SUBSURFACE

PERMIT RENEWAL APPLICATION
CLASS I NONHAZARDOUS WASTE INJECTION WELL
WDW NO. 1

Volume 1 of 3

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO
SUBSURFACE PROJECT NO. 60D6894

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLES

FIGURES

TABLE OF CONTENTS (CONT'D)

FIGURES (CONT'D)

DRAWINGS

TABLE OF CONTENTS (CONT'D)

APPENDICES

INTRODUCTION

INTRODUCTION

Navajo Refining Company, L.L.C. (Navajo), located in Artesia, New Mexico, is applying to renew the discharge permit for Class I Nonhazardous Waste Disposal Well No. 1 (WDW-1) which is located approximately ten (10) miles to the southeast of the refinery. WDW-1 was initially permitted by the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals and Natural Resources Department under the Water Quality Act in 1998 and has been operating under Permit UIC-CLI-008-1.

The Navajo refinery is located at 501 East Main Street in Artesia, Eddy County, New Mexico. WDW-1 is one of three Class I nonhazardous waste injection wells operated by the refinery. The three injection wells are designated WDW-1, WDW-2 and WDW-3. All three wells are permitted to inject nonhazardous waste water into a subsurface Injection Zone consisting of the lower portion of the Wolfcamp Formation and the underlying Cisco and Canyon Formations. The depth and thickness of the Injection Zone at the three Navajo refinery injection wells are as follows:

- WDW-1: 7,450 to 9,016 ft KB
- WDW-2: 7,270 to 8,894 ft KB
- WDW-3: 7,303 to 8,894 ft KB

Please note that the three Navajo injection wells are permitted separately coinciding with the life of the regulatory permit issued for each well. This permit renewal application is for WDW-1 only. A permit renewal application for WDW-3 was submitted in June 2012 and approved by OCD in December 2012. A permit renewal application for WDW-2 will be submitted in October 2014. Given the fact that all three Navajo wells are injecting into the same Injection Zone, modeling projections of pressure front and plume movement presented in this document account for injection into the common Injection Zone by all three wells. This same modeling approach was utilized in the WDW-3 permit renewal application and will be utilized when the permit renewal application document is submitted for WDW-2 in 2014.

Information concerning the locations of oil and gas wells and freshwater wells within the regulatory 1-mile radius area of review (AOR) surrounding WDW-1 were obtained from OCD and New Mexico Water Rights Reporting System, respectively. No corrective action is needed for any of the artificial penetrations within the 1-mile radius AOR.

The regional and local geology have been evaluated, and no problems have been identified that will cause adverse effects as a result of the ongoing injection operations.

Reservoir characteristics of the Injection Zone indicate the reservoir has sufficient properties to accommodate the historical and planned future injection rate, volume and pressure from the three Navajo injection wells. Based on information gathered from the Navajo refinery injection well system, there are no adverse reactions identified with the waste stream and the well components of construction and the Injection Zone matrix and formation fluid.

WDW-1 meets the construction and operating standards set forth in 20.6.2.5205 NMAC. A procedure to permanently plug and abandon the well has been included per the requirements of 20.6.2.5209 NMAC.

DISCHARGE PERMIT

District I
1625 N. French Dr., Hobbs, NM 88240
(575) 393-6161
District II
811 S. 1st St., Artesia, NM 88210
(575) 748-1283
District III
1000 Rio Brazos Road, Aztec, NM 87410
(505) 334-6178
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505
(505) 476-3470

State of New Mexico
Energy, Minerals and Natural Resources Department
Oil Conservation Division
Environmental Bureau
1220 South St. Francis Dr.
Santa Fe, NM 87505
(505) 476-3440

Revised January 10, 2012

Submit Original
Plus 1 Copy
to Environmental
Bureau
1 Copy to Appropriate
District Office

DISCHARGE PERMIT APPLICATION FOR UNDERGROUND INJECTION CONTROL (UIC) CLASS I (NON-HAZARDOUS), CLASS III SOLUTION MINING, AND CLASS V WELLS

(Refer to WQCC Regulations (20.6.2.5000 through 20.6.2.5299 NMAC)
for assistance in completing this application)

☐ New ☒ Renewal ☐ Modification

The information in items 1 through 6 and items 8 through 14 is required for all Class I, Class III, and Class V Underground Injection Control Wells. The additional information in item 9 is required for Class I and Class III Underground Injection Control Wells (see 20.6.2.5006 and 20.6.2.5101 NMAC).

1. **Underground Injection Control Well Class:**
☒ Class I (NH) ☐ Class III - Brine Well
☐ Class V - Geothermal ☐ Class V - Ground Water Management ☐ Class V - Other

2. **Operator:** Navajo Refining Company, L.L.C.
Address: 501 East Main
Artesia, NM 88210
Contact Person: Micki Schultz Phone: 575-746-5281 E-mail: Micki.Schultz@hollyfrontier.com

3. **Location:** SW /4 SE /4 Section 31 Township 17S Range 28E
Latitude: 32.7852 Longitude: -104.21380 NAD: ☒ 1927 ☐ 1983
Submit 7.5 Minute U.S.G.S. Quadrangle Topographic Map showing exact location of the facility.

4. **Landowner(s):** Attach the name, address, and telephone number of the landowner of the facility site.
Surface Owner: ☒ Federal ☐ State ☐ Private ☐ Tribal Trust or Indian Allotment

5. **Facility Description:** Attach a description of the facility with a diagram depicting pertinent features, *i.e.*, facility/property boundaries, buildings, roads, fences, process areas, areas of discharge, aboveground piping, underground piping, wells (all types), pits, ponds, dikes, sumps, above and below-grade tanks, landfarms, landfills, surface and/or ground water contamination abatement devices, *etc.*

6. **Proposed discharge plan (see 20.6.2.3106C NMAC):** Specify the methods or techniques that the owner/operator will use to ensure compliance with the regulations. At a minimum include the following information::
(a) Quantity, quality and flow characteristics of the discharge;
(b) Location of the discharge and of any bodies of water, watercourses and ground water discharge sites within one mile of the outside perimeter of the discharge site, and existing or proposed wells to be used for monitoring;
(c) Depth to and TDS concentration of the ground water most likely to be affected by the discharge;
(d) Flooding potential of the site;
(e) Location and design of site(s) and method(s) to be available for sampling, and for measurement or calculation of flow;
(f) Depth to and lithological description of rock at base of alluvium below the discharge site if such information is available; and,
(g) Any additional information that may be necessary to demonstrate that the discharge permit will not result in concentrations in excess of the standards of Section 20.6.2.3103 NMAC or the presence of any toxic pollutant at

any place of withdrawal of water for present or reasonably foreseeable future use. OCD may require additional detailed information on site geologic and hydrologic conditions.

7. **INFORMATION FOR CLASS I NONHAZARDOUS WASTE INJECTION WELLS AND CLASS III BRINE WELLS (20.6.2.5210 NMAC):** For Class I and III injection wells, attach the information required in Subsection B of Section 20.6.2.5210 NMAC. Include sources and an appropriate analysis of injection fluid and compatibility with the receiving formation produced water and if injection is for disposal purposes into a zone not productive of oil or gas at or within one mile of the proposed well, attach a chemical analysis of the disposal zone formation water (may be measured or inferred from existing literature, studies, nearby wells, *etc.*).

(a) Area of Review: A map showing the Class I non-hazardous waste injection well, or Class III well or well fields and the applicable area of review. Within the AOR, the map must show the number, name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells and other pertinent surface features, including residences and roads;

(b) Data Tabulation: A tabulation of data on all wells within the AOR which may penetrate into the proposed injection zone. Such data shall include a description of each well's type, the distance and direction to the injection well or well field, construction, date drilled, location, depth, record of plugging and/or completion information;

(c) Corrective Action: For wells within the area of review which penetrate the injection zone, but are not properly completed or plugged, the corrective action proposed to be taken under Section 20.6.2.5203 NMAC;

(d) Maps and Cross-Sections: Maps and cross-sections indicating the general vertical and lateral limits of all ground water having 10,000 mg/l or less TDS within the AOR, the position of such ground water within the AOR relative to the injection formation, and the direction of water movement in each zone of ground water which may be affected by the proposed injection;

(e) **Geology:** Maps and cross-sections detailing the geology and geologic structure of the local area, including faults and the regional geologic setting;

(f) Proposed Operating Data: including;

- Average and maximum daily flow rate and volume of the fluid to be injected;
- Average and maximum injection pressure;
- Source of injection fluids and an analysis or description of their chemical, physical, radiological and biological characteristics;

(g) Formation Testing Program: Results of the formation testing program to obtain an analysis or description of the chemical, physical, and radiological characteristics of the receiving formation;

(h) Fluids and Pressure: Expected pressure changes, native fluid displacement, and direction of movement of the injected fluid;

(i) Stimulation Program: Proposed stimulation program;

(j) Injection Procedure: Proposed or actual injection procedure;

(k) Drawings: Schematic or other appropriate drawings of the surface and subsurface construction details of the well;

(l) Construction: Pursuant to 20.6.2.5205 NMAC, the owner/operator must demonstrate that the construction and operation of Class I non-hazardous waste injection wells and Class III brine wells will not cause or allow movement of fluids into ground water having 10,000 mg/l or less TDS except for fluid movement approved pursuant to Section 20.6.2.5103NMAC. The owner/operator must provide the following information:

- Depth to the injection zone;
- Injection pressure, external pressure, annular pressure, axial loading, and other stresses that may cause well failure;
- Hole size;
- Size and grade of all casing strings, including wall thickness, diameter, nominal weight, length, joint specification, and construction material;
- Type and grade of cement;
- Rate, temperature, and volume of injected fluid;
- Chemical and physical characteristics of the injected fluid, including corrosiveness, density, and temperature;
- Chemical and physical characteristics of the formation fluids including pressure and temperature;
- Chemical and physical characteristics of the receiving formation and confining zones including lithology and stratigraphy, and fracture pressure; and
- Depth, thickness and chemical characteristics of penetrated formations which may contain ground water.

Include a cementing and casing program (provide details on liners, tubing, packers, size, setting depth, sacks of cement used, hole size, top of cement, and how top was determined, etc.), logging procedures, deviation checks, and a drilling, testing, and coring program for new wells.

Include the name of the injection formation and, if applicable, the field or pool name; the injection interval and whether it is perforated or open-hole; state if the well was drilled for injection or, if not, the original purpose of the well; give the depths of any other perforated intervals and detail on the sacks of cement or bridge plugs used to seal off such perforations; and give the depth to and the name of the next higher and next lower oil or gas zone in the area of the well, if any.

(m) Contingency plans: Contingency plans to cope with all shut-ins or well failures so as to prevent movement of fluids into ground water having 10,000 mg/l or less TDS;
(n) MIT Monitoring Plans: MIT Monitoring Plans, including maps, for meeting the monitoring requirements of Section 20.6.2.5207 NMAC; and
(o) Additional Fluid Monitoring Plans For Class I Non-Hazardous Waste Injection Wells: Provide a fluid monitoring plan for the analysis of the injected fluids for Class I Wells at least quarterly to determine their characteristics. (See 20.6.2.5207B NMAC).
(p) Additional Fluid Monitoring Plans For Class III Wells: Provide a quarterly fluid monitoring plan for Class III wells that meets 20.6.2.5207C NMAC.
(q) Financial Assurance: Provide an instrument that documents the ability of the owner/operator to undertake measures necessary to prevent contamination of ground water after the cessation of operation, including the proper closing, plugging and abandonment of a well, ground water restoration if applicable, and any post-operational monitoring as may be needed. The Owner/Operator shall submit one of the following:

- A surety bond;
- A trust fund with a New Mexico bank in the name of the State of New Mexico, with the State as Beneficiary;
- A non-renewable letter of credit made out to the State of New Mexico;
- Liability insurance specifically covering the contingencies listed in this paragraph; or
- A performance bond, generally in conjunction with another type of financial assurance.

(r) Logging and testing data: Provide all available logging and testing program data on the well (if well logs have been filed with the Division, they need not be resubmitted).;
(s) Mechanical Integrity Data: Provide mechanical integrity data (see 20.6.2.5204 NMAC);
(t) Maximum Pressure and Flow Rate: Specify the anticipated maximum pressure and flow rates;
(u) Formation Testing Program Data: Provide the results of the formation testing program;
(v) Compatibility: Discuss the physical, chemical, and biological interactions between the injected fluids and fluids in the injection zone, and minerals in both the injection zone and the confining zone; and
(w) Area of review corrective actions: Discuss the status of corrective action(s) on defective wells in the area of review.

8. **Modification(s):** Attach a description of proposed modifications to existing discharge processes.

9. **Inspection/Maintenance and Reporting:** Attach a routine inspection, operation, and maintenance plan to ensure permit compliance.

10. **Contingency plans:** Attach a contingency plan for reporting and taking corrective action(s) to address any spills and/or releases.

11. **Other information:** Attach any additional information that may be necessary to demonstrate that the discharge permit will not result in concentrations in excess of the standards of Section 20.6.2.3103 NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use.

12. **Filing Fee:** Attach application filing fee of $100.00. The check or money order must be made payable to Water Quality Management Fund. The permit fee will be required prior to permit issuance.

13. **Draft Public Notice:** Attach a draft of your public notice as specified in Subsection F of 20.6.2.3108 NMAC. All applicants must furnish proof that a copy of the application has been furnished, by certified or registered mail, to the

owner of the surface of the land on which the injection well is to be located and to each leasehold operator within one-third mile of the well location. Proof of public notice must be submitted in accordance with 20.6.2.3108 NMAC for new and renewal applications for discharge permits.

14. CERTIFICATION:

I hereby certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name: Michael G. McKee *Title:* VP + Refinery Manager

Signature: Michael G. McKee *Date:* 14 March 2013

E-mail Address: Michael.McKee@Hollyfrontier.com

Disclaimer: Note that some of the above information may include non-WQCC or OCD Regulated items, i.e., pits, ponds, below-grade tanks, sumps, etc. that may require a separate application and/or permit process than WQCC regulated items through the OCD.

TECHNICAL REPORT

1.0 Underground Well Control Well Class

The Navajo refinery Waste Disposal Well No. 1 (WDW-1) is classified as a Class I Nonhazardous Waste Injection Well.

2.0 Operator

The operator information for WDW-1 is provided below:

Facility Address
Navajo Refining Company, L.L.C.
501 East Main
Artesia, New Mexico 88210
(575) 748-3310

Contact Person
Micki Schultz, Environmental Specialist
(575) 746-5281
Micki.Schultz@hollyfrontier.com

3.0 Location

WDW-1 is located in the SW/4, SE/4, Section 31, Township 17 South, Range 28 East (660 feet from the south line and 2,310 feet from the east line of Section 31).

