
RESTLER STATE #2	30-015	35973
RESTLER STATE #3	30-015	37313
RESTLER STATE #4	30-015	38514
RESTLER STATE #5	30-015	40308
SIMON A 5 M FEDERAL #2	30-015	41640
SIMON A 5 N FEDERAL #3	30-015	41436
STALEY STATE #12	30-015	37673
STALEY STATE #16	30-015	40338
STALEY STATE #17	30-015	40026
STALEY STATE #2	30-015	31285
STALEY STATE #20	30-015	40983
STALEY STATE #24	30-015	41065
STALEY STATE #4	30-015	31287
STALEY STATE #26	30-015	40988
STALEY STATE #6	30-015	37056
STALEY STATE #9	30-015	36564
STALEY STATE #11	30-015	36976
STALEY STATE #19	30-015	40340
WINDFOHR 4I FEDERAL #10	30-015	42052
WINDFOHR 4P FEDERAL #11	30-015	42038
WINDFOHR 4O FEDERAL #12	30-015	42037
WINDFOHR 4J FEDERAL #9	30-015	42550

Appendix F
Closure Plan

The MWFM pit is expected to contain a small volume of solids, the majority of which will be windblown sand and dust with some mineral precipitates from the water.

Closure Notice

Lime Rock Resources ll-A, L.P. (Lime Rock) will not commence closure without first obtaining approval of the closure plan submitted with the C-144 application. To allow for review time and site inspection, Lime Rock will notify the Division's Santa Fe office at least 60 days prior to cessation of operations and provide a proposed schedule for closure. Lime Rock will close the permitted MWFM pit within 60 days of cessation of operation of the pit in accordance with an approved closure plan.

At least 72 hours, but not more than one week, prior to any closure activities, Lime Rock will notify the surface owner (State Land Office) by certified mail, return receipt requested. This notice will include the project name and location description.

Excavation and Removal Closure Plan – Protocols and Procedures

1. Lime Rock will remove all liquids from the pits and either:
    a. Dispose of the liquids in a division-approved facility (e.g. Round Tank SWD #1), or
    b. Recycle, reuse or reclaim the water for reuse in drilling and stimulation.
2. Lime Rock will remove all solid pit contents and synthetic pit liners and transfer those materials to the following division-approved facility:
    Disposal Facility Name: R360 Permit Number NM 01-0006
3. After the removal of the pit contents and liners, soils beneath the MWFM pit will be tested as follows
    a. Collect a five-point (minimum) composite from beneath the pit liner sample to include any obviously stained or wet soils, or any other evidence of impact from the pits for laboratory analyses for the constituents listed in Table I of 19.15.17.13 NMAC.
    b. If any concentration is higher than the parameters listed in Table I, additional delineation may be required and closure activities will not proceed without Division approval.
4. If all constituents' concentrations are less than or equal to the parameters listed in Table I, then Lime Rock will proceed to backfill the former pit location in accordance with the **Soil Cover Design** (below) with non-waste containing, uncontaminated, earthen material blended to the surrounding topography and arranged in a manner that prevents surface erosion.
5. Re-vegetation as outlined below

Soil Cover Design

If required by the surface owner, Lime Rock will backfill the former pit locations and the soil cover will consist of

1. At least 3-feet of compacted, uncontaminated, non-waste containing earthen fill with chloride concentrations less than 600 mg/kg as analyzed by EPA Method 300.0.
2. Either the background thickness of topsoil or one foot of suitable material to establish vegetation at the site, whichever is greater, over the 3-foot earth material.
3. Contours to blend with the surrounding topography and to prevent erosion of the cover and ponding over the cover.

Closure Documentation

1. Within 60 days of closure completion, Lime Rock will submit a closure report on form C-144, with necessary attachments to document all closure activities including sampling results; information required by 19.15.17 NMAC; a plot plan; and details on back-filling, capping and covering, where applicable.
2. In the closure report, Lime Rock will certify that all information in the report and attachments is correct and that Lime Rock has complied with all applicable closure requirements and conditions specified in the approved closure plan.

Reclamation and Re-vegetation

As required by the surface owner, Lime Rock will reclaim to a safe and stable condition that existed prior to oil and gas operations and that blends with the surrounding undisturbed area

Areas not reclaimed as described herein due to their use in production or drilling operations will be stabilized and maintained to minimize dust and erosion.

For all areas disturbed by the closure process that will not be used for production operations or future drilling, the Lime Rock will

1. Replace topsoils and subsoils to their original relative positions
2. Grade so as to achieve erosion control, long-term stability and preservation of surface water flow patterns
3. Reseed in the first favorable growing season following closure

Re-vegetation and reclamation plans imposed by the surface owner will be outlined in communications with the OCD.

Lime Rock will notify the Division when the surface grading work element of reclamation is complete.

Lime Rock will notify the Division when the site meets the surface owner's requirements or exhibits a uniform vegetative cover that reflects a life-form ratio of plus or minus fifty percent (50%) of pre-disturbance levels and a total percent plant cover of at least seventy percent (70%) of pre-disturbance levels, excluding noxious weeds.

Appendix G
Variance Requests

1. Leak Detection System
2. 30-mil LLDPE Secondary Liner
3. Additional Time for OCD Review (2)
4. 45-mil LLDPE Primary Liner

Statement Explaining Why the Applicant Seeks a Variance

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.17.11.J:

> (8) The operator shall place a leak detection system between the upper and lower geomembrane liners that consists of two feet of compacted soil with a saturated hydraulic conductivity of 1 x 10-5 cm/sec or greater to facilitate drainage. The leak detection system shall consist of a properly designed drainage and collection and removal system placed above the lower geomembrane liner in depressions and sloped to facilitate the earliest possible leak detection. The operator may install alternative methods that the appropriate division's district office approves.

With respect to the leak detection system, the current standard of care for lagoon leak detection is synthetic drainage material (not compacted soil), similar to the 200-mil GSE Hypernet which is proposed in this application. The Hypernet is easier to install and is less expensive than the prescribed method of the Rule. This request was recently approved by OCD for the Mack Energy Round Tank Permanent Pit.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment.

With respect to the use of the 200-mil Hypernet drainage system in lieu of 2-feet of compacted soil, we believe the table below that contrasts the two systems provides ample demonstration.

Geonet Hypernet	**Compacted Soil**
Installation does not put strain on secondary liner	Equipment and compaction can stress secondary liner
Hydraulic conductivity is homogeneous and isotropic	Hydraulic conductivity can vary based upon the nature of the compaction and percent fines in a given load of placed soil
Fluid transmissivity is 2×10^{-3} m^2/sec	Mandated transmissivity is 6×10^{-8} m^2/sec
Settling after loading/unloading pit with fluid should be minimal	Settling after loading/unloading pit with fluid could be measureable, creating liner strain and changes in flow patterns to the detection system

The variance request to use the Hypernet drainage system in lieu of 2-feet of compacted soil is exactly the same as the recently-approved exception request by Mack Energy for the Round Tank Permanent Pit.

Statement Explaining Why the Applicant (Lime Rock) Seeks a Variance

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.17.11.J:

> (4) The primary (upper) liner and secondary (lower) liner shall be geomembrane liners. The geomembrane liner shall consist of 30- mil flexible PVC or 60-mil HDPE liner, or an equivalent liner material that the division's district office approves. The geomembrane liner shall have a hydraulic conductivity no greater than 1 x 10-9 cm/sec. The geomembrane liner shall be composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. Liner compatibility shall comply with EPA SW- 846 Method 9090A or subsequent relevant publication.
>
> (5) The operator shall minimize liner seams ... The operator shall ensure field seams in geosynthetic material are thermally seamed (hot wedge) with a double track weld to create an air pocket for non-destructive air channel testing. The operator shall test a seam by establishing an air pressure between 33 and 37 psi in the pocket and monitoring that the pressure does not change by more than one percent during five minute after the pressure source is shut off from the pocket…

With respect to the material of the secondary liner, the applicant proposes 30-mil LLDPE or LLDPE-R liner. The thermal fusion seams will be as directed by the manufacturer and QC tested as outlined in the attached Frobel Technical Memo.

The proposed materials for the secondary liner are easier to install, will contain fewer field seams as required by the OCD and is less expensive than the prescribed 60-mil HDPE. More importantly, cost estimates from contractors suggest that a mandate to employ the 60-mil HDPE liner as a secondary liner may reverse the economics of the use of this (or perhaps any) MWFM Pit to hold produced water. Thus the applicant seeks a variance to create more favorable economics which will promote the use of these pits to conserve fresh water resources.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

With respect to the evaluation of the proposed materials for the secondary liner, we believe the following elements are critical. First, in discussing liner media for Multi-Well Fluid Management Pits, NMOCD Rules state [emphasis added]:

> (5) The appropriate division's district office may approve other liner media if the operator demonstrates to the satisfaction of the appropriate division's district office that the alternative liner <u>protects fresh water, public health, and the environment</u> as effectively as the specified media.

And

> 19.15.17.15 EXCEPTIONS AND VARIANCES:
> A. Variances.
> (1) An operator shall demonstrate with a complete application to the appropriate division district office that the requested variance <u>provides equal or better protection of fresh water, public health</u> and the environment. The appropriate division district office shall approve or deny the variance within 60 days of receipt of the complete application.
> (2) If the appropriate division district office denies the variance….

(3) An application for a variance shall include:
(a) a statement in detail explaining why the applicant wants to vary from the requirement of 19.15.17 NMAC, and
(b) a detailed written demonstration that the variance will provide equal or better protection of fresh water, public health and the environment.

The Rule does not state that the alternative media must be equivalent to the specified material; it states that the liner media (as described in a variance or exception) must provide equal or better protection of fresh water, public health or the environment [as the specified liner media, for example]. In the denial of a similar request (an exception request to employ 30-mil LLDPE as a secondary liner), OCD stated [emphasis added]:

> Mack requested exceptions to allow alternative seam testing procedures for an alternative liner, an alternate bottom liner, and to use geonet in the leak detection system. In its Conditions of Approval, OCD specified that Mack must demonstrate that the proposed exceptions protect the environment as effectively as the Rule 17- specified media and methodology. OCD specifically accepted the exception request to use geonet; however, Mack had the burden to demonstrate that the proposed 30-mil LLDPE liner was equally as protective as the 60-mil HDPE. Mack was unable to demonstrate this. OCD independently determined that 30-mil LLDPE is not able to meet the same performance standards as 60-mil HDPE. Further, the more recent proposal to use 30-mil HDPE also fails to match the specifications of 60-mil HDPE and also raises Public Notice issues. Therefore, OCD formally denies Mack's exception request to use an alternative bottom liner, which renders the alternate seaming exception request moot.

Because NMOCD staff does not include Professional Engineers with experience in liner system design and operation for impoundments, we are concerned that OCD might be confusing equivalent performance standards (e.g. tear resistance) with equivalent or better protection of fresh water, public health or the environment. A secondary liner does not require equivalent performance standards as the primary liner because the stresses to the liners are not the same. As explained in the attached letter from Mr. Ron Frobel:

A. UV degradation is zero for the secondary liner, this is not true for the primary liner.
B. The primary liner and 200-mil geonet drainage system absorb surface stresses (such as wave action, filling and emptying the pit, thermal expansion/contraction), the primary liner is in direct contact with these stresses.
C. While the primary liner will be exposed to the chemistry of treated produced water (essentially salt water) for long periods, the secondary liner is exposed to the salt water during the time between the creation of a leak and the detection of the leak (days or weeks) and the repair of the leak (weeks or months), the chemical resistance of the secondary liner need not be as robust as the primary liner. However, the chemical resistance and in fact the Polymeric Formulation of LLDPE is very similar to HDPE although less in range of chemical that it is resistant to.
D. Thermal Fusion Welding and QC seam testing of LLDPE or LLDPE-R are routinely completed in accordance with industry standard methods and procedures. Either double fusion welding (with air channel) or single wedge fusion welding (with high pressure air lance testing) are acceptable industry practice.
E. Electrical Leak Location Survey (ELLS) standard methods are routinely used to test the in place lining system over 100% of the surface area including thermal fusion seams. These same methods can be used to locate a leak if one occurs during operation of the pit.