A topographic map showing the location of the Navajo refinery and WDW-1 is provided as Figure 1. An enlarged version of the topographic map showing the location of WDW-1 is provided as Figure 2.

4.0 Landowner(s)

The parcel of land where WDW-1 is located is owned by the following:

U.S. Department of the Interior
Bureau of Land Management
620 Greene Street
Carlsbad, New Mexico 88220
(575) 887-6544

The parcel of land where WDW-1 is located is surrounded by additional land owned by the Bureau of Land Management as shown in Appendix A.

5.0 Facility Description

The Class I non-hazardous injection well WDW-1 is located approximately ten (10) miles southeast of the Navajo refinery, the largest refinery in New Mexico. Drawing 1 presents an aerial photograph of the refinery's location with respect to the wellhead facility, identifying pertinent features between the two sites. The wellhead facility is located within a fenced area that encloses the well, injection pumps, filters and piping, wellhead annulus monitoring system (WAMS) on a contained concrete pad, and a power panel. The pumps and filters are located on a separate, contained concrete pad. There are no buildings or tanks, other than the 250 gallon glycol tank, associated with the WAMS unit.

6.0 Proposed Discharge Plan (see 20.6.2.3106C NMAC)

This permit renewal application is for an existing Class I nonhazardous waste injection well. Those portions of 20.6.2.3106.C NMAC that are relevant to underground injection, especially 20.6.2.3103.C(8) NMAC, are addressed in Section 7.0 of this document.

6(a) is addressed in 7(f)
6(b) is addressed in 7(a)
6(c) is addressed in 7(d)
6(d) is addressed in 7(e)
6(e) measurement of flow is a flow meter at the wellhead with information transmitted electronically to the refinery control room.
6(f) is addressed in 7(e)
6(g) is addressed in 7(e)

7.0 Information for Class I Nonhazardous Waste Injection Well and Class III Brine Wells (20.6.2.5210 NMAC)

The following sections present the information required in Subsection B of Section 20.6.2.5210 NMAC.

7 (a) Area of Review

The WDW-1 Area of Review (AOR) consists of the area within a 1-mile radius surrounding the well as shown on Drawing 2. All potential sources of information relevant to the location of non-freshwater artificial penetrations and freshwater wells within the AOR were reviewed.

Non-Freshwater Wells in Area of Review

The locations of non-freshwater artificial penetrations (oil and gas wells, exploratory tests, disposal wells, etc.) within the 1-mile radius AOR surrounding WDW-1 are identified in Drawing 2. A total of 156 non-freshwater artificial penetrations are present in the 1-mile radius AOR as shown on the map. Each artificial penetration is identified by a Map ID number. Table 1A presents a tabulation of the 156 non-freshwater artificial penetrations in the AOR.

Of the 156 non-freshwater artificial penetrations identified within the AOR, a total of four (4) penetrations, including WDW-1, were advanced to a depth to penetrate the top of the WDW-1 Injection Zone. Table 1B presents a listing of these wells. Appendix B contains records and schematics for these four (4) non-freshwater artificial penetrations.

Freshwater Wells in Area of Review

Based upon information obtained from records maintained by the New Mexico Water Rights Reporting System, there are no freshwater wells within the 1-mile radius AOR surrounding WDW-1.

Drawing 3 presents a topographic map depicting the 1-mile radius AOR. The map contains all surface bodies of water, mines (surface and subsurface), quarries, springs, and other surface features, including roads and residences.

There are no subsurface faults in the AOR known to have surface expression; therefore, no surface fault traces have been included on this map.

7 (b) Data Tabulation

Table 1A presents a tabulation of the 156 non-freshwater artificial penetrations in the 1-mile radius AOR surrounding WDW-1. Of the 156 non-freshwater artificial penetrations identified within the AOR, a total of four (4) penetrations, including WDW-1, were advanced to a depth to penetrate the top of the WDW-1 Injection Zone. Table 1B presents a listing of these wells. Appendix B contains records and schematics for the four (4) non-freshwater artificial penetrations that penetrate the Injection Zone.

7 (c) Corrective Action

The available records for each of the four (4) artificial penetrations that penetrate the top of the Injection Zone within the WDW-1 AOR were evaluated to determine if corrective action would be required to prevent movement of fluids into or between USDWs which could be caused by pressures in the Injection Zone. These records are contained in Appendix B.

No corrective actions are warranted because all artificial penetrations have been properly constructed, plugged and/or abandoned, or are still operating.

7 (d) Maps and Cross-Sections

The base of the Underground Source of Drinking Water (USDW), groundwater with total dissolved solids concentration with less than 10,000 milligrams per liter (mg/L), occurs at a depth of approximately 493 feet on the WDW-1 well log which is at an elevation of approximately 3,200 feet above mean sea level. Figure 3 presents a generalized hydrogeologic cross-section for the local area. Figure 4 presents a published map indicating the direction of shallow groundwater movement in the local area.

The top of the WDW-1 Injection Zone is separated from the base of the USDW by several thousand feet of low permeability carbonates, siltstones and shale as depicted on the geologic cross-sections presented on Drawings 5, 6 and 7. Drawing 4 is a cross-section index map.

7 (e) Geology

The Navajo refinery is located in Eddy County, New Mexico on the Northwestern Shelf of the larger Permian Basin as shown on Figure 5. Figure 6 is stratigraphic column presenting the geologic formations relevant to the underground injection operations at WDW-1. The refinery is located on the southern flank of the Artesia-Vacuum anticline (also referred to as the Vacuum Arch), which trends east to west across the study area as shown Figure 7. Figure 8 is a published regional structural map of the San Andres Formation.

As depicted on the three geologic cross-sections presented on Drawings 5, 6, and 7, the subsurface geology in the area of the Navajo refinery is rather simplistic. Structural dip of all geologic formations is about 100 feet/mile to the southeast away from the Vacuum Arch depicted on Figure 7.

Injection Zone

The Injection Zone into which all three injection wells at the Navajo refinery are injecting is composed of the lower portion of the Wolfcamp Formation and the underlying Cisco and Canyon Formations. These formations occur in WDW-1, WDW-2 and WDW-3 at the depths shown in the table below.

Injection Zone Formations	WDW-1 (KB = 3,693 ft MSL)		WDW-2 (KB = 3,623 ft MSL)		WDW-3 (KB = 3,625 ft MSL)	
	MD below KB (ft)	Subsea Depth (ft)	MD below KB (ft)	Subsea Depth (ft)	MD below KB (ft)	Subsea Depth (ft)
Lower Wolfcamp	7,450	-3,757	7,270	-3,647	7,303	-3,678
Cisco	7,816	-4,123	7,645	-4,022	7,650	-4,025
Canyon	8,475	-4,782	8,390	-4,767	8,390	-4,765
Base of Injection Zone (base of Canyon)	9,016	-5,323	8,894	-5,271	8,894	-5,269

The following are brief descriptions of the three geologic formations that form the Injection Zone.

Lower Portion of Wolfcamp Formation (Permian Age)
The lower portion of the Wolfcamp Formation is a light brown to tan, fine to medium grained, fossiliferous limestone with shale interbeds.

Cisco Formation (Pennsylvanian Age)
The Cisco Formation is a uniform, light-colored, chalky, fossiliferous limestone with shale interbeds.

Canyon Formation (Pennsylvanian Age)
The Canyon Formation is a white to tan to light brown fine grained, chalky, fossiliferous limestone with shale interbeds.

Drawing 8 presents a structure contour map of the Injection Zone and Drawing 9 presents an isopach map of the Injection Zone.

Confining Zone

The Confining Zone overlying the Injection Zone, in descending order, is composed of the Yeso Formation, Abo Formation, and the upper portion of the Wolfcamp Formation. The following are brief descriptions of the three geologic formations that form the Confining Zone.

Yeso Formation (Permian Age)

The Yeso Formation consists of orange shale, light gray to white dolostone and bedded anhydrite.

Abo Formation (Permian Age)

The Abo Formation is a non-marine to marginal marine red shale and fine-grained sandstone interbedded sequence.

Upper Portion of Wolfcamp Formation (Permian Age)

The upper portion of the Wolfcamp Formation is a light brown to tan, fine to medium grained, fossiliferous limestone with shale interbeds.

Drawing 10 presents a structure contour map of the Confining Zone and Drawing 11 presents an isopach map of the Confining Zone.

Faulting

No evidence has been found of any subsurface faulting within or immediately surrounding the 1-mile radius AOR of WDW-1 that would provide hydraulic connection between the Injection Zone and the shallow USDW. The nearest documented subsurface fault is the "K-M" fault located approximately 17 miles to the northwest, well outside the geologic study area for the Navajo refinery injection wells.

Seismicity

The southeastern portion of New Mexico is historically an area of low seismicity with naturally occurring earthquakes being rare and of low magnitude. The Navajo refinery is located in one of the areas recognized as having the lowest level of seismic risk in the continental United States (Figure 9).

The potential for earthquakes to occur in the vicinity of the Navajo site are minimal. Appendix C presents a listing of all recorded seismic events within 200 miles of the Navajo refinery for the period from 1973 through 2012.

The injection operations at the Navajo refinery do not have the potential to cause any seismic activity which could alter the confining capability of the subsurface Injection Zone and overlying Confining Zone.

Surface Geology and Flooding Potential

The surface geology of the local area is shown on Figure 10. The Pecos River, located about three miles east of Artesia is the only surface water body in the area of the Navajo refinery. Local annual rainfall is approximately 13.5 inches. As indicated on the topographic map on Figure 1, the land surface elevation at the refinery is higher than that near the river; therefore, the potential for flooding at the Navajo refinery is minimal.

7 (f) Proposed Operating Parameters

Source and Description of Injection Fluid

The fluid injected into the Navajo injection wells is comprised of exempt and nonexempt nonhazardous oilfield waste that is generated in the refining process. Waste waters from process units, cooling towers, boilers, streams from water purification units, desalting units, recovered and treated ground water, and general waste waters will be blended to form the fluid to be injected into the injection wells. Table 2 and Appendix D present data characterizing the injection fluid.

Average and Maximum Daily Flow Rate and Volume

The maximum permitted composite injection rate into all three Navajo injection wells is 800 gallons per minute (gpm). This rate of injection is equal to 1,152,000 gallons per day or 420,480,000 gallons per year or 2,102,400,000 gallons into the injection zone over the upcoming 5-year permit time frame for WDW-1. The historical daily volumes of fluid injected into the three injection wells are summarized in Appendix E-1.

Average and Maximum Surface Injection Pressure

The average wellhead injection pressure is approximately 817 pounds per square inch gauge (psig) and an estimated bottom-hole pressure of 4,167 pounds per square inch absolute (psia). Appendix E-1 includes a tabulation of historical injection rates and associated surface injection pressures.

Maximum Allowable Surface Injection Pressure (MASIP) Calculation

The maximum operating injection wellhead pressure will not exceed 1,585 psi or 0.2 psi per foot of depth to the top of the injection zone at 7,924 feet, as required by the OCD Proposed Rule 21.B(7), dated October 6, 1997.

The depth to the top of injection zone in WDW-1 is 7,924 feet. The maximum allowable surface injection pressure is calculated as follows:

7,924 feet x 0.2 psi/ft = 1,585 psi

7 (g) Formation Testing Program

Formation testing was conducted during the initial construction of the Navajo refinery injection wells to obtain site-specific data relating to the chemical, physical and radiological characteristics of the injection zone.

The analysis of formation fluids can be found in Appendix F. The three wells were converted oil and gas wells and no cores were cut from the confining zone or injection intervals. Correlations were made using data from offset wells.

7 (h) Fluids and Pressure

The following are descriptions of the changes in reservoir conditions that have been observed to-date and the predicted changes over the upcoming 5-year permit time frame for WDW-1. This information is based on the known historical rates and volumes that have been injected into the wells and the future 5-year emplacement of the permitted maximum volume at the maximum permitted injection rate between the three wells of 800 gpm.

The interface between injected waste and the formation brine (the waste front) expands radially from the WDW-1 wellbore. As fluid is injected, the injection zone will continue to pressurize due to the resistance of fluid movement and the compression of the fluid and rock matrix.

Current Cone of Influence and Waste Plume Front

The maximum lateral spread of the waste front and the predicted pressure rise during the operational life of WDW-1 to-date were initially calculated and included in the original permit application.

Calculated Cone of Influence (Current)

The current cone of influence within the injection zone is presented on Drawing 12. The current cone of influence is based on the injection operations through December 31, 2012.

Calculated Plume Front Migration (Current)

The radius of the current dispersed plume for the wells is:

WDW-1: 3,053 feet

WDW-2: 2,395 feet (WDW-2 is approximately 7,850 feet from WDW-1)

WDW-3: 1,613 feet (WDW-3 is approximately 7,900 feet from WDW-1)

Future Cone of Influence and Waste Plume Front

The maximum lateral spread of the waste front and the predicted pressure rise during the upcoming 5-year permit time frame for WDW-1 were calculated using the software program PredictW. The equations used in the program are presented in Appendix E-2.

Calculated Cone of Influence (5 Years)

The predicted cone of influence can be found on Drawings 13 through 16. The following four analyses were performed for the cone of influence calculations:

1. Injection into WDW-1 and WDW-2 with no injection into WDW-3.
2. Injection into WDW-1 and WDW-3 with no injection into WDW-2.
3. Injection into WDW-2 and WDW-3 with no injection into WDW-1.
4. Injection into WDW-1, WDW-2 and WDW-3.

The cone of influence is defined as the area with increased injection zone pressures caused by injection of wastes which would be sufficient to cause vertical fluid movement through any wellbore or other conduits into a USDW. This demonstration shows that the conservative worst-case cone of influence of the injection operations is smaller than the regulatory 1-mile radius AOR in which artificial penetrations were investigated.

In the worst case, an undocumented abandoned well is imagined to be open to both the injection zone and the base of the USDW. In addition, the well is filled to within 100 feet of the ground surface with formation brine from the injection zone and fresh water from the base of the USDW. The cone of influence can be calculated by comparing the hydraulic heads of the injection zone and the lowermost USDW. It is only where the injection zone head is above the USDW head that fluid movement from the injection zone into the USDW could occur. This worst-case model of the potential effect of injection on the USDW is conservative. No wells within the 1-mile radius AOR surrounding WDW-1 are open to both the injection zone and the USDW and they are filled with brine.