The letter from Mr. Frobel also explains the following features of 30-mil LLDPE:

- Prefabrication in factory controlled conditions into very large panels results in ease of installation, less thermal fusion field seams and less on-site Quality Control testing than the 60-mil HDPE.
- Large prefabricated panels provide better control of thermal fusion welding in a factory environment that will improve the liner system integrity for the long term.
- The LLDPE geomembrane provides lay flat characteristics that are superior to 60-mil HDPE for a secondary liner which allows for more intimate contact with the underlying soil or geotextile as well as overlying materials thus providing better flow characteristics for drainage of water to sump areas.
- Ease of installation of large prefabricated custom size panels results in a greater reduction of installation time and associated installation costs.
- The LLDPE geomembrane is easily repaired (e.g. if damaged during installation) using the same thermal fusion bonding method without the need for special surface grinding/preparation for extrusion welding used in repair of HDPE geomembranes.
- With reinforcement , the 30-mil LLDPE geomembrane provides superior installation and operation resistance to mechanical damage and is excellent resistant to tear propagation

However, given the fact that exposure time will be limited and temperature or hydraulic head is not a factor, LLDPE will perform its function as a secondary liner for many years beyond the 7-10 year life expectancy of the most pits used for MWFM pits and most permanent pits. The LLDPE or LLDPE-R will meet or exceed published GRI Standards including GRI GM 17 for LLDPE and GRI GM 25 for LLDPE-R (see attached technical memo by R. K. Frobel for clarification).

The most important element of this demonstration that the proposed variance provides equal or better protection of fresh water, public health and the environment is a proposed conference call between the Professional Engineers of this project (Mr. Fobel, Mr. Eddings, Ms. Hicks and the applicant) and the Professional Engineers from OCD/EMNRD assigned to the evaluation of this variance. The purpose of this call is to present this submission and discuss any comments/concerns of the OCD Engineers. Our engineering team will provide a written response to fill in any gaps identified in the phone conference.

Information on the qualifications of Mr. Frobel are also included in this submission.

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Mr. Randall Hicks, PG
R.T. Hicks Consultants Ltd.
901 Rio Grande Boulevard
Suite F-142
Albuquerque, New Mexico 87104

May 1, 2014

RE: Technical Memorandum
LLDPE and LLDPE-R Alternative Secondary Liner System
Mack Energy Pits

Dear Mr. Hicks:

At your request, I have again investigated the suitability of application for both 30 mil LLDPE and 30 mil LLDPE-R reinforced geomembrane as an alternative secondary liner in the Mack Pits as well as other produced water pits. I have again reviewed your C-1445 Supplemental Information Report and the Processed Water Chemical Analysis as well as variance requests and correspondence from the New Mexico OCD. In consideration of the secondary lining system application, size of impoundments and depth, design details as well as the chemical analysis provided for the processed water, it is my professional opinion that LLDPE or LLDPE-R geomembrane will provide the requisite barrier against processed water loss and will function better than 60 mil HDPE as a secondary liner system. The following are discussion points that hopefully will exhibit the attributes of an LLDPE secondary lining system:

The nature and formulation of LLDPE resin is very similar to HDPE. The major difference is that LLDPE is lower density, lower crystallinity (more flexible and less chemical resistant). However, in covered conditions, LLDPE will resist aging and degradation and remain intact for many decades. Although the lifetime of LLDPE in covered conditions (secondary liner) will be somewhat reduced with respect to HDPE, a secondary liner of LLDPE will outlast and exposed HDPE liner. In fact, according to the Geosynthetic Research Institute (GRI) study on lifetime prediction (GRI Paper No. 6), the half life of HDPE (GRI GM 13) exposed is > 36 years and the half-life of LLDPE (GRI GM 17) exposed is approximately 36 years (the Mack Pits life span is expected to be only 7 years maximum). It is understood that in order to ensure compliance of materials, the primary 60 mil HDPE to be used in the Mack pits must meet or exceed GRI GM 13. Likewise, the secondary liner that is not exposed to the same environmental and chemical conditions must meet or exceed GRI GM 17 for non-reinforced LLDPE and GRI GM 25 for reinforced LLDPE-R. Adhering to the minimum requirements of the GRI Specifications, 30 mil LLDPE or LLDPE-R when used as a secondary liner will be equally as protective as the primary 60 mil HDPE liner (reference: www.geosynthetic-institute.org/grispecs)

Durability of Geomembranes is directily affected by exposure conditions. Buried or covered geomembranes are not affected by the same degradation mechanisms (UV,

Ozone, Chemical, Stress, Temperature, etc) as are fully exposed geomembranes. In this regard, the secondaryliner material and thickness can be much less robust than the fully exposed primary liner which in this case is 60 mil HDPE. This is also the case for landfill lining systems where the secondary geomembrane in a bottom landfill cell may be 30 mil PVC or LLDPE.

Thermal FusionSeaming Requirements. Thermal seaming and QC seam test requirements for geomembranes are product specific and usually prescribed by the sheet manufacturer. Both dual wedge and single wedge thermal fusion welding is commonly used on LLDPE and QC testing by air channel (ASTM D 5820) or High Pressure Air Lance (ASTM D 4437) is fully acceptable and recognized as industry standards. In this regard, there should be no exception or recommended practice for seaming and QC testing in the OCD rules. This would be fully covered in comprehensive specifications for both the Primary and Secondary geomembranes that would be reviewed by OCD (Reference: www.ASTM.org/Standards).

Potential for Leakage through the Primary and Secondary Liners. Leakage through geomembrane liners is directly a function of the height of liquid head above any hole or imperfection. The geonet drainage media provides immediate drainage to a low point or sump and thus no hydrostatic head or driving gradient is available to push leakage water through a hole in the secondary liner. In this regard, secondary geomembrane materials can be (and usually are) much less robust in both thickness and polymer type.

Leakage through the 60 mil HDPE Primary is driven by size of hole and depth and will be detected by the increase of waste water in the sumps and the volume being pumped. If required, location of holes in the Primary can be found by Electrical Leak Location Survey (ELLS) using a towed electrode (ASTM D 7007). Holes found can then be repaired and thus water seepage into the Secondary will be kept to a minimum. Dependent on OCR requirements for Action Leakage Rate (ALR), the sump volumes may only be monitored. For example, a typical ALR is < 20 gpad whereas a rapid and large leak (RLL) may be > 100 gpad. Most states specify maximum ALR values for waste impoundments usually in the range of 100 to 500 gpad. However, New Mexico does not specify any ALR for waste water impoundments (GRI Paper No. 15). Reference: www.geosynthetic-institute.org/griwhitepapers .

Testing of Secondary Liner by ELLS. Regardless of the type and thickness of the Secondary liner which is placed in intimate contact with the subgrade, the entire secondary liner can be tested over 100% of its area by ELLS in accordance with ASTM D 7002. This industry standard testing will ensure that there are no holes in the secondary liner that would allow very minimal seepage of waste water into the subsoils. Reference: www.ASTM.org/Standards.