On July 25, 1998, formation fluid was swabbed from the perforations of the deeper Cisco interval between 8,220 feet and 8,476 feet in WDW-1. The total dissolved solids (TDS) concentration of the sample was 33,000 milligrams per liter (mg/L), and the specific gravity of the sample at room temperature was 1.034. On July 29, 1998, formation fluid was swabbed from the perforations of the shallower Cisco interval between 7,924 feet and 8,188 feet in WDW-1. The analysis of a sample of this fluid indicated that the TDS concentration of the sample was 18,000 mg/L, and the specific gravity at room temperature was 1.018. The chemical analysis of the formation fluid samples is included as Appendix F. These values compare favorably with information from the analysis of fluid retrieved during drill-stem test (DST) No. 5, which was conducted on August 26, 1993 in WDW-1 (Appendix F). The salinity of the formation fluid retrieved during DST No. 5 was reported as having a chlorides concentration of 25,000 mg/L. The formation fluid is therefore assumed to have a sodium chloride

concentration of 25,000 mg/L. The specific gravity of the formation brine was approximately 1.02.

The pre-injection pressure of the injection interval was measured on July 30, 1998 in WDW-1 to be 2,928 psia at 7,911 feet below ground level (BGL). Using the reservoir brine with the lightest specific gravity (1.018) will yield a high initial pressure, P_i, which is conservative. The pre-injection pressure, P_i, at the top of the injection zone in WDW-1 at 7,924 feet BGL is 2,934 psia, and is calculated as follows:

$$\begin{aligned} P_i(7{,}924 \text{ feet}) &= P_i(7{,}911 \text{ feet}) + (7{,}924 \text{ feet} - 7{,}911 \text{ feet})\ (0.433 \text{ psi/ft})\ (1.018) \\ &= 2{,}928 \text{ psia} + 6 \text{ psi} \\ &= 2{,}934 \text{ psia} \end{aligned}$$

The hydraulic head of the lowermost USDW is estimated to be 100 feet BGL. This estimate is reasonably conservative, as it is based on a static water level measurement of 81 feet.

The critical pressure, P_c at 7,924 feet BGL that would be necessary to raise the hydrostatic head of the injection interval to the head of the lowermost USDW at 100 feet BGL is 3,446 psia, and is calculated as follows:

$$\begin{aligned} P_c &= (\text{Top of Injection Zone - Base of USDW})\ (0.433 \text{ psi/ft})(1.018) \\ &\quad + (\text{Base of USDW - Head of USDW})\ (0.433 \text{ psi/ft}) \\ &= (7{,}924 \text{ feet} - 493 \text{ feet})\ (0.433 \text{ psi/ft})\ (1.018) \\ &\quad + (493 \text{ feet} - 100 \text{ feet})\ (0.433 \text{ psi/ft}) \\ &= 3{,}446 \text{ psia} \end{aligned}$$

The critical increase in reservoir pressure, ΔP_c, above the native pressure that is necessary to raise the hydrostatic head of the injection zone to the head of the lowermost USDW is 512 psi, and is calculated as follows:

$$\begin{aligned} \Delta P_c &= P_c - P_i \\ &= 3{,}446 \text{ psia} - 2{,}934 \text{ psia} \\ &= 512 \text{ psi} \end{aligned}$$

An increase in reservoir pressure greater than 512 psi would be sufficient to raise the head of the Injection zone above the head of the lowermost USDW. The cone

of influence is the area around the injection wells within which the increase in reservoir pressure caused by injection is greater than 512 psi.

The gridded pressure increases created with PredictW were contoured using Surfer, a commercial contouring software package. Contour plots of the predicted pressure increase in the injection zone (Drawings 13 through 16) were generated using historical injection rates and volumes and the permitted maximum injection rate of 800 gpm over the upcoming 5-year permit time frame.

Conservative values for reservoir thickness and permeability were used to overestimate the predicted increase in reservoir pressure. The porosity was assumed to be 10 percent. The reservoir was assumed to have a thickness of 85 feet. The permeability of the reservoir was assumed to be 251 millidarcies (md). The modeled permeability-thickness, kh, of 21,335 millidarcy-ft (md-ft) (251 md x 85 feet), is approximately 18 percent of the kh, of 115,670 md-ft, that was determined from the pressure falloff test conducted in WDW-1 between September 21, 2012 and September 23, 2012 (Appendix G). Using a low kh yields a predicted pressure increase that is greater than expected and a cone of influence that is larger than expected.

The viscosity of the formation fluid with TDS concentration of 25,000 ppm at 130°F is 0.53 cp (Appendix E-3). The compressibility of the pore volume of the formation is c_r, is 5.5×10^{-6} psi^{-1}. The compressibility of the formation fluid is c_w, is 2.9×10^{-6} psi^{-1}. The total compressibility ($c_t = c_r + c_w$) is 8.4×10^{-6} psi^{-1} (Appendix E-4).

Historical injection data for WDW-1, WDW-2 and WDW-3 were used for the injection period from September 23, 1999 (initial injection at the site) through December 31, 2012. WDW-1, WDW-2 and WDW-3 were then modeled as injecting from January 1, 2013 through December 31, 2017 at a continuous rate of 800 gpm distributed among the three wells. The maximum modeled per-well injection rate for any one well is 400 gpm.

The 512-psi pressure-increase contour, which defines the outline of the worst-case cone of influence, is located less than one mile from WDW-1, WDW-2, and WDW-3, as shown on Drawing 16. An improperly abandoned wellbore or other conduit filled with formation fluid that is located farther than one mile from the proposed wells would not transmit sufficient pressure from the injection zone to move fluids into the USDW. Navajo researched public and private sources of information about

wells within the 1-mile radius AOR. Information is presented in Section 7 (b) that demonstrates that each of the injection zone penetrations is properly constructed to prevent migration of fluids into the USDW. The output from PredictW is presented in Appendix E-5.

Modeled Plume Front Migration (to December 31, 2017)

The lithologic character of the injection zone, with the resulting hydrodynamic characteristics, is expected to be horizontally uniform. Given the anticipated homogeneity of the injection zone, plume geometry during the active injection phase is expected to be cylindrical.

More than 175 feet of formation is anticipated to exist in the injection zone at the locations of the three Navajo injection wells. Each well is completed in the same interval with 100 to 200 feet of perforations per well. For a conservative estimate of the injection plume size, the plume radius is calculated on the basis of all flow emplaced in an 85-foot thick interval. Based on historical injection data, the volume of fluid injected into WDW-1 to December 31, 2012 is approximately 1,483,862,206 gallons. Assuming a continuous injection rate of 400 gpm over a 5-year injection period, the volume of fluid injected into WDW-1 is 210,240,000 gallons. The total volume of fluid injected to December 31, 2017 is then 2,535,062,206 gallons. Using the total volume of fluid injected and the following equation, the radius of the concentrated plume will be approximately 3,983 feet.

$$r_c = \left[\frac{(0.1337\, v\, t)}{(0.8\, \pi \phi\, h}\right]^{1/2}$$

where:

0.1337	=	factor to convert gallons to cubic feet
r_c	=	radius of the concentrated plume, feet
v	=	annual injected volume, 2,535,062,206 gallons
0.80	=	factor to compensate for immovable connate water
ϕ	=	formation porosity, 10%
h	=	thickness of the injection reservoir, 85 feet
t	=	time of injection, 1 year (the total volume of fluid injected is used)

$$r_c = \left[\frac{(0.1337)(2{,}535{,}062{,}206)(1)}{(0.80)(3.1416)(0.10)(85)}\right]^{1/2}$$

$$= 3{,}983 \text{ feet}$$

The radius of the dispersed plume from WDW-1 on December 31, 2017 is calculated to be 3,987 feet as follows:

$$r_d = 2.3\,(C_d)(r_c)^{0.05} + r_c$$

where:

2.3 = constant
r_d = radius of the dispersed plume, feet
c_d = coefficient of dispersion; for sandstone = 3, for limestone = 65
r_c = concentrated plume radius, 3,983 feet

$$r_d = (2.3)\left[(65)(3{,}983)\right]^{0.05} + 3{,}983$$

$$= 3{,}987 \text{ feet}$$

WDW-1

The radius of the current dispersed plume versus the radius of the projected plume on December 31, 2017 is:

- Current plume radius: 3,053 feet
- Projected plume radius: 3,987 feet

Using the same equations, the radius of the current dispersed plume versus the radius of the projected dispersed plume on December 31, 2017 for WDW-2 and WDW-3 are:

WDW-2

- Current plume radius: 2,395 feet
- Projected plume radius: 3,512 feet

WDW-2 is approximately 7,850 feet from WDW-1. The total fluid injected on December 31, 2017 is approximately 1,964,326,057 gallons.

WDW-3

- Current plume radius: 1,613 feet
- Projected plume radius: 3,033 feet

WDW-3 is approximately 7,900 feet from the WDW-1. The total fluid injected on December 31, 2017 is approximately 1,464,681,362 gallons.

The plume radius calculations for WDW-1, WDW-2, and WDW-3 are presented in Appendix E-6.

7 (i) Stimulation Program

Historical Information

The only stimulation performed on the well has consisted of acid treatments of which the majority was performed through coil tubing pumped across the existing perforation. No fracturing of the injection interval has been performed.

Future Stimulation Programs and Procedures

Currently, no changes are planned in the way the well is stimulated. Navajo reserves the right to fracture the injection interval with approval from OCD. Approximately once every two years an acid stimulation is performed on the wells. The stimulation procedure will consist of pumping 4,000 gallons to 8,000 gallons of 15 percent NEFE Hydrochloric acid through coil tubing at 1 bpm to 2 bpm across the perforations. The acid will be displaced into the formation down the tubing at the highest possible rate.

7 (j) Injection Procedure

Injection into all three Navajo injection wells is on a continuous basis. The injection fluid is routed from the refinery process areas via pipeline to each injection well. Figure 11 presents the pre-injection facilities for WDW-1.

Historical Injection Rates and Volumes

The historical rates and volumes can be found in Appendix E-1.

Predicted Injection Rates and Volumes

The maximum permitted composite injection rate into all three Navajo injection wells is 800 gpm. This rate of injection is equal to 1,152,000 gallons per day or 420,480,000 gallons per year or 2,102,400,000 gallons into the injection zone over the upcoming 5-year permit time frame for WDW-1.

7 (k) Drawings

Figure 11 presents a schematic of the pre-injection surface facilities. Figure 12 presents an as-built diagram of the below-grade portions of WDW-1. Figure 13 presents an as-built diagram of the WDW-1 wellhead.

7 (l) Construction

WDW-1 was converted from the following oil and gas well originally drilled to a depth of 10,200 feet in 1993:

Mewbourne Oil Company
Chalk Bluff "31" State
Section 31, Township 17 South, Range 28 East
(API No. 30-015-27592)

The oil and gas well was re-entered in 1998 and converted to Injection Well WDW-1. Appendix H includes a copy of the report documenting the well conversion that provides relevant information about how the well was originally constructed and how it was converted to an injection well. Figure 12 presents an as-built diagram of the below-grade portions of WDW-1. Figure 13 presents an as-built diagram of the WDW-1 wellhead.

General Description of the Well

Size, Type, and Depth of Injection Tubing: The information for the tubing string was obtained from OCD records on file with the state and geophysical logs.

- **Tubing**: 4 1/2-inch, 11.6 pound per foot, steel construction, API grade N-80, with long thread connections (LTC) set at 7,879.

- **Packer**: Arrow X-1, 7-inch by 3 1/2-inch set at 7,879 feet.

Size, Type, and Depth of Casing: There are three casing strings in the well. The information for these casing strings was obtained from OCD records on file with the state and geophysical logs.

- **13-3/8-inch**, 48.0 pound per foot, steel construction, API grade J-55, with short thread connections (STC), set at a depth of 390 feet back to surface. The casing was cemented to the surface with 525 sacks of cement. The casing was set in an open hole with a diameter of 17.5 inches. This information was obtained from OCD records.

- **9-5/8-inch**, 36.0 pound per foot, steel construction, API grade J-55, STC, set at a depth of 2,555 feet back to surface. The casing was cemented to the surface with 1,000 sacks of cement. The casing was set in an open hole with a diameter of 12.25 inches. This information was obtained from OCD records.

- **7-inch**, 29.0 pound per foot, steel construction, API grade N-80, with long thread connections (LTC), set at a depth of 9,094 feet to 7,031 feet; 29.0 pound per foot, steel construction, API grade P-110, LTC from 7,031 feet to 5,845 feet; and 26.0 pound per foot, P-110, LTC at 5,845 feet back to surface. The casing was cemented to the surface with 1,370 sacks of cement. The casing was set in an open hole with a diameter of 8.75 inches.

The original oil and gas well was drilled to a total depth of 10,200 feet. When the well was converted to an injection well in 1999, a cement plug was set from 9,624 to 9,734 feet and 7-inch protection casing was set at 9,094 feet. A bottom plug was installed into the base of the 7-inch casing with the top of the plug tagged at 9,004 feet. The 7-inch protection casing was perforated with a 0.5-inch diameter hole at 2 shots per foot on a 60° phasing. The perforations are located between 7,924 feet and 8,188 feet and from 8,220 feet to 8,476 feet as depicted on Figure 12.

Current Loading on Pipe and Pipe Specifications

Pipe Size	Type	Weight	Depth Ref. to Kelly Bushing Level (12.5 ft above GL)		Hole Size	Cement Volume	Collapse	Yield
(in)		(lb/ft)	Top	Bottom	(in)	(sks)	(psi)	(psi)
13-3/8	Conductor Casing, J-55	48	Surface	390	17.5	525	1130	2730
9-5/8	Surface Casing	36	Surface	2555	12.25	1000	2020	3520
7	Protection, J-55 Casing, N-80, P-110	29 & 26	Surface	9094	8.75	1390	5410	7240
4-1/2	Injection Tubing, N-80	11.6	Surface	7879	6.184	N/A	4960	5350
7x 2-7/8	Arrow X-1 Packer	N/A	7871	7879	2.5	N/A	N/A	N/A

Depth to Injection Zone

The WDW-1 Injection Zone is 7,450 to 9,016 feet (MD below KB), and the Injection Interval (perforated interval) is 7,924 to 8,476 feet (MD below KB) as depicted on Figure 12.

Pressures and Other Stresses That May Cause Well Failure

There are no known pressures or stresses that may cause failure of WDW-1.

Hole Size

The borehole advanced for the original oil and gas well that was later converted to WDW-1 was 12.25 inches in diameter.

Well Casing Information

Figure 12 and Appendix H include information about the WDW-1 well casing. The preceding table provides an overview of the casing information.

Cement Information

Figure 12 and Appendix H include information about the WDW-1 cement.

Rate, Temperature and Volume of Injected Fluid

Average and Maximum Daily Flow Rate and Volume

The average injection rate for all three Navajo injection wells is approximately 400 gpm and the maximum permitted injection rate between the three wells is 800 gpm.