Chemical Attack. Chemical attack to polymeric geomembranes is directly a function of type of chemical, temperature and exposure time. Again, the HDPE Primary provides the chemically resistant liner and is QC tested to reduce potential defects or holes. If there is a small hole, the geonet drain takes any leakage water immediately to the sump for

extraction. Thus exposure time is very limited in addition to low temperature, little volume and virtually no head pressure. In this regard, a less chemically resistant geomembrane material such as LLDPE can be specified for the secondary.

HDPE can not be prefabricated into large panels and thus LLDPE and LLDPE-R offer the following for Secondary Liner Containment:

- Prefabrication in factory controlled conditions into very large panels (up to 29,000 sf) results in ease of installation, less thermal fusion field seams and less on site QC and CQA. The OCD rules require that the operator "minimize liner seams".

- Large prefabricated panels of LLDPE or LLDPE-R will provide better control of thermal fusion welding in a factory environment that will improve the liner system integrity for the long term.

- The scrim reinforcement of LLDPE-R provides a very dimensionally stable sheet in temperature extremes which results in far less field wrinkles and waves during and after installation.

- The LLDPE-R geomembrane provides superior lay flat characteristics for a secondary liner which allows for more intimate contact with the underlying soil or geotextile as well as overlying materials thus providing better flow characteristics for drainage of water to sump areas. HDPE exhibits extreme wrinkling and when overlaid with a geonet drain, wrinkles tend for form pockets and dams affecting drainage of any leakage water to sumps.

- Ease of installation of large prefabricated custom size panels results in a greater reduction of installation time and associated installation and QC costs.

- The LLDPE or LLDPE-R geomembrane is easily repaired using the same thermal fusion bonding method without the need for special surface grinding/preparation for extrusion welding used in repair of HDPE geomembranes.

- Due to the scrim reinforcement, the LLDPE-R geomembrane will provide superior installation and operation resistance to mechanical damage and is especially resistant to tear propagation (i.e., 190 lb tear vs 42 lb tear for HDPE sheet)

In summary, it is my professional opinion that LLDPE or LLDPE-R geomembranes will provide a secondary liner system that is equal to or better than 60 mil HDPE and will provide the requisite protection of fresh water, public health and the environment for many years and especially for the estimated 7 year life of the Mack Pits. With respect to the primary liner, I again advise that 60 mil HDPE be used as prescribed in the Rule.

If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

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Attachments:

R. K. Frobel C. V.
R. K. Frobel Publications
R. K. Frobel Water Impoundments

RONALD K. FROBEL, MSCE, P.E.

CIVIL ENGINEERING
GEOSYNTHETICS
EXPERT WITNESS
FORENSICS

FIRM: R. K. FROBEL & ASSOCIATES
Consulting Civil / Geosynthetics Engineers

TITLE: Principal and Owner

PROFESSIONAL AFFILIATIONS:

American Society for Testing and Materials (ASTM) -
Founding member of Committee D 35 on Geosynthetics
Chairman ASTM D35 Subcommittee on Geomembranes 1985-2000
ASTM Award of Merit Recipient/ASTM Fellow - 1992
ASTM D18 Soil and Rock - Special Service Award - 2000
Transportation Research Board (TRB) of The National Academies
Appointed Member A2K07 Geosynthetics 2000 - 2003
National Society of Professional Engineers (NSPE) - Member
American Society of Civil Engineers (ASCE) - Member
Colorado Section - ASCE - Member
International Society of Soil Mechanics and Foundation Engineers
(ISSMFE) - Member
International Geosynthetics Society (IGS) - Member
North American Geosynthetics Society (NAGS) - Member
International Standards Organization (ISO) - Member TC 221
Team Leader - USA Delegation Geosynthetics 1985 - 2001
European Committee for Standardization (CEN) - USA Observer
EPA Advisory Committee on Geosynthetics (Past Member)
Association of State Dam Safety Officials (ASDSO) – Member
U. S. Committee on Irrigation and Drainage (USCID) - Member
Technical Advisory Committee - Geosynthetics Magazine
Editorial Board - Geotextiles and Geomembranes Journal
Editorial Board - Geotechnical Testing Journal (ASTM)
Co-Chairman International Conference on Geomembranes
Co-Chairman ASTM Symposium on Impermeable Barriers
U.S. Naval Reserve Officer (Inactive)
Registered Professional Engineer – Civil (Colorado)
Mine Safety Health Administration (MSHA) Certified

ACADEMIC BACKGROUND:

University of Arizona: M.S. - Civil Engineering - 1975
University of Arizona: B. S. - Civil Engineering - 1969
Wentworth Institute of Technology: A.S. Architecture – 1966

PROFESSIONAL EXPERIENCE:

R. K. Frobel & Associates - Consulting Engineers
Evergreen, Colorado, Principal and Owner, 1988 - Present

Chemie Linz AG and Polyfelt Ges.m.b.H., Linz, Austria
U. S. Technical Manager Geosynthetics, 1985 - 1988

U.S. Bureau of Reclamation, Engineering and Research Center
Denver, Colorado, Technical Specialist in Construction Materials Research and Application, 1978 - 1985

Water Resources Research Center (WRRC), University of Arizona
Tucson, AZ, Associate Research Engineer, 1975 - 1978

Engineering Experiment Station, University of Arizona
Tucson, AZ, Research Assistant, 1974 - 1975

United States Navy, Commissioned Naval Officer, 1970 - 1973

REPRESENTATIVE EXPERIENCE:

R.K. Frobel & Associates: Civil engineering firm specializing in the fields of geotechnical, geoenvironmental and geosynthetics. Expertise is provided to full service civil/geotechnical engineering firms, federal agencies, municipalities or owners on a direct contract, joint venture or sub-consultant basis. Responsibilities are primarily devoted to specialized technical assistance in design and application for foreign and domestic projects such as the following: Forensics investigations into geotechnical and geosynthetics failures; providing expert report and testimony on failure analysis; providing design and peer review on landfill lining and cover system design, mine waste reclamation, water treatment facilities, hydro-technical canal, dam, reservoir and mining projects, floating reservoir covers; oil and gas waste containment; design of manufacturers technical literature and manuals; development and presentation of technical seminars; new product development and testing; MQA/CQA program design and implementation.

Polyfelt Ges.m.b.H., Linz, Austria and Denver Colorado: As U.S. technical manager, primary responsibilities included technical development for the Polyfelt line of geosynthetics for the U.S. civil engineering market as well as world wide applications.