Temperature

The temperature of the injected fluid is within average ambient temperature ranges.

Volume of Injected Fluid

The maximum annual volume of injected fluid, based on a maximum composite injection rate of 800 gpm between the three injection wells is 420,480,000 gallons.

Chemical and Physical Characteristics of Injected Fluid

The fluid injected into WDW-1 is comprised of exempt and nonexempt nonhazardous oilfield waste that is generated in the refining process. Waste waters from process units, cooling towers and boilers, streams from water purification units and desalting units, recovered and treated groundwater, and general wash waters are blended to form the fluid injected into WDW-1. Table 2 and Appendix D present data characterizing the injection fluid.

Chemical and Physical Characteristics of Formation Fluid

Formation testing was conducted during the initial construction of the Navajo refinery injection wells to obtain site-specific data relating to the chemical, physical and radiological characteristics of the Injection Zone. The formation fluid contained in the Injection Zone is compatible with the well construction components and the injected fluid. Formation fluid information pertinent to the reservoir calculations is included in Appendix E.

Chemical and Physical Characteristics of the Receiving Formation

The Injection Zone is porous carbonates of the lower portion of the Wolfcamp Formation, the Cisco Formation, and the Canyon Formation.

The lower portion of the Wolfcamp Formation (Lower Wolfcamp) is the shallowest porous unit in the proposed injection interval. The Wolfcamp Formation (Permian-Wolf campaign age) consists of light brown to tan, fine to medium-grained, fossiliferous limestones with variegated shale interbeds (Meyer, 1966, page 69). The top of the Wolfcamp Formation was correlated for this study to be below the base of the massive, dense dolomites of the overlying Abo Formation. The base of the Wolfcamp coincides with the top of the Cisco Formation. The thickness of log porosity greater than 5 percent in the entire Wolfcamp Formation ranges from 0 feet to 295 feet in a band three miles wide that trends northeast-southwest across the study area.

The Cisco Formation (Pennsylvanian-Virgilian age) of the Northwest Shelf is described by Meyer (1966, page 59) as consisting of uniform, light colored, chalky, fossiliferous limestones interbedded with variegated shales. Meyer (1966, page 59) also describes the Cisco at the edge of the Permian basin as consisting of biothermal (mound) reefs composed of thick, porous, coarse-grained dolomites. Locally, the Cisco consists of porous dolomite that is 659 feet thick in WDW-1, 745 feet in WDW-2, and 720 feet in WDW-3. The total thickness of intervals with log porosity greater than 5 percent is approximately 310 feet in WDW-1, 580 feet in WDW-2, and 572 feet in WDW-3. The total thickness with log porosity greater than 10 percent is approximately 100 feet in WDW-1, 32 feet in WDW-2, and 65 feet in WDW-3. The thickness of the porous intervals in the Cisco ranges from 0 feet in

the northwestern part of the study area to nearly 700 feet in a band three miles wide that trends northeast-southwest.

The Canyon Formation (Pennsylvanian-Missourian age) consists of white to tan to light brown fine grained, chalky, fossiliferous limestone with gray and red shale interbeds (Meyer, 1966, page 53). Locally, the Canyon occurs between the base of the Cisco dolomites and the top of the Strawn Formation (Pennsylvanian-Desmoinesian age). The total thickness of intervals with log porosity greater than 5 percent is 34 feet in WDW-1, 30 feet in WDW-2, and 10 feet in WDW-3. No intervals appear to have log porosity greater than 10 percent in any of the three injection wells.

Permeability measurements that range from less than 100 md to 2,733 md are available for the Lower Wolfcamp-Cisco-Canyon injection zone. Permeability measurements from hydrocarbon-producing intervals in the Wolfcamp, Cisco, and Canyon from Meyer (1966, Table) are summarized in Appendix I. Meyer reported permeabilities in the Cisco of up to 114 millidarcies (md), up to 38 md in the Canyon, and up to 200 md in the Wolfcamp.

Permeability was estimated to be 597 md from DST No. 5 conducted in WDW-1 on August 26, 1993. DST No. 5 was conducted near the top of the Cisco Formation from 7,817 feet to 7,851 feet (Appendix I).

Historical falloff data obtained during the life of the wells shows that the permeability ranges from 500 md to 1,000 md throughout the injection interval.

Chemical and Physical Characteristics of the Confining Zone

The Confining Zone extends from 4,000 feet to 7,450 feet in WDW-1, from 4,120 feet to 7,270 feet in WDW-2, and from 4,030 feet to 7,303 feet in WDW-3. The Confining Zone includes massive low-porosity carbonate beds and layers of shale in the Upper Wolfcamp, Abo, and Yeso Formations that will confine the injected fluids to the permitted Injection Zone (Lower Wolfcamp, Cisco, and Canyon Formations). The formations that comprise the Confining Zone are described below.

The Injection Zone is directly overlain by the confining layers of the upper portion of the Wolfcamp Formation. Three (3) DSTs were conducted in the upper portion of the Wolfcamp in WDW-1, in the interval from 7,016 feet to 7,413 feet, that indicate that the interval has low permeability and can confine injected fluids to the injection zone. An average permeability of 0.36 md was calculated from the data from DST No. 3, as follows:

$$k = 162.6 \frac{q\ B\ \mu}{mh}$$

$$= 162.6 \frac{(20\ \text{bbl/}\ 89\ \text{min}\ \text{x}\ 1440\ \text{min/day})(1\ )(0.53\ \text{cp})}{(570.883\ \text{psi/cycle})\ (7382\ \text{feet}\ -\ 7230\ \text{feet})}$$

$$= 162.6 \frac{(323.6\ \text{bpd})(1)(0.\ 53\ \text{cp})}{(570.883\ \text{psi/cycle})\ (152\ \text{feet})}$$

$$= 0.36\ \text{md}$$

A permeability on the order of 0.1 md is at the low end of the permeability range for carbonates, and is at the high end of the permeability range for shales, according to Freeze and Cherry (1979, p. 29). Therefore, the low-permeability carbonates of the upper Wolfcamp will provide the first level of confinement for the Injection Zone.

The Abo Formation overlies the Wolfcamp and extends from 5,400 feet to 6,890 feet in WDW-1, from 5,506 feet to 6,728 feet in WDW-2, and from 5,380 feet to 6,745 feet in WDW-3. Although the Abo is well known as a major oil producer in the AOR, the producing intervals lie in the upper Abo, whose equivalents are above 6,100 feet in WDW-1 and above 6,200 feet in WDW-2. The deepest Abo test well in the area is located 6,000 feet east (downdip) of WDW-3 and was drilled to 6,412 feet. No Abo production in the area has been established below 6,298 feet, the producing interval in Map ID No. 112, located 3,800 feet southeast (downdip) of WDW-1. The base of the producing interval within the Abo Formation in the AOR, therefore, is over 900 feet above the top of the injection zone. The lower 600 feet of the Abo Formation (below the deepest producing interval in the AOR), consisting primarily of dolomite with an average porosity less than 5 percent and interbedded shale, will serve as the secondary confining layer above the proposed injection zone.

The Yeso Formation, which will provide additional confining capabilities, directly overlies the Abo Formation. The top of the Yeso is not consistently identified in the AOR, according to well records submitted to the OCD and available scout tickets. However, the top of the Confining Zone can be considered to extend to the top of the low-porosity limestone interval below the higher-porosity dolomites below the Glorieta Member of the San Andres Formation (at 4,000 feet in WDW-1, 4,120 feet in WDW-2, and 4,030 feet in WDW-3). The Yeso consists of low-porosity carbonates and clastic beds. The Tubb shale, a shale interval that is up to 150 feet thick in some wells in the study area, also occurs in this interval. Although no faults are known to exist in the confining zone within the AOR, the Tubb shale will serve to prevent movement of fluids through a hypothetical unknown fault.

Depth, Thickness and Chemical Characteristics of Penetrated Formations Containing Ground Water

The base of the USDW, groundwater with total dissolved solids concentration with less than 10,000 milligrams per liter (mg/L), occurs at the base of the Tansill Formation. Figure 3 presents a hydrostratigraphic cross-section for the local area. Figure 4 presents a potentiometric surface map indicating the direction of groundwater movement in the freshwater aquifers.

The base of the USDW occurs at the following approximate depths in Navajo's three injection wells:

- WDW-1: approximately 493 feet KB (3,200 feet above mean sea level)
- WDW-2: approximately 473 feet KB (3,150 feet above mean sea level)
- WDW-3: approximately 420 feet KB (3,150 feet above mean sea level)

In the eastern part of the study area, at depth, the Tansill Formation is overlain by the Salado Formation (Permian - Ochoan age). The Salado consists of halite, polyhalite, anhydrite, and potassium salts, which are soluble. The Salado is overlain by the Rustler Formation (Permian - Ochoan age). In the AOR, which straddles the outcrop area of the Salado, and to the east, the Salado has been removed by solution by ground water flowing through the Rustler.

To the east, where the Rustler is present, the Rustler is the USDW. To the west, where the Rustler has been removed by erosion and the Salado has been removed by solution, the Tansill is the USDW. The Tansill Formation and the underlying Yates Formation comprise the Three Twins Member of the Chalk Bluff Formation known in outcrops in the region (Hendrickson and Jones, 1952, page 20), and listed as a freshwater-producing interval.

The top of the Injection Zone (Lower Wolfcamp, Cisco, and Canyon Formations) is separated from the base of the USDW by several thousand feet of lower permeability carbonates, siltstones and shales as follows:

- WDW-1: 6957 feet (7,450 feet - 493 feet)
- WDW-2: 6,797 feet (7,270 feet - 473 feet).
- WDW-3: 6,883 feet (7,303 feet - 420 feet).

7 (m) Contingency Plans

WDW-1 is equipped with a high-level shutoff switch to prevent operation of the injection pump at pressures greater than the designated MASIP. The well is equipped with a low pressure shutoff switch that will deactivate the injection pump in the event of a surface leak. In addition, the well is equipped with a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This pressure switch is intended to stop the injection pump in the event of 1) a tubing leak, or 2) a casing, packer, or wellhead leak.

If an alarm or shutdown is triggered, the cause of the alarm or shutdown will be immediately investigated.

- Immediately cease injection operations;
- Take all necessary steps to determine the presence or absence of a leak; and
- Provide verbal notification to OCD within 24 hours.

If the alarm or shutdown is not related to mechanical integrity and the cause of the alarm or shutdown is corrected, injection operations will be resumed. If the mechanical integrity of the well is in question, the well will remain out of service

until the mechanical integrity of the well is restored to the satisfaction of OCD and the agency approves resumption of injection operations.

7 (n) MIT Monitoring Plans (20.6.2.5207 NMAC)

Navajo has an ongoing monitoring program that satisfies all applicable requirements of 20.6.2.5207.NMAC.

- The mechanical integrity of WDW-1 is demonstrated on an annual basis.
- Continuous monitoring devices are used to provide a record of injection pressure, flow rate, flow volume, and annular pressure.

The results of these monitoring activities are reported to NMED as required by regulation.

7 (o) Additional Monitoring Plans for Class I Non-Hazardous Waste Injection Wells (20.6.2.5207B NMAC)

Appendix J includes an Injected Fluids Monitoring Plan that describes the procedures to be carried out on a quarterly basis to obtain a detailed chemical and physical analysis of a representative sample of the injected fluid, including the quality assurance procedures. The plan will be updated as necessary.

The plan includes the following elements:

- The parameters for which the injected fluid will be analyzed and the rationale for the selection of these parameters;
- The test methods that will be used to test for these parameters;
- The sampling method that will be used to obtain a representative sample of the injected fluid being analyzed;
- Field sampling documentation methodologies;
- The commercial laboratory who performs the analysis; and
- Method of reporting analytical results to OCD.

7 (p) Additional Monitoring Plans for Class III Wells (20.6.2.5207C NMAC)

This section is not applicable; WDW-1 is not a Class III well.

7 (q) Financial Assurance

Appendix K includes a well closure plan for WDW-1. The estimated cost to plug and abandon WDW-1 is presented in the table below. This cost estimate has been prepared to reflect the estimated costs that would be incurred by Navajo to abandon the well in accordance with the procedures in Appendix K.

Description of Service	Estimated Cost
Wireline (BHP, RTS, PFOT, Perforate)	20,000
Rental Tools	5,000
Pumping Service	10,000
Cementing Service	20,000
Excavating and Welding	2,500
Mud/Brine	5,000
Frac Tanks	2,500
Vacuum Trucks	2,500
Miscellaneous	2,500
SUBTOTAL	**70,000**
Field Supervision, Project Management, Procurement	25,000
Total Estimated Cost	**$95,000**

Appendix L includes a copy of the financial assurance instrument that Navajo has established to provide the appropriate monies for plugging and abandoning WDW-1, any groundwater restoration that may be necessary, and any post-operational monitoring that may be required.

7 (r) Logging and Testing Data

Appendix M includes a copy of pertinent open-hole logs run on the original oil and gas well that was drilled in 1993 and later converted to WDW-1. Appendix N includes copies of pertinent cased-hole logs that were run in WDW-1 as the well

was being converted to disposal services. Copies of additional open-hole and cased-hole logs are contained in the following report submitted to OCD in September 1998:

- *Reentry and Completion Report, Waste Disposal Well No. 1, Navajo Refining Company, Artesia, New Mexico* prepared by Envirocorp Well Services, Inc., Houston, Texas

7 (s) Mechanical Integrity Data (20.6.2.5204 NMAC)

Mechanical Integrity Testing (MIT) is conducted on WDW-1 on an annual basis in accordance with OCD regulations. Copies of each annual MIT report are submitted to OCD. Appendix G includes the text portion of the 2012 Annual MIT Report documenting the most recent annual MIT work at WDW-1. A complete copy of this report and previous annual MIT reports are contained in OCD files.

7 (t) Maximum Pressure and Flow Rate

The maximum injection rate and the maximum surface injection pressure at WDW-1 are as follows:

- Maximum Injection Rate: 500 gpm
- Maximum Surface Injection Pressure: 1,585 psi

7 (u) Formation Testing Program Data

Appendix E includes the results of formation testing that was performed on the well when it was originally drilled as an oil and gas exploratory well.

7 (v) Compatibility

All components of WDW-1 that are in direct contact with the non-corrosive waste stream and formation fluids in the Injection Interval (e.g., wetted surfaces) are constructed of materials that are compatible with these fluids.

7 (w) Area of Review Corrective Actions

No corrective action plan is required for any of the artificial penetrations identified in the 1-mile radius AOR because all artificial penetrations have been properly constructed, plugged and/or abandoned in order to prevent movement of fluids into or between USDWs which could be caused by pressures in the Injection Zone.

8.0 Modification(s)

There are no proposed modifications to existing discharge processes.

9.0 Inspection/Maintenance and Reporting

Navajo performs daily visual inspections of their three injection wells and the pipeline and performs required maintenance (PM) activities as scheduled to ensure safe operation of the wells.

Navajo performs routine reporting in accordance with the requirements of 20.6.2.5208.A NMAC for Class I nonhazardous waste injection wells.

10.0 Contingency Plans

Navajo has an Integrated Contingency Plan detailing responses to spills of all types, reporting spills/releases, mitigation and corrective actions, clean up and disposal as applicable. The remote WDW-1 is equipped with a high-pressure shutoff switch to prevent operation of the injection pump at pressures greater than the designated MASIP. The well is equipped with a low pressure shutoff switch that will deactivate the injection pump in the event of a surface leak. In addition, the well is equipped with a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This pressure switch is intended to stop the injection pump in the event of 1) a tubing leak, or 2) a casing, packer, or wellhead leak.

If an alarm or shutdown is triggered at the wellhead, electronic signals are sent to the Control Room at the refinery notifying of the shutdown and the cause of the alarm or shutdown will be immediately investigated.

Operators will immediately cease injection operations at the wellhead and divert flow to another well; and notify Maintenance and Environmental to take all necessary steps to determine the presence or absence of a leak; and Environmental will provide verbal notification to OCD within 24 hours.

If the alarm or shutdown is not related to mechanical integrity and the cause of the alarm or shutdown is corrected, injection operations will be resumed. If the mechanical integrity of the well is in question, the well will remain out of service until the mechanical integrity of the well is restored to the satisfaction of OCD and the agency approves resumption of injection operations.

11.0 Other Information

No additional information is required to demonstrate that the discharge permit will not result in concentrations in excess of the standards of 20.6.2.3103 NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use.

12.0 Filing Fee

A check in the amount of $100, made payable to Water Quality Management Fund, accompanies this permit renewal application document.

13.0 Draft Public Notice

20.6.2.3108.C NMAC requires that Navajo provide notice in accordance with 20.6.2.3108.F NMAC within thirty (30) days of OCD deeming the permit renewal application to be administratively complete. Appendix O includes a draft copy of the public notice that will be published following receipt of written notification from OCD that this discharge permit renewal application has been deemed administratively complete.

Navajo understands the requirement to submit to OCD within 15 days of completion of public notice requirements of 20.6.2.3108.C NMAC proof of notice, including an affidavit of mailing(s) and the list of property owner(s), proof of publication, and an affidavit of posting, as appropriate.

14.0 Certification

The required certification language is included at the end of the completed OCD Discharge Permit Application Form in the front of this permit renewal application document. The appropriate Navajo refinery authority has signed the form.

TABLES

TABLE 1A

NON-FRESHWATER (OIL AND GAS) WELLS IN WDW-1 AREA OF REVIEW
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

ID NO	API	Sect	TWP	RNG	NS FTG	EW FTG	WELL NAME	OPERATOR	WELL TYPE	PLUG DATE	WELL STATUS	DRILLL DATE	DEPTH (ft)
1	30-015-01636	31	17S	28E	330	2310	Pre-Ongard Well #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
2	30-015-01633	31	17S	28E	330	330	Aston & Fair A #001	George A Chase JV dba G&C Service	O	NA	Active	12/28/1945	525
3	30-015-01634	31	17S	28E	350	345	Pre-Ongard Well #001	Pre-Ongard Well Operator	O	1/1/1901	PA	1/1/1900	?
4	30-015-01645	31	17S	28E	990	990	Pre-Ongard Well #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
5	30-015-32162	31	17S	28E	460	990	Enron State #4	LRE Operating, LLC	O	NA	Active	3/26/2003	3460
6	30-015-38512	31	17S	28E	990	940	Enron State #16	LRE Operating, LLC	O	NA	Active	8/11/2011	3658
7	30-015-33994	36	17S	27E	915	420	Red Lake 36 A State #002	Apache Corp	O	NA	Active	3/24/2005	3650
8	30-015-00646	36	17S	27E	990	330	Delhi #007	George A Chase JV dba G&C Service	O	NA	Active	12/31/9999	540
9	30-015-00689	36	17S	27E	1650	330	Gates State #001	George A Chase JV dba G&C Service	O	NA	Active	7/22/1951	557
10	30-015-36978	31	17S	28E	990	330	Enron State #015	LRE Operating, LLC	O	11/1/2004	Active	6/25/2009	3700
11	30-015-00647	36	17S	27E	1650	990	Gates State #002	Aspen Oil Inc.	O	NA	PA	12/31/9999	9999
12	30-015-31123	36	17S	27E	1980	760	No Bluff State Comm #002	LRE Operating, LLC	G	NA	Active	3/19/2001	10050
13	30-015-00669	36	17S	27E	2310	330	Homan #001	George A Chase JV dba G&C Service	O	NA	Active	12/31/9999	1804
14	30-015-31036	36	17S	27E	2310	990	Gates State #003	George A Chase JV dba G&C Service	O	NA	Active	3/26/2000	614
15	30-015-36116	36	17S	27E	2305	1650	South Red Lake 11 Unit #057	Legacy Reserves Operating LLC	O	NA	Active	4/14/2008	2121
16	30-015-00687	36	17S	27E	2310	990	Ramapo #002	Kersey & Co.	G	6/14/1996	PA	12/31/9999	9999
17	30-015-05934	36	17S	27E	1650	1650	Empire ABO Unit #019A	Apache Corp	O	NA	Active	NA	5970
18	30-015-39325	36	17S	27E	990	2210	Big Boy State #007	COG Operating LLC	O	NA	Active	1/6/2012	5120
19	30-015-00670	36	17S	27E	2970	330	Ramapo #003	Kersey & Co.	O	6/17/1996	PA	1/1/1990	9999
20	30-015-00688	36	17S	27E	2310	330	Ramapo #001	Kersey & Co.	O	6/18/1996	PA	10/3/1941	590
21	30-015-00685	36	17S	27E	1650	330	Pre-Ongard Well #020	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
22	30-015-39401	36	17S	27E	1110	630	Empire ABO Unit #417	Apache Corp	O	NA	Active	1/9/2012	6300
23	30-015-39323	36	17S	27E	870	1560	Big Boy State #005	COG Operating LLC	O	NA	Active	4/21/2012	4953
24	30-015-01251	36	17S	27E	660	1980	Empire ABO Unit #019	BP America Production Co.	O	9/9/2009	PA	NA	6200
25	30-015-39324	36	17S	27E	480	2210	Big Boy State #006	COG Operating LLC	O	NA	Active	12/18/2011	5072
26	30-015-39326	36	17S	27E	275	1560	Big Boy State #008	COG Operating LLC	O	NA	N	NA	NA
27	30-015-40410	36	17S	28E	615	10	Big Girl 31 State #011H	COG Operating LLC	O	NA	N	NA	NA
28	30-015-00677	36	17S	27E	330	990	Empire ABO Unit #020	BP America Production Co.	O	9/9/2009	PA	12/31/9999	6013
29	30-015-39021	6	18S	28E	40	145	Empire ABO Unit #411	Apache Corp	O	NA	T	10/31/2011	6312
30	30-015-32309	1	18S	27E	330	1690	AAO Federal #003	Apache Corp	O	NA	Active	3/13/2003	4125
31	30-015-00708	1	18S	27E	660	1980	Empire ABO Unit #019B	Apache Corp	O	NA	Active	12/31/9999	6078
32	30-015-01215	1	18S	27E	667	666	Empire ABO Unit #020D	Apache Corp	O	NA	Active	12/31/9999	6118
33	30-015-32310	1	18S	27E	990	990	AAO Federal #004	Apache Corp	O	NA	Active	7/14/2003	4110
34	30-015-39898	1	18S	27E	1258	1005	Empire ABO Unit #412	Apache Corp	O	NA	N	NA	NA
35	30-015-33784	1	18S	27E	1650	330	AAO Federal #008	Apache Corp	O	NA	Active	2/28/2005	4310
36	30-015-00711	1	18S	27E	1980	660	Empire ABO Unit #020C	Apache Corp	O	NA	Active	12/31/9999	6218
37	30-015-22656	1	18S	27E	2400	700	Empire ABO Unit #203	Apache Corp	O	NA	Active	12/31/9999	6225
38	30-015-23116	6	18S	28E	2050	100	Empire ABO Unit #213	Apache Corp	O	NA	Active	12/31/9999	6242
39	30-015-22637	6	18S	28E	2450	400	Empire ABO Unit #212	Apache Corp	O	NA	Active	12/31/9999	6267
40	30-015-21553	1	18S	27E	2501	20	Empire ABO Unit #201	Apache Corp	O	NA	Active	12/31/9999	6225
41	30-015-02622	6	18S	28E	2219	660	Empire ABO Unit #21D	Apache Corp	O	NA	Active	12/31/9999	6194
42	30-015-02619	6	18S	28E	1990	660	Empire ABO Unit #21C	Apache Corp	O	NA	Active	12/31/9999	6202
43	30-015-02613	6	18S	28E	990	660	Empire ABO Unit #21B	Apache Corp	O	NA	Active	12/31/9999	6119

Map ID No. - Refer to Drawing 2
Well Type - O=Oil, I=Injction, G=Gas, N= New
(ft) - Feet
NA - Not Applicable
? - Data Not Available
Well Status: PA=Plug and Abandon, N=Not Drilled, T=Temp Abandoned

TABLE 1A

NON-FRESHWATER (OIL AND GAS) WELLS IN WDW-1 AREA OF REVIEW
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

ID NO	API	Sect	TWP	RNG	NS FTG	EW FTG	WELL NAME	OPERATOR	WELL TYPE	PLUG DATE	WELL STATUS	DRILLL DATE	DEPTH (ft)
44	30-015-22012	6	18S	28E	1350	1572	Empire ABO Unit #222	Apache Corp	O	NA	Active	12/31/9999	6303
45	30-015-02626	6	18S	28E	1650	1650	Pre-Ongard Well #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
46	30-015-10107	6	18S	28E	1874	1874	State FX #001	Pre-Ongard Well Operator	O	NA	Active	12/31/9999	1985
47	30-015-02620	6	18S	28E	1990	2082	Empire ABO Unit #22D	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	6206
48	30-015-02621	6	18S	28E	66	1980	Empire ABO Unit #22E	Apache Corp	O	NA	Active	12/31/9999	6033
49	30-015-02625	6	18S	28E	470	2170	Empire ABO Unit #23C	Apache Corp	O	NA	Active	12/31/9999	6194
50	30-015-02615	6	18S	28E	660	660	Empire ABO Unit #24B	Apache Corp	O	NA	Active	12/31/9999	6241
51	30-015-02614	6	18S	28E	1980	1980	Empire ABO Unit #23B	Apache Corp	O	NA	Active	12/31/9999	6242
52	30-015-02611	6	18S	28E	2310	2310	Pre-Ongard Well #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
53	30-015-21395	6	18S	28E	2630	1300	Empire ABO Unit #211	Apache Corp	O	NA	Active	12/31/9999	6200
54	30-015-22527	6	18S	28E	2630	1930	Empire ABO Unit #223	Apache Corp	O	NA	Active	12/31/9999	6250
55	30-015-02623	6	18S	28E	2248	2075	Empire ABO Unit #022F	Apache Corp	O	NA	Active	12/31/9999	6210
56	30-015-23548	6	18S	28E	1950	1000	Empire ABO Unit #211A	Apache Corp	O	NA	Active	12/31/9999	6311
57	30-015-02628	6	18S	28E	2260	2270	Empire ABO Unit #023D	BP America Production Co.	O	12/5/2008	PA	4/3/1960	6310
58	30-015-02618	6	18S	28E	1647	2076	Pre-Ongard #001	Pre-Ongard Well Operator	G	1/1/1900	PA	1/1/1900	?
59	30-015-22491	6	18S	28E	1700	2350	Empire ABO Unit #231B	BP America Production Co.	O	8/24/2009	PA	12/31/9999	6350
60	30-015-02610	6	18S	28E	955	1750	Empire ABO Unit #22C	Apache Corp	O	NA	Active	12/31/9999	6243
61	30-015-02624	6	18S	28E	968	2270	Pre-Ongard #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	?
62	30-015-02617	6	18S	28E	2310	990	Empire ABO Unit #024K	BP America Production Co.	O	12/12/2002	PA	12/31/9999	6346
63	30-015-22528	6	18S	28E	2300	1570	Empire ABO Unit #232A	BP America Production Co.	O	10/9/2009	PA	6/27/1978	6350
64	30-015-22490	6	18S	28E	2550	2050	Empire ABO Unit #233	BP America Production Co.	O	10/9/2009	PA	7/1/1978	6300
65	30-015-21746	6	18S	28E	2610	2713	Empire ABO Unit #221	Apache Corp	O	NA	Active	12/31/9999	6305
66	30-015-21737	6	18S	28E	2253	1576	Empire ABO Unit #232A	BP America Production Co.	O	10/9/2009	PA	12/31/9999	6345
67	30-015-23574	6	18S	28E	1950	660	Empire ABO Unit #241	BP America Production Co.	O	12/23/2008	PA	12/31/9999	6386
68	30-015-02616	6	18S	28E	1650	990	Empire ABO Unit #024C	Apache Corp	O	NA	Active	12/31/9999	6253
69	30-015-22913	6	18S	28E	1750	1600	Empire ABO Unit #235	Apache Corp	O	?	PA	12/31/9999	600
70	30-015-21542	6	18S	28E	1260	1580	Empire ABO Unit #231B	Apache Corp	O	NA	Active	12/31/9999	6261
71	30-015-21626	6	18S	28E	1361	2531	Empire ABO Unit #231A	Apache Corp	O	NA	Active	12/31/9999	6390
72	30-015-22593	6	18S	28E	1900	2441	Empire ABO Unit #234	BP America Production Co.	O	12/25/2008	PA	12/31/9999	6260
73	30-015-30785	6	18S	28E	430	330	NW State #015	LRE Operating, LLC	O	NA	Active	12/20/1999	3225
74	30-015-20019	6	18S	28E	330	330	NW Artesia Unit #016	LRE Operating, LLC	O	NA	Active	12/31/9999	3273
75	30-015-39008	6	18S	28E	160	1300	Empire ABO Unit #410	Apache Corp	O	NA	N	12/31/9999	?
76	30-015-25522	5	18S	28E	2240	400	Walter Solt State #001	Walter Solt LLC	SWD	NA	Active	12/31/9999	8500
77	30-015-10244	5	18S	28E	2310	330	State AG #001	Mack Energy Corp	O	3/27/2001	PA	12/31/9999	6365
78	30-015-24485	5	18S	28E	1980	990	Illinois Camp A Com #001	Conoco Phillips Co	G	NA	Active	12/31/9999	10450
79	30-015-31086	5	18S	28E	1650	990	LP State #001	Marbob Energy Corp	O	3/11/2008	PA	7/3/2000	4503
80	30-015-02602	5	18S	28E	1650	1650	Empire ABO Unit #026D	Apache Corp	O	NA	Active	11/28/1959	6265
81	30-015-22697	5	18S	28E	1080	1914	Empire ABO Unit #261A	BP America Production Co.	O	6/15/2009	PA	12/31/9999	6350
82	30-015-02607	5	18S	28E	660	660	Empire ABO Unit #25C	Apache Corp	O	NA	Active	12/31/9999	6273
83	30-015-22750	5	18S	28E	660	150	Empire ABO Unit #251	Apache Corp	O	NA	Active	12/31/9999	6250
84	30-015-02605	5	18S	28E	330	2271	Empire ABO Unit #27E	BP America Production Co.	O	6/16/2009	PA	12/31/9999	6261
85	30-015-02606	5	18S	28E	330	1941	Empire ABO Unit #26E	Apache Corp	O	NA	Active	12/31/9999	6254
86	30-015-22009	32	17S	28E	330	2481	Empire ABO Unit #272	Apache Corp	O	NA	Active	12/31/9999	6370