U.S. Bureau of Reclamation, Denver, Colorado: As technical specialist, responsibilities included directing laboratory research, design and development investigations into geosynthetics and other construction materials for use on large western water projects such as dams, canals, power plants and other civil structures. Included were material research, selection and testing, specification writing, large scale pilot test programs, MQA/CQA program design and supervision of site installations. Prime author or contributor to several USBR technical publications incorporating geosynthetics.

University of Arizona, Tucson, Arizona: As research engineer at the Water Resources Research Center, responsibilities included research, design and development of engineering materials and methods for use in construction of major water projects including potable water reservoirs, canals and distribution systems. Prime author or contributor to several WRRC technical publications.

Northeast Utilities, Hartford, Connecticut: As field engineer for construction at Northeast Utilities, responsibilities included liason for many construction projects including additions to power plants, construction of substations, erection of fuel oil pipe lines and fuel oil storage tanks. Responsibilities also included detailed review, inspection and reporting on numerous construction projects.

U.S. Navy: Commissioned Naval Officer – Nuclear Program

PUBLICATIONS: Over 85 published articles, papers and books.

CONTACT DETAILS:

Ronald K. Frobel, MSCE, P.E.
R. K. Frobel & Associates
Consulting Civil/Geosynthetics Engineers
32156 Castle Court
Suite 211/M240
Evergreen, Colorado 80439 USA
Ph 303-679-0285
M 720-289-0300
Email: geosynthetics@msn.com

PUBLICATIONS – RONALD K. FROBEL, MSCE, PE

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Frobel, R.K., "Using Structured Geomembranes in Final Solid-Waste Landfill Closure Designs", Geosynthetics Magazine, Vol 25, No 1, IFAI Publishers, March 2007.

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Statement Explaining Why the Applicant Seeks a Variance

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> B. Whether or not the division deems an application to be administratively complete within the 30 day evaluation period, the division shall also have an additional 30 days to approve, deny or approve with conditions an application. <u>If the division does not take action within the 60 days review period, then the application is deemed denied and the operator may file an application for hearing with the division clerk.</u>

It is our understanding that the intent of this mandate of the Pit Rule is to limit the time of review of a permit application. In general, limiting the review time is good for all.

However, in response to communications with OCD regarding the environmental setting of this location, Lime Rock requests an extra 40 days from the 60-day limit (July 8) to provide more detailed site-specific data regarding the stability of the ground (i.e. potential of collapse due to karst features). One option we are exploring is gaining access to the State land in advance of our mining lease (in process) to conduct a 2-4 boring geotechnical investigation. This investigation will provide site-specific data regarding the minimum thickness of the competent overburden (Permian rocks, alluvium and caliche) and the engineering properties of this material. At least one boring will be advanced to 50 feet or to the top of a Rustler Formation anhydrite/gypsum unit (karst potential).

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

The MWFM Pit permit currently under review by OCD calls for a geotechnical investigation during the caliche mining program. In theory, this investigation would occur after OCD approval of the permit and Lime Rock would submit the findings of the investigation and pit foundation design criteria in advance of lining the pit (and after OCD review).

We believe that conducting geotechnical borings and gaining the site-specific information in advance of final permit approval will provide equal or better protection of fresh water, public health and the environment.

Statement Explaining Why the Applicant Seeks a Variance

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It is our understanding that the intent of this mandate of the Pit Rule is to limit the time of review of a permit application. In general, limiting the review time is good for all.

However, in response to communications with OCD regarding the environmental setting of this location, Lime Rock requests an extension of time to October 15 to allow OCD to review a single permit document with all variance requests and modifications. We will assemble this document, including the minor modification showing a larger footprint of the proposed pit to accommodate a depth of 15 feet rather than 20 feet. While the surface footprint is larger, the total volume of the All Thorn Pit remains as shown in the existing permit. Please expect this assembled document transmitted to OCD on Wednesday October 8th and mailed or hand-delivered that same day.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

Currently, this permit application contains numerous addenda and variance requests submitted over a period of several months. We believe that submission of a single document will provide equal or better protection of fresh water, public health and the environment.

Statement Explaining Why the Applicant (Lime Rock) Seeks a Variance

The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.17.11.J:

> (4) The primary (upper) liner and secondary (lower) liner shall be geomembrane liners. The geomembrane liner shall consist of 30- mil flexible PVC or 60-mil HDPE liner, or an equivalent liner material that the division's district office approves. The geomembrane liner shall have a hydraulic conductivity no greater than 1 x 10-9 cm/sec. The geomembrane liner shall be composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. Liner compatibility shall comply with EPA SW- 846 Method 9090A or subsequent relevant publication.
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> (5) The operator shall minimize liner seams ... The operator shall ensure field seams in geosynthetic material are thermally seamed (hot wedge) with a double track weld to create an air pocket for non-destructive air channel testing. The operator shall test a seam by establishing an air pressure between 33 and 37 psi in the pocket and monitoring that the pressure does not change by more than one percent during five minute after the pressure source is shut off from the pocket…

With respect to the material of the primary liner, Lime Rock proposes 45-mil LLDPE-R liner. The thermal fusion seams will be as directed by the manufacturer and QC tested as outlined in the attached Frobel Technical Memo.

The proposed materials for the primary liner are easier to install, will contain fewer field seams, and has several additional characteristics that are better than the prescribed 30-mil PVC. The applicant seeks a variance to provide a better product that will promote the use of these pits to conserve fresh water resources.

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

With respect to the evaluation of the proposed materials for the primary liner, we believe the following elements are critical. First, in discussing liner media for Multi-Well Fluid Management Pits, NMOCD Rules state [emphasis added]:

> (5) The appropriate division's district office may approve other liner media if the operator demonstrates to the satisfaction of the appropriate division's district office that the alternative liner protects fresh water, public health, and the environment as effectively as the specified media.
>
> And
>
> 19.15.17.15 EXCEPTIONS AND VARIANCES:
> A. Variances.
> (1) An operator shall demonstrate with a complete application to the appropriate division district office that the requested variance provides equal or better protection of fresh water, public health and the environment. The appropriate division district office shall approve or deny the variance within 60 days of receipt of the complete application.
> (2) If the appropriate division district office denies the variance….

(3) An application for a variance shall include:
(a) a statement in detail explaining why the applicant wants to vary from the requirement of 19.15.17 NMAC, and
(b) a detailed written demonstration that the variance will provide equal or better protection of fresh water, public health and the environment.

The Rule does not state that the alternative media must be equivalent to the specified material; it states that the liner media (as described in a variance or exception) must provide equal or better protection of fresh water, public health or the environment [as the specified liner media, for example]. Nevertheless, the attached letter from Mr. Ron Frobel compares and contrasts the characteristics of 30-mil PVC and 45-mil LLDPE-R as primary liner systems for MWFM Pits and other containment structures.

The most important element of this demonstration that the proposed variance provides better protection of fresh water, public health and the environment than the specified 30-mil PVC material and, for the limited lifetime of these impoundments, is an excellent material to use for the primary liner.

Information on the qualifications of Mr. Frobel are also included in this submission.

R.K. FROBEL & ASSOCIATES
Consulting Engineers

Mr. Randall Hicks, PE
R.T. Hicks Consultants Ltd.
901 Rio Grande Boulevard
Suite F-142
Albuquerque, New Mexico 87104

August 20, 2014

RE: Technical Memorandum
LLDPE-R and PVC as Alternative Primary Liner Systems in Produced Water Pits
NMOCD Draft Recycling Rule Title 19, Chapter 15 Requirements
Multi-Well Fluid Management Pits

Dear Mr. Hicks:

At your request, I have reviewed the specification for the Geomembrane materials and in particular the suitability of application for both 30 mil PVC and 45 mil LLDPE-R reinforced geomembrane as alternative primary liners for Multi-Well Fluid Management (MWFM) Pits and other produced water storage pits with a lifetime of less than 10 years. In consideration of the primary lining system application, life expectancy of the pits, size of impoundments and depth, design details as well as the chemical analysis provided for the processed water, it is my professional opinion that the 45 mil LLDPE-R geomembrane will provide the requisite barrier against processed water loss and will function far better than 30 mil PVC as a primary liner system in short term (5 to 7 years) exposure. The following are discussion points that hopefully will exhibit the attributes of a 45 mil LLDPE-R primary lining system:

LLDPE-R Base Polymer. As discussed in previous technical memorandums, the LLDPE resin is similar to HDPE with the major difference noted that LLDPE exhibits lower density, lower crystallinity (more flexible and less chemical resistant) and better thermal fusion weld capability.. LLDPE resin will resist aging and degradation and remain intact for many years in exposed conditions. As referenced in my June technical memorandum, the Geosynthetic Research Institute (GRI) study on lifetime prediction (GRI Paper No. 6), shows that the half life of HDPE (GRI GM 13) exposed is > 36 years and the half-life of LLDPE (GRI GM 17) exposed is also approximately 36 years (the Yates and Lime Rock Multi-Well Fluid Management Pits life span is expected to be only 7 years maximum). It is understood that in order to ensure compliance of materials, the primary geomembrane to be used in the pits must meet or exceed GRI Specification Requirements and in this case should meet or exceed GRI GM 17 for non-reinforced LLDPE and/or GRI GM 25 for reinforced LLDPE-R. Adhering to the minimum requirements of the GRI Specifications, 45 mil LLDPE-R when used as an alternate primary liner will be far superior to an exposed 30 mil PVC. It should be noted that PVC geomembranes are not addressed in GRI specifications.

PVC Base Polymer. PVC base resin is formulated with a number of components including oils, plasticizers, fillers and carbon black. The polymer structure is relatively

amorphous and low in crystallinity and thus more permeable than the semi-crystalline LLDPE structure. PVC must include plasticizers to make the sheet flexible and the plasticizers tend to leach out of the PVC polymer over time making the sheet stiff and very difficult to repair. Plasticizer migration is accelerated in exposed conditions by heat and UV/ozone attack. Thus PVC geomembranes are always designed with soil cover to protect the polymer from premature degradation. PVC geomembranes have been observed to deteriorate in exposed conditions in less than 2 years.

Durability of Geomembranes is directily affected by exposure conditions. Buried or covered geomembranes are not affected by the same degradation mechanisms (UV, Ozone, Chemical, Stress, Temperature, etc) as are fully exposed geomembranes. In this regard, the PVC lining material is much less robust when fully exposed to the elements than LLDPE-R. PVC geomembranes are required to be covered by other geosynthetics or earth materials to prevent exposure to UV, heat and oxidation. In particular, PVC geomembrane materials will degrade due to the extraction of plasticizers which is accelerated due to UV and heat exposure. LLDPE-R geomembranes do not have extractable resin components that would degrade the base polymer when subjected to fully exposed conditions.

Thermal FusionSeaming Requirements. Thermal seaming and QC seam test requirements for geomembranes are product specific and usually prescribed by the sheet manufacturer. Both dual wedge and single wedge thermal fusion welding is commonly used on LLDPE-R and QC testing by air channel (ASTM D 5820) or High Pressure Air Lance (ASTM D 4437) is fully acceptable and recognized as industry standards. In this regard, there should be no exception or recommended practice for seaming and QC testing in the OCD rules. This would be fully covered in comprehensive specifications for both the Primary and Secondary geomembranes that would be reviewed by OCD.

Potential for Leakage through the Primary Liner. Leakage through geomembrane liners is directly a function of the height of liquid head above any hole or imperfection. The geonet drainage media provides immediate drainage to a low point or sump and thus no hydrostatic head or driving gradient is available to push leakage water through a hole in the secondary lining system. Leakage through the Primary geomembrane is driven by size of hole and depth and will be detected by the increase of waste water in the sumps and the volume being pumped. If required, location of holes in the Primary can be found by Electrical Leak Location Survey (ELLS) using a towed electrode (ASTM D 7007). Holes found can then be repaired and thus water seepage into the Secondary will be kept to a minimum. This is particularly important when considering impoundments that will be in operation for only 5 to 7 years. Dependent on New Mexico OCR requirements for Action Leakage Rate (ALR), the sump volumes may only be monitored. For example, a typical ALR is < 20 gpad whereas a rapid and large leak (RLL) may be > 100 gpad. Most states specify maximum ALR values for waste impoundments usually in the range of 100 to 500 gpad. However, New Mexico does not specify any ALR for waste water impoundments (GRI Paper No. 15). .

Chemical Attack. Chemical attack to polymeric geomembranes is directly a function of exposure time as well as crystallinity. For short term exposure of 5 to 7 years, the LLDPE-R when used as a primary liner will provide a chemically resistant liner that can be QC tested to reduce potential defects or holes. Due to extractable components of PVC and less chemically resistant nature of the polymer (more amorphous and low crystallinity), PVC will not provide the requisite chemical resistant barrier in exposed conditions.