Map ID No. - Refer to Drawing 2
Well Type - O=Oil, I=Injction, G=Gas, N= New
(ft) - Feet
NA - Not Applicable
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Well Status: PA=Plug and Abandon, N=Not Drilled, T=Temp Abandoned

TABLE 1A

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ARTESIA, NEW MEXICO

ID NO	API	Sect	TWP	RNG	NS FTG	EW FTG	WELL NAME	OPERATOR	WELL TYPE	PLUG DATE	WELL STATUS	DRILLL DATE	DEPTH (ft)
87	30-015-21539	32	17S	28E	150	1400	Empire ABO Unit #261A	Apache Corp	O	NA	Active	12/31/9999	6220
88	30-015-39007	32	17S	28E	70	100	Empire ABO Unit #409	Apache Corp	N	NA	N	12/31/9999	6400
89	30-015-37058	32	17S	28E	330	330	NW State #32	LRE Operating, LLC	O	NA	Active	8/12/2009	3425
90	30-015-37057	32	17S	28E	330	1750	NW State #31	LRE Operating, LLC	O	NA	Active	7/21/2009	3500
91	30-015-01659	32	17S	28E	660	1980	Empire ABO Unit #26A	Apache Corp	O	NA	Active	12/31/9999	6172
92	30-015-01660	32	17S	28E	660	660	Empire ABO Unit #25	BP America Production Co.	O	6/30/2009	PA	12/31/9999	6187
93	30-015-30685	32	17S	28E	990	990	NW State #007	LRE Operating, LLC	O	NA	Active	8/30/1999	3220
94	30-015-10834	32	17S	28E	990	2030	NW Artesia Unit #13	SDX Resources, Inc.	O	11/2/2006	PA	12/31/9999	2006
95	30-015-30815	32	17S	28E	1090	2126	NW State #008	LRE Operating, LLC	I	NA	Active	11/18/1999	3310
96	30-015-20043	32	17S	28E	990	760	NW Artesia Unit #012	LRE Operating, LLC	I	NA	Active	12/31/9999	1998
97	30-015-01661	32	17S	28E	1650	2310	Empire ABO Unit #26B	Apache Corp	O	NA	Active	12/31/9999	6083
98	30-015-36989	32	17S	28E	1630	1710	NW State #30	LRE Operating, LLC	O	NA	Active	7/7/2009	3405
99	30-015-01662	32	17S	28E	1650	990	Empire ABO Unit #25A	Apache Corp	O	NA	Active	12/31/9999	6123
100	30-015-36554	32	17S	28E	1770	550	NW State #29	LRE Operating, LLC	O	NA	Active	1/21/2009	3450
101	30-015-39927	32	17S	28E	1750	1765	AA State #002	Apache Corp	O	NA	N	12/31/9999	5800
102	30-015-30781	32	17S	28E	1900	2146	NW State #005	LRE Operating, LLC	I	NA	Active	10/28/1999	3190
103	30-015-10818	32	17S	28E	2310	2105	NW Artesia #008	SDX Resources, Inc.	O	11/6/2006	PA	12/31/9999	2003
104	30-015-30777	32	17S	28E	2310	990	NW State #006	LRE Operating, LLC	O	NA	Active	10/19/1999	3204
105	30-015-10795	32	17S	28E	2310	66	NW Arteisa #009	Lime Rock Resources L.P.	O	5/28/2008	PA	12/31/9999	1980
106	30-015-01657	32	17S	28E	2280	1980	AA State #001	Apache Corp	O	NA	Active	7/30/1960	6171
107	30-015-01671	32	17S	28E	2280	978	Empire ABO Unit #25B	BP America Production Co.	O	7/21/2008	PA	12/31/9999	6013
108	30-015-31920	32	17S	28E	990	990	Enron State #002	LRE Operating, LLC	O	NA	Active	9/4/2001	4030
109	30-015-40339	32	17S	28E	99	330	Enron State #018	LRE Operating, LLC	O	NA	N	12/31/9999	4250
110	30-015-35050	32	17S	28E	330	500	Enron State #012	LRE Operating, LLC	O	NA	Active	11/20/2006	3810
111	30-015-01654	32	17S	28E	33	330	Pre-Ongard #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	651
112	30-015-39638	30	17S	28E	412	679	Anthoney State #003	LRE Operating, LLC	O	NA	Active	2/21/2012	5039
113	30-015-38234	30	17S	28E	430	800	Anthoney State #002	LRE Operating, LLC	O	NA	Active	2/1/2011	4823
114	30-015-01616	30	17S	28E	330	990	Blake State #1	CFM Oil LLC	O	NA	Active	12/31/9999	615
115	30-015-36564	30	17S	28E	330	2210	Staley State #009	LRE Operating, LLC	O	NA	Active	12/15/2008	4010
116	30-015-40026	30	17S	28E	330	2410	Staley State #017	LRE Operating, LLC	O	NA	Active	3/15/2012	5108
117	30-015-37673	30	17S	28E	330	1650	Staley State #012	LRE Operating, LLC	O	NA	Active	5/24/2010	4785
118	30-015-38203	30	17S	28E	330	990	Maple State #008	COG Operating LLC	O	NA	N	12/31/9999	4750
119	30-015-21594	31	17S	28E	330	1650	Powco State #001	Finney Oil Co	O	NA	Active	12/31/9999	650
120	30-015-01638	31	17S	28E	330	990	Pre-Ongard #001	Pre-Ongard Well Operator	O	1/1/1990	PA	1/1/1990	2003
121	30-015-30784	31	17S	28E	330	480	NW State #002	LRE Operating, LLC	O	NA	Active	11/11/1999	3300
122	30-015-30893	31	17S	28E	973	959	NW State #028	LRE Operating, LLC	O	NA	Active	9/14/2000	2808
123	30-015-25621	31	17S	28E	980	1620	Powco State #002	Finney Oil Co	O	NA	Active	12/31/9999	734
124	30-015-30783	31	17S	28E	1650	330	NW State #11	LRE Operating, LLC	O	NA	Active	11/4/1999	3205
125	30-015-36343	31	17S	28E	1650	2310	Malco State #002	George A Chase JV dba G&C Service	O	NA	Active	6/30/2008	633
126	30-015-10537	31	17S	28E	2277	330	NW Artesia Unit #004	LRE Operating, LLC	O	NA	Active	3/3/1966	6200
127	30-015-01652	31	17S	28E	2288	1625	Boling #001	Kersey & Co.	O	NA	Active	12/14/1989	1938
128	30-015-37428	31	17S	28E	1980	1980	Malco State #003	George A Chase JV dba G&C Service	O	NA	Active	12/20/2009	650
129	30-015-01637	31	17S	28E	2310	2310	Malco State #001	George A Chase JV dba G&C Service	O	NA	Active	1/14/1953	1852

Map ID No. - Refer to Drawing 2
Well Type - O=Oil, I=Injction, G=Gas, N= New
(ft) - Feet
NA - Not Applicable
? - Data Not Available
Well Status: PA=Plug and Abandon, N=Not Drilled, T=Temp Abandoned

TABLE 1A

NON-FRESHWATER (OIL AND GAS) WELLS IN WDW-1 AREA OF REVIEW
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

ID NO	API	Sect	TWP	RNG	NS FTG	EW FTG	WELL NAME	OPERATOR	WELL TYPE	PLUG DATE	WELL STATUS	DRILLL DATE	DEPTH (ft)
130	30-015-01635	31	17S	28E	2310	2310	Aston & Fair #001Y	George A Chase JV dba G&C Service	O	NA	Active	12/31/9999	1926
131	30-015-01643	31	17S	28E	2310	2360	Empire ABO Unit #22	BP America Production Co.	O	7/10/2009	PA	12/31/9999	5971
132	30-015-24887	31	17S	28E	2310	990	Hudson Saikin State #002	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1950
133	30-015-02666	31	17S	28E	2310	330	Hudson Saikin State #001	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1860
134	30-015-30849	31	17S	28E	2310	270	NW State #009	LRE Operating, LLC	O	NA	Active	12/14/1999	3195
135	30-015-10833	31	17S	28E	1980	660	NW Artesia Unit #010	LRE Operating, LLC	O	NA	Active	12/31/9999	2000
136	30-015-01644	31	17S	28E	1650	330	Empire ABO Unit #24A	BP America Production Co.	O	6/15/2009	PA	12/31/9999	6106
137	30-015-40409	31	17S	28E	1920	330	Big Girl 31 State #009H	COG Operating LLC	O	NA	N	12/31/9999	8447
138	30-015-01650	31	17S	28E	1650	1958	Empire ABO Unit #23A	BP America Production Co.	O	9/17/2003	PA	12/31/9999	6094
139	30-015-01642	31	17S	28E	1650	2310	State FW #001	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1937
140	30-015-01651	31	17S	28E	1650	2387	Empire ABO Unit #22B	BP America Production Co.	O	2/10/2010	PA	12/31/9999	6046
141	30-015-01648	31	17S	28E	1651	1089	Empire ABO Unit #21A	BP America Production Co.	O	8/24/2002	PA	4/15/1960	5971
142	30-015-01640	31	17S	28E	2310	330	Rampo #002	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1996
143	30-015-39011	31	17S	28E	1190	1320	Empire ABO Unit #419	Apache Corp	O	NA	Active	10/11/2011	6310
144	30-015-20042	31	17S	28E	990	660	NW Artesia Unit #011	LRE Operating, LLC	O	NA	Active	12/31/9999	2012
145	30-015-01653	31	17S	28E	990	1650	Pre-Ongard #001	Pre-Ongard Well Operator	O	1/1/1900	PA	1/1/1900	742
146	30-015-01639	31	17S	28E	990	330	Ramp #001	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1975
147	30-015-30760	31	17S	28E	735	330	NW State #010	LRE Operating, LLC	O	NA	Active	10/12/1999	3210
148	30-015-01641	31	17S	28E	660	660	Empire ABO Unit #24	Apache Corp	O	NA	Active	12/31/9999	6122
149	30-015-39004	31	17S	28E	150	1300	Empire ABO Unit #401	Apache Corp	O	NA	N	12/31/9999	6400
150	30-015-01649	31	17S	28E	660	1939	Empire ABO Unit #23	BP America Production Co.	O	1/14/2010	PA	12/31/9999	6094
151	30-015-27592	31	17S	28E	660	2310	WDW #1	Navajo Refining Co.	I	NA	Active	8/4/1993	10200
152	30-015-10118	31	17S	28E	766	2188	State FV #001	Alamo Permian Resources, LLC	O	NA	Active	12/31/9999	1957
153	30-015-01646	31	17S	28E	660	2082	Empire ABO Unit #22A	BP America Production Co.	O	8/20/2009	PA	12/31/9999	6050
154	30-015-01647	31	17S	28E	660	660	Empire ABO Unit #21	BP America Production Co.	O	7/23/2005	PA	12/31/9999	9999
155	30-015-39020	31	17S	28E	140	2560	Empire ABO Unit #408	Apache Corp	O	NA	T	10/18/2011	6318
156	30-015-33473	1	18S	27E	1750	1650	AAO Federal #007	Apache Corp	O	NA	Active	10/22/2004	4100

Map ID No. - Refer to Drawing 2
Well Type - O=Oil, I=Injction, G=Gas, N= New
(ft) - Feet
NA - Not Applicable
? - Data Not Available
Well Status: PA=Plug and Abandon, N=Not Drilled, T=Temp Abandoned

TABLE 1B

NON-FRESHWATER (OIL AND GAS) WELLS IN WDW-1 AREA OF REVIEW
PENETRATING TOP OF INJECTION ZONE
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

ID NO	API	SECT	TWP	RNG	NS FTG	EW FTG	WELL NAME	OPERATOR	WELL TYPE	PLUG DATE	WELL STATUS	DRILL DATE	DEPTH (ft)
12	30-015-31123	36	17S	27E	1980	760	No Bluff State Comm #002	LRE Operating, LLC	G	NA	Active	3/19/2001	10050
76	30-015-25522	5	18S	28E	2240	400	Walter Solt State #001	Walter Solt LLC	SWD	NA	Active	12/31/9999	8500
78	30-015-24485	5	18S	28E	1980	990	Illinois Camp A Com #001	Conoco Phillips Co	G	NA	Active	12/31/9999	10450
151	30-015-27592	31	17S	28E	660	2310	WDW #1	Navajo Refining Co.	I	NA	Active	8/4/1993	10200

Map ID No. - Refer to Drawing 2
Well Type - O=Oil, I=Injection, G=Gas
(ft) - Feet
NA - Not Applicable

TABLE 2
INJECTION FLUID CHARACTERIZATION DATA
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

	Feb 2011	May 2011	Aug 2011	Nov 2011	Feb 2012	May 2012	Sept 2012	Nov 2012
Miscellaneous								
Reactive Cyanide (mg/Kg)	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0
Reactive Sulfide (mg/Kg)	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0
Chloride (mg/L)	410	213	404	332	519	646	458	401
Sulfate (mg/L)	1,510	2,240	2,290	2,350	1,870	2,220	3,460	2,580
Alkalinity (Total) (mg/L)	441	243	302	217	466	175	284	239
Sp. Cond. (umhos/cm)	6,270	4,680	7,380	5,430	5,990	6,650	8,370	6,680
Ignitability (°F)	>212	>212	>212	>212	>212	>212	>212	>212
pH (S.U.)	7.40	7.85	8.11	7.52	7.30	6.76	7.33	7.63
TDS (mg/L)	3,310	3,400	4,320	4,840	3,890	3,100[(1)]	6,140	4,780

mg/Kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
umhos/cm	Micromhos per centimeter.
°F	Degrees Fahrenheit.
S.U.	Standard Units.
>	Greater than.
<	Less than.
(1)	TDS Sample collected in July 2012.