Geomembrane Installation. In consideration of the MWFM Pits as well as other impoundments, the following installation attributes of LLDPE-R should be considered:

- The scrim reinforcement of LLDPE-R provides a very dimensionally stable sheet in temperature extremes which results in far less field wrinkles and waves during and after installation. Non reinforced PVC is not as dimensionally stable.

- The LLDPE-R geomembrane is easily repaired using the same thermal fusion bonding method without the need for special surface grinding/preparation for extrusion welding. PVC, when oxidized and exhibiting loss of plasticizer is very difficult to repair and repair is usually by chemical fusion methods that are not as reliable as thermal fusion methods.

- Due to the scrim reinforcement, the LLDPE-R geomembrane will provide superior installation and operation resistance to mechanical damage and is especially resistant to tear propagation, puncture and abrasion. 30 mil PVC does not exhibit the same strength requirements necessary for a primary geomembrane that will be exposed to the elements.

- LLDPE-R does not require a soil cover or other type of cover system to protect it from exposure to the elements over a 5 to 7 year period whereas PVC geomembranes should be protected from direct exposure to the elements.

In summary, it is my professional opinion that 45 mil LLDPE-R geomembrane will provide a short term (5 to 7 years) primary liner system that is superior to 30 mil PVC and will provide the requisite protection of fresh water, public health and the environment for many years and especially for the estimated 5 to 7 year life of the MWFM Pits.

If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

References:

C-1445 Supplemental Information
Round Tank # 1 and # 2 Permanent Pits
Mack Energy Corporation
Section 19 T15S R29E Chaves County
September 2013
Prepared by R. T. Hicks Consultants Ltd.

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R.K. FROBEL & ASSOCIATES
Consulting Engineers

Mr. Randall Hicks, PE
R.T. Hicks Consultants Ltd.
901 Rio Grande Boulevard
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Albuquerque, New Mexico 87104

August 20, 2014

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If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email geosynthetics@msn.com

Sincerely Yours,

R K Frobel

Ronald K. Frobel, MSCE, PE

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It is our understanding that the intent of this mandate of the Pit Rule is to limit the time of review of a permit application. In general, limiting the review time is good for all.

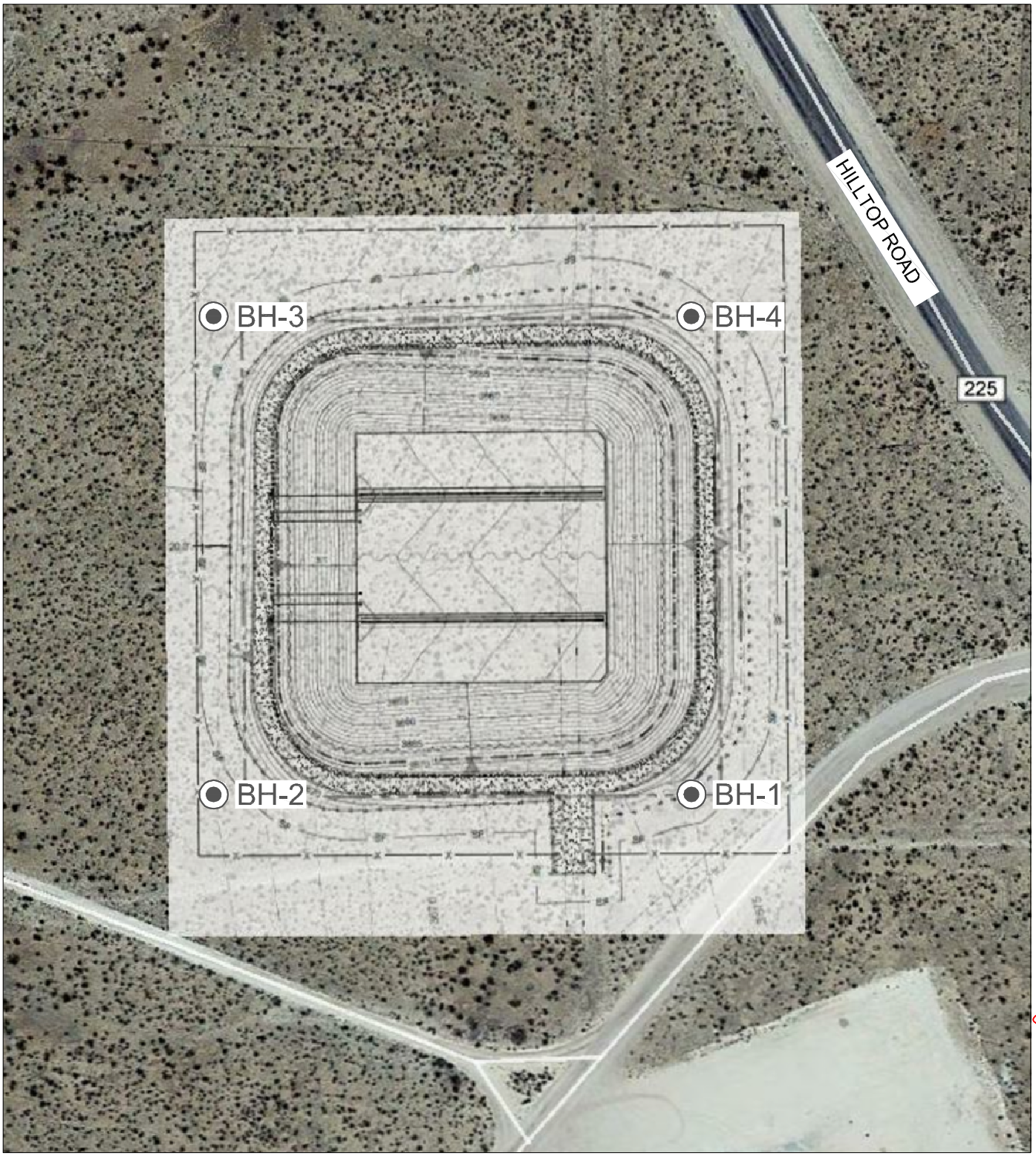
In July, Lime Rock requested an extra 40 days from the 60-day limit to provide more detailed site-specific data regarding the stability of the ground (i.e. potential of collapse due to karst features). Gaining a permit from the State Land Office to conduct this investigation took several weeks longer than anticipated and the transmission of the geotechnical data to OCD occurred on August 22, 2014. Therefore, we request that OCD take an additional 15 days to evaluate the data (September 6, 2014) and render a decision on the permit application. .

Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment

We believe that conducting geotechnical borings and gaining the site-specific information in advance of final permit approval provides equal or better protection of fresh water, public health and the environment. Allowing OCD sufficient time to review the findings also provides better protection of fresh water, public health and the environment.