TABLE 2
INJECTION FLUID CHARACTERIZATION DATA
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

	Feb 2011	May 2011	Aug 2011	Nov 2011	Feb 2012	May 2012	Sept 2012	Nov 2012
Metals								
Aluminum	6.0	0.438	0.625	0.752	1.87	0.394	1.11	4.04
Arsenic	0.0557	0.0198	0.0207	0.0365	0.141	0.0791	0.0468	0.070
Barium	0.0590	0.0541	0.0796	0.0182	0.0282	0.0202	0.0182	0.0599
Boron	0.216	0.353	0.276	0.243	0.335	0.238	0.253	0.286
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004
Chromium	0.00562	<0.005	<0.005	<0.005	0.00598	<0.005	<0.005	<0.010
Copper	0.0265	0.00715	0.00709	<0.005	0.0117	<0.005	0.0108	0.018
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.010
Manganese	0.0940	0.0239	0.0559	0.0213	0.0555	0.0524	0.0329	0.0669
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.0002
Molybdenum	0.202	0.168	0.145	0.0443	0.0987	0.154	0.243	0.255
Nickel	0.0141	0.00605	0.00767	<0.005	0.106	0.0122	0.0112	0.0109
Selenium	0.382	0.646	0.465	0.99	0.312	0.690	1.00	0.842
Silver	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.010
Zinc	1.42	0.0884	0.0983	0.012	0.0746	0.0402	0.0560	0.0836

All concentrations reported in milligrams per liter (mg/L).
< Less than.

TABLE 2
INJECTION FLUID CHARACTERIZATION DATA
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

	Feb 2011	May 2011	Aug 2011	Nov 2011	Feb 2012	May 2012	Sept 2012	Nov 2012
Semivolatiles								
1,2,4-Trichlorobenzene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
2,4,5-Trichlorophenol	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
2,4,6-Trichlorophenol	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
2,4-Dinitrotoluene	NA	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
2-Methylnaphthalene	<0.025	<0.005	<0.050	0.040	<0.005	<0.005	<0.0002	<0.005
2-Methylphenol	<0.025	<0.005	<0.050	0.29	<0.005	<0.005	NA	<0.005
2-Nitroaniline	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
3&4-Methylphenol	<0.025	<0.005	<0.050	0.52	<0.005	<0.005	NA	<0.005
3-Nitroaniline	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
4-Nitroaniline	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
4-Nitrophenol	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Acenaphthene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Acenaphthylene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Aniline	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Anthracene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Benz(a)anthracene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	<0.0002	<0.005
Benzidine	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Hexachlororthane	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Indeno(1,2,3-cd)pyrene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Isophorone	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Naphthalene	<0.025	<0.005	<0.050	0.038	<0.005	<0.005	<0.0002	<0.005
Nitrobenzene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
N-Nitrosodimethylylamine	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
N-Nitosodi-n-propylamine	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
N-Nitrosodiphenylamine	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Pentachlorophenol	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Phenanthrene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Phenol	<0.025	<0.005	<0.050	0.99	<0.005	<0.005	NA	0.013
Pyrene	<0.025	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005
Pyridine	NA	<0.005	<0.050	<0.005	<0.005	<0.005	NA	<0.005

All concentrations reported in milligrams per liter.
< Less Than.
NA Not Analyzed.

TABLE 2
INJECTION FLUID CHARACTERIZATION DATA
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

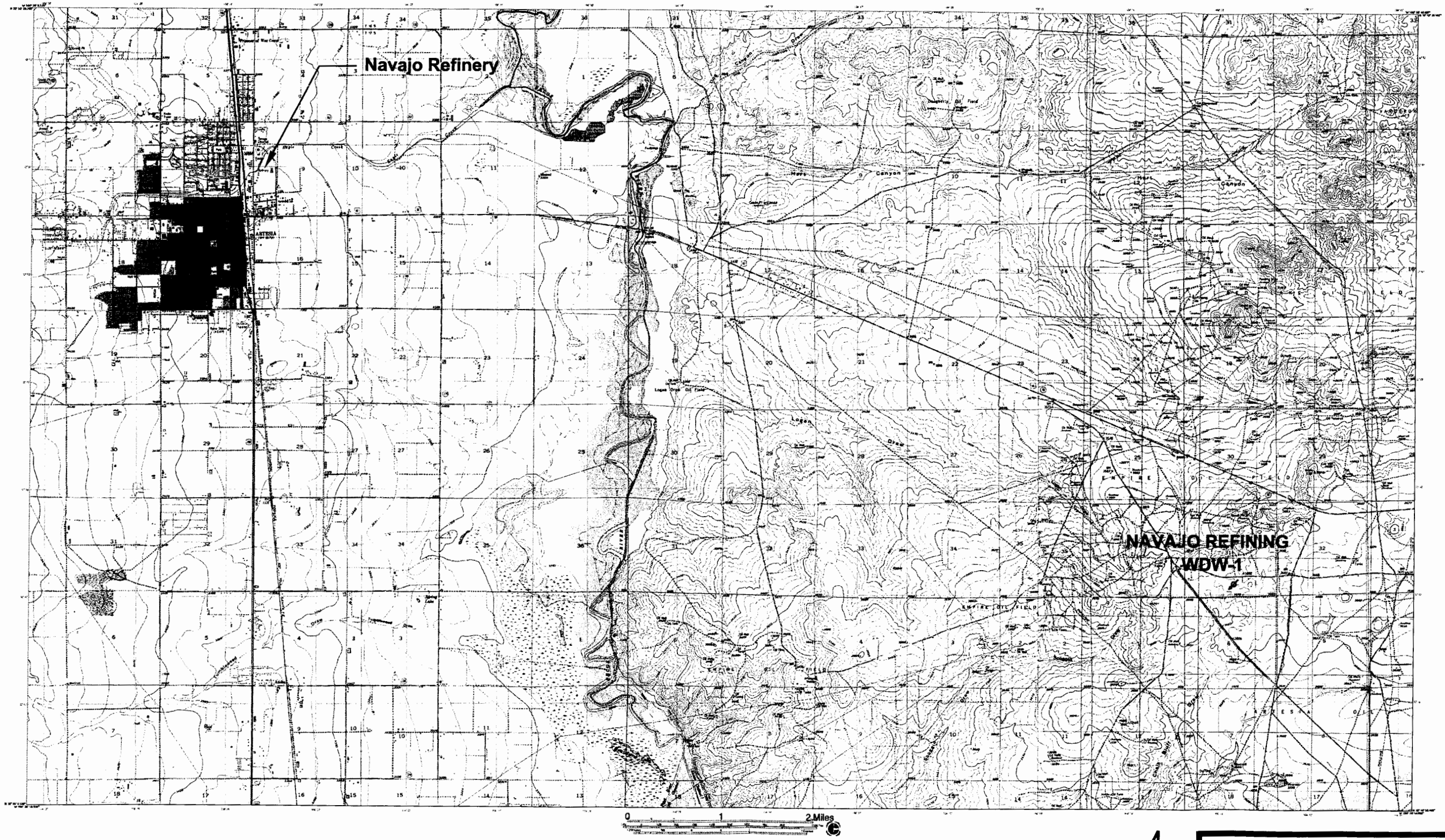
	Feb 2011	May 2011	Aug 2011	Nov 2011	Feb 2012	May 2012	Sept 2012	Nov 2012
Volatiles								
1,1,1-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2,2-Tetrachloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2-Butanone	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
2-Chloroethyl vinty ether	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
2-Hexanone	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
4-Methyl-2-pentanone	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
Acetone	0.025	<0.010	<0.010	0.200	0.120	<0.010	NA	<0.055
Benzene	<0.005	<0.005	<0.005	0.200	<0.005	<0.005	<0.005	<0.005
Bromodichloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Bromoform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Bromomethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
bon disulfide	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
Carbon tetrachloride	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Chlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Chloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Chloroform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
cis-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Dibromochloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Ethylbenzene	<0.005	<0.005	<0.005	0.190	<0.005	<0.005	<0.005	<0.005
m,p-Xylene	<0.010	<0.010	<0.010	0.360	<0.010	<0.010	NA	<0.010
Methylene chloride	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.010
Styrene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Tetrachloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	<0.005	<0.005	<0.005	0.510	<0.005	<0.005	<0.005	<0.005
trans-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Trichloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005
Vinyl acetate	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NA	<0.010
Vinyl chloride	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes, Total	<0.015	<0.015	<0.015	0.560	<0.015	<0.015	<0.015	<0.015

All concentrations reported in milligrams per liter (mg/L).

< Less Than.

Not Analyzed.

FIGURES



Maps compiled from USGS Quads: Artesia, NM; Spring Lake, NM; Red Lake, NM; Illinois Camp, NM; Dayton, NM; Lake Mcmillan N, NM

QUADRANGLE LOCATION

SUBSURFACE

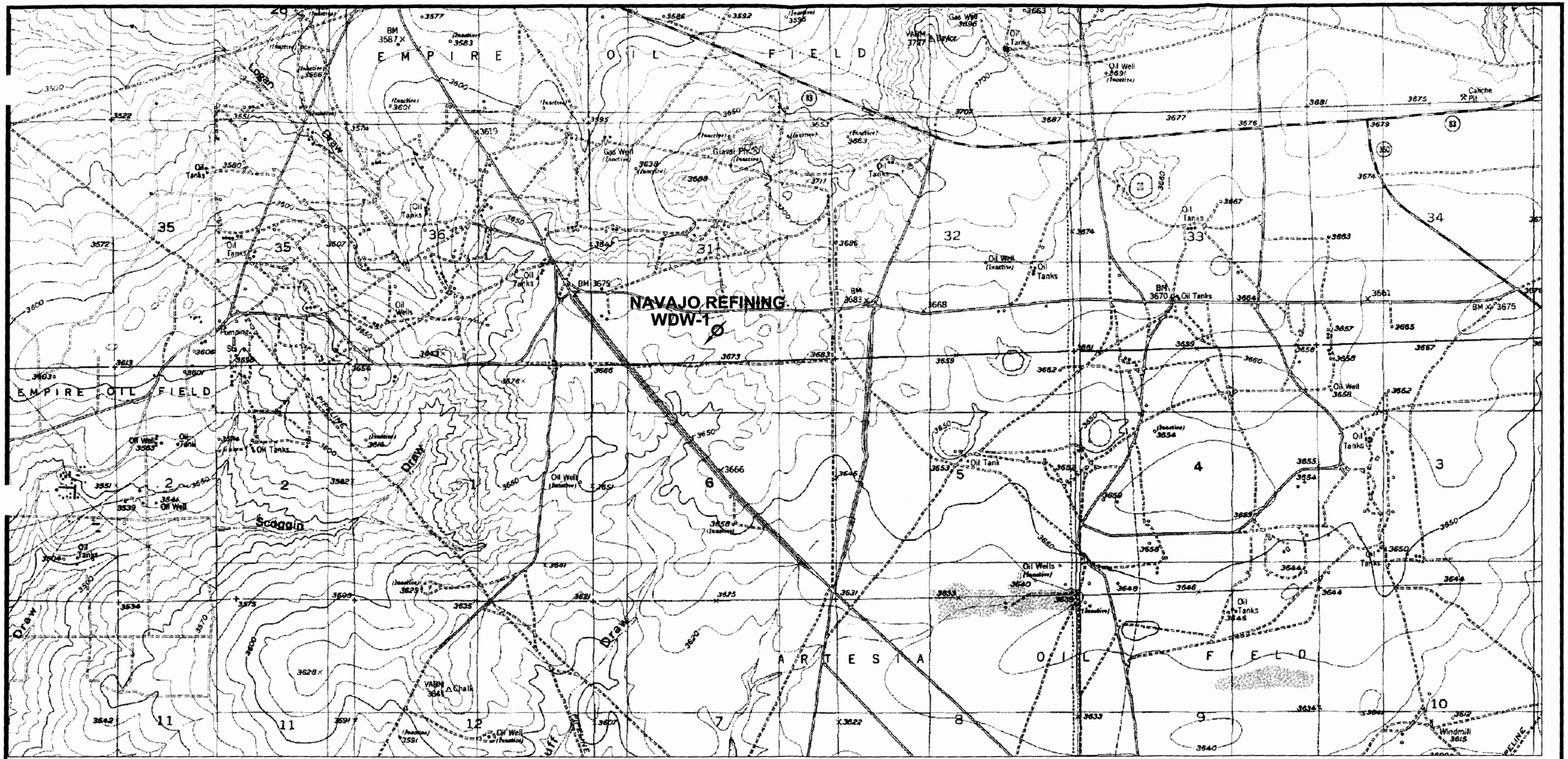
HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 1

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

SITE LOCATION MAP

DATE: 01/23/13	CHECKED BY:	JOB NO: 60D6894
DRAWN BY: WDD	APPROVED BY:	DWG. NO:



0 ½ 1 2 Miles
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 10,000 Feet
1,000 Meters 500 0 ½ 1 2 Kilometers

N

QUADRANGLE LOCATION

SUBSURFACE

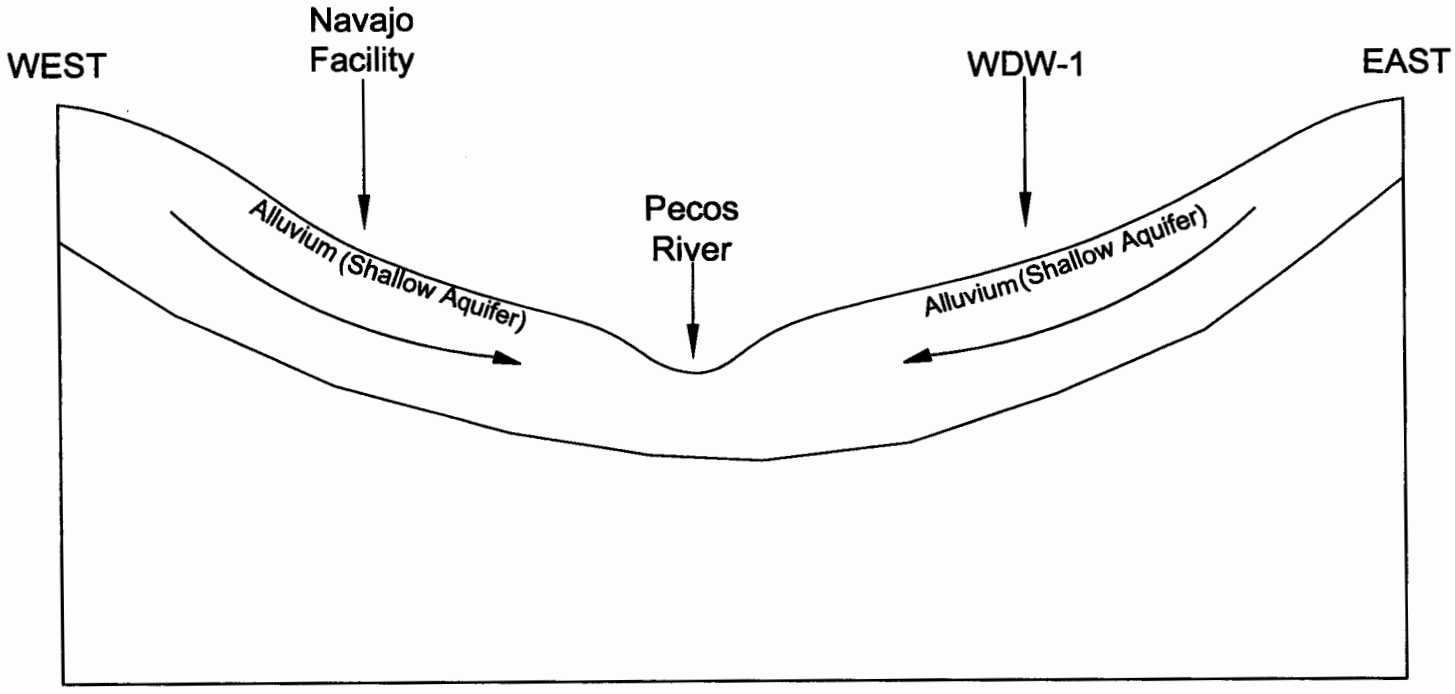
HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 2

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

SITE MAP

DATE: 01/07/13	CHECKED BY:	JOB NO: 60D6894
DRAWN BY: WDD	APPROVED BY:	DWG. NO:



NOT TO SCALE

SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 3

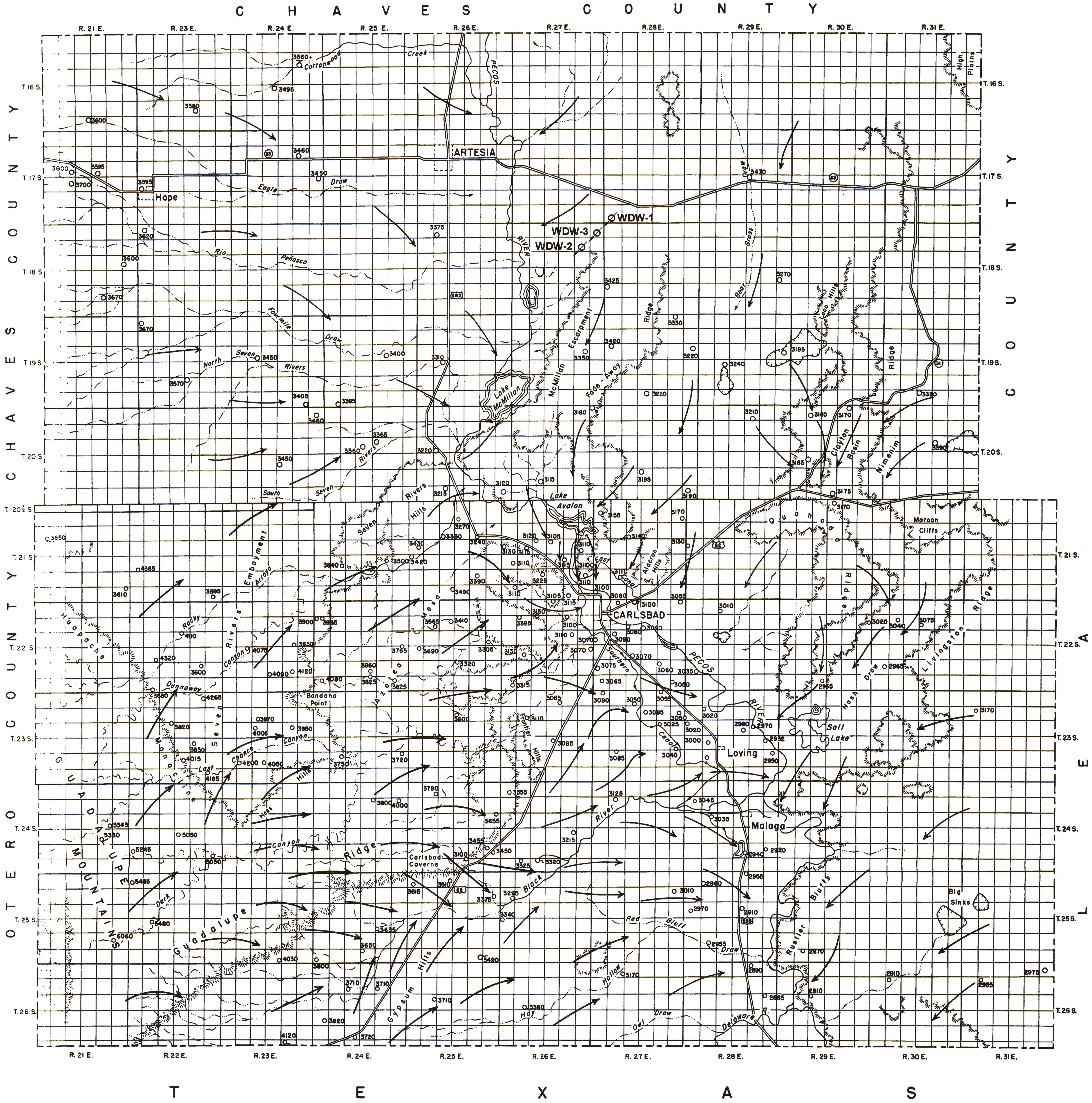
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

GENERALIZED HYDROGEOLOGIC CROSS-SECTION

DATE: 01/04/13	CHECKED BY:	JOB NO: 60D6894
DRAWN BY: WDD	APPROVED BY:	DWG. NO:

EXPLANATION

Direction of Groundwater Movement



GENERAL DIRECTION OF MOVEMENT OF GROUND WATER

IN EDDY COUNTY, NEW MEXICO

SCALE

5 0 5 10 MILES

EXPLANATION

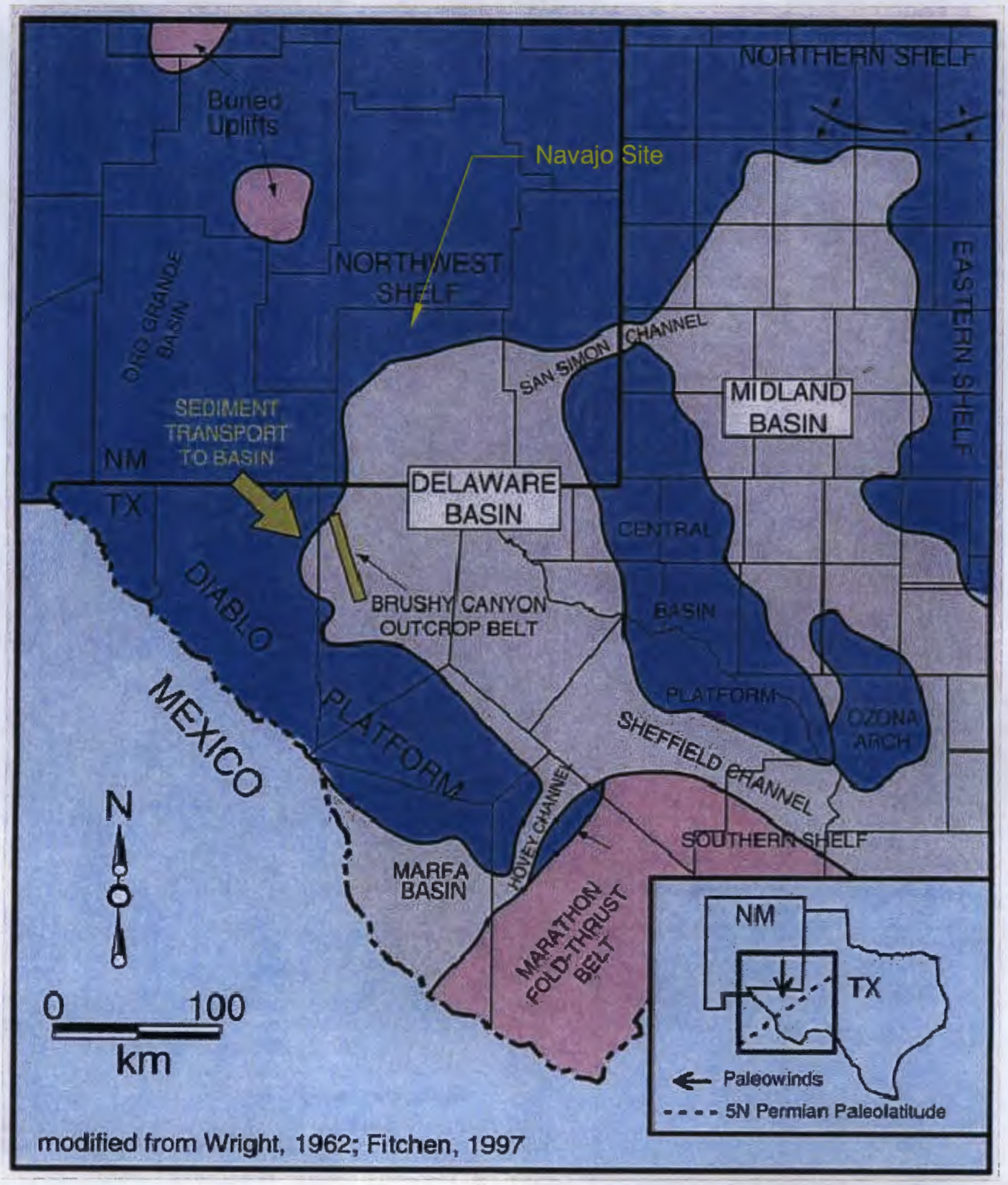
o Well

Spring

Direction of ground water movements

3380 Altitudes (feet above sea level) of ground water levels

FIGURE 4



SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 5

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

PERMIAN BASIN MAP

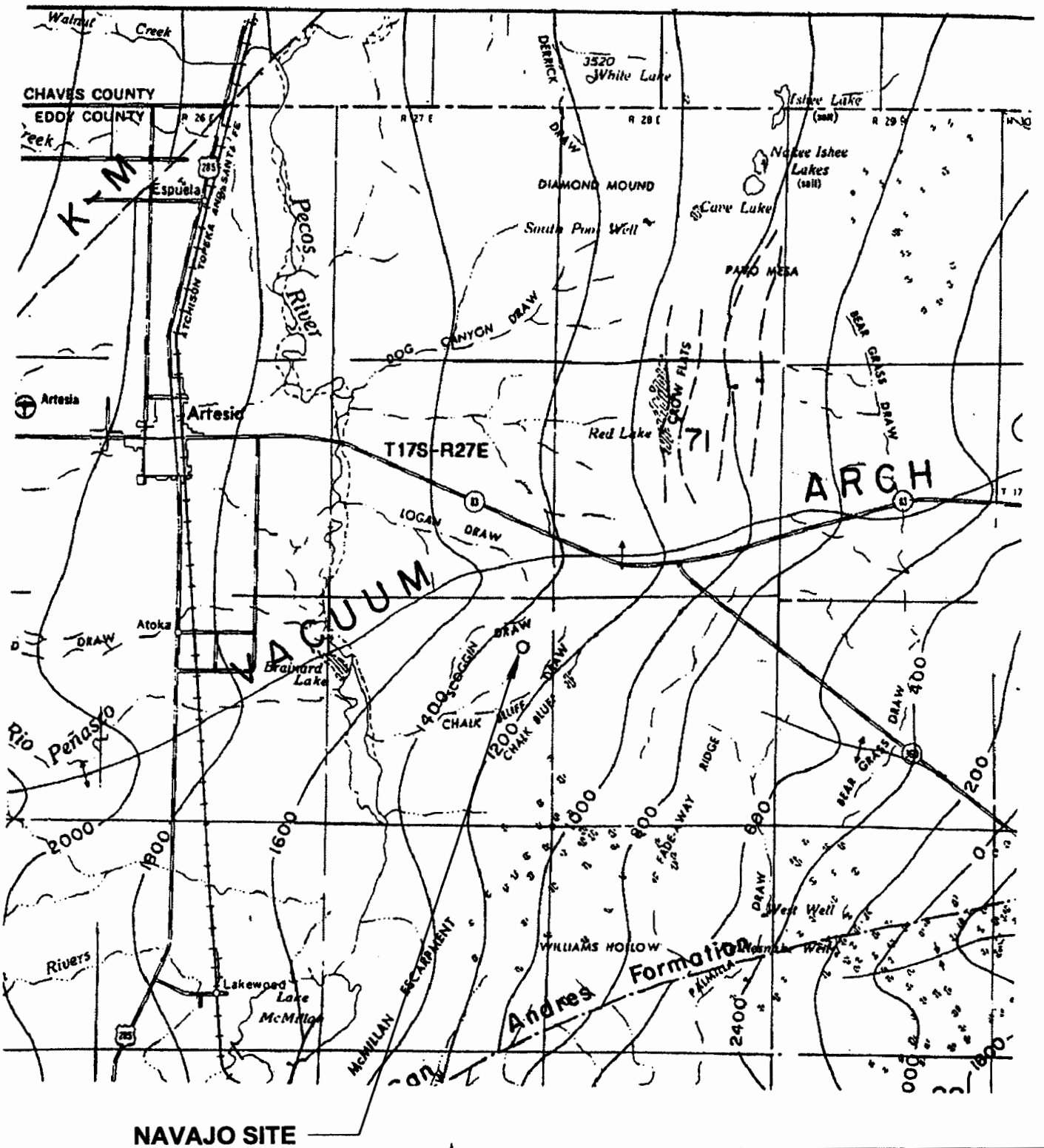
DATE: 01/07/13	CHECKED BY:	JOB NO: 6006894
DRAWN BY: WDD	APPROVED BY:	