Appendix H

Pettigrew and Associates Geotechnical Data



BOREHOLE MAP

PROJECT NAME:	ALL THORN MWFM PIT
CLIENT:	RT HICKS CONSULTANTS LTD
PROJECT NUMBER:	2014.1120
PROJECT MANAGER:	EH/DPH

PETTIGREW & ASSOCIATES PA
ENGINEERING | SURVEYING | TESTING
DEFINING QUALITY SINCE 1965
100 E. Navajo Drive Suite 100 Hobbs New Mexico 88240
T 575 393 9827 | F 575 393 1543 | Pettigrew.us

R. T. Hicks Consultants, Ltd.
All Thorn MWFM Pit (Lime Rock)
P&A Project No. 2014.1120

Standard Penetration Test (spt N)

The standard penetration resistance (N) in blows per foot is obtained by ASTM D1586 procedure using 2" O.D., 1-3/8" I.D. samplers. A 140 lb. hammer is used and free falls 30 inches onto the sampler. Values are recorded in 6 inch increments and summed for the one foot spt (N) count.

The terminology used when describing the relative density of cohesionless, uncemented sands and sand-gravel mixtures are shown below:

N	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
50+	Very Dense

We typically recommend an allowable bearing capacity of 3,000 pounds per square foot (psf) for most designs. For a sandy soil, a (N) value of 18 would correlate to an estimated allowable bearing capacity of 3,180 psf. Higher values would yield higher allowable bearing capacities. As shown on the attached logs, the majority of the N-values exceed 18 blows per foot beyond 5 feet below ground surface. Low bearing values, at an approximate depth of 30 feet below ground surface, are present in Borehole 3.

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-1

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.337' E 574349.734'
SURFACE ELEVATION: 3684.05'
BOREHOLE DEPTH: 41'9"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
0		3	Dry Brown Silty Sand (Topsoil)													
		24	Dry Tan Silty Sand with Gravel (Caliche)													
		15														
		15														
		24														
5		23														
		29														
		57														
		51														
		60														
10		47														
		46														
15		60/11"														

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ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-1

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.337' E 574349.734'
SURFACE ELEVATION: 3684.05'
BOREHOLE DEPTH: 41'9"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
20		50/9"	Dry to Moist Red Clay with Gypsum													
25		37														
		60/9"														
30		50/3"														
35		22														
		51														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-1

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.337' E 574349.734'
SURFACE ELEVATION: 3684.05'
BOREHOLE DEPTH: 41'9"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL		BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
40			40 74/9"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-2

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.201' E 574014.592'
SURFACE ELEVATION: 3684.45'
BOREHOLE DEPTH: 41'10"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
0		10/6"	Dry Brown Silty Sand (Topsoil)													
		45/6"														
		72	Dry Tan Silty Sand with Gravel (Caliche)													
		27														
		16														
		18														
5		27														
		41														
		50/6"														
		67/11"														
10		80/11"														
15		75/8"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-2

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.201' E 574014.592'
SURFACE ELEVATION: 3684.45'
BOREHOLE DEPTH: 41'10"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
20		50/3"														
		50/1"	Dry to Moist Red Clay with Gypsum													
25		35/3"														
30		50/4"														
35		50/3"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-2

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650143.201' E 574014.592'
SURFACE ELEVATION: 3684.45'
BOREHOLE DEPTH: 41'10"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL		BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
40			17 59/10"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-3

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650478.437' E 574014.506'
SURFACE ELEVATION: 3682.83'
BOREHOLE DEPTH: 51'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
0		8/6"	Dry Brown Silty Sand (Topsoil)													
		32														
		50/6"	Dry Tan Silty Sand with Gravel (Caliche)													
		37														
		29														
		23														
5		24														
		63														
		61														
		39														
		71														
10		83														
		50/6"														
15		50/6"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-3

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650478.437' E 574014.506'
SURFACE ELEVATION: 3682.83'
BOREHOLE DEPTH: 51'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
20		50/4"														
		75/3"														
25		50/6"														
			Dry to Moist Red Clay with Gypsum													
30		5/6"														
		2														
		50/3"														
			White Gypsum													
35		23														
		73														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-3

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650478.437' E 574014.506'
SURFACE ELEVATION: 3682.83'
BOREHOLE DEPTH: 51'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
			Moist Red Clay with Gypsum													
40		50/6"														
45		50/6"														
50		67														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-4

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650478.428' E 574349.564'
SURFACE ELEVATION: 3683.73'
BOREHOLE DEPTH: 36'5"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
0		7/6"	Dry Brown Silty Sand (Topsoil)													
		70	Dry Tan Silty Sand with Gravel (Caliche)													
		29														
		19														
		54														
5		92														
		50/6"														
		66														
		50/4"														
10		50/5"														
15		50/3"														

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DEFINING QUALITY SINCE 1965

BORING NO.: BH-4

CLIENT: R.T. Hicks Consultants, Ltd.
PROJECT NAME: All Thorn MWFM Pit (Lime Rock)
PROJECT NO.: 2014.1120
DATE DRILLED: 7/29/14

COORDINATES: N 650478.428' E 574349.564'
SURFACE ELEVATION: 3683.73'
BOREHOLE DEPTH: 36'5"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
					% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
20		50/6"	Dry to Moist Red Clay with Gypsum													
25		50/5"														
30		35														
		60														
35		52														
		50/5"														

Randall Hicks

From: Debra P. Hicks <dhicks@pettigrew.us>
Sent: Tuesday, September 23, 2014 4:28 PM
To: 'Bratcher, Mike, EMNRD'
Cc: 'Spencer Cox'; 'Randall Hicks'; 'David Hamilton'; 'Erica Hart'; scott.dawson@state.nm.us; jim.griswold@state.nm.us
Subject: Lime Rock All Thorn MWFM Pit
Attachments: StabilityReporttoOCD.pdf

Mike,

I have reviewed the attached Stability Report prepared by R.T. Hicks and our geotechnical findings from the field and laboratory exploration. I am in agreement that the ground is suitably stable for construction and operation of the proposed MWFM Pit.

Debra P. Hicks, PE/LSI | President & CEO

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DEFINING QUALITY SINCE 1965

100 E. Navajo Drive, Suite 100, Hobbs, NM 88240

575.393.9827 ext. 16
575.393.1543 fax
505.379.4533 cell
dhicks@pettigrew.us
www.pettigrew.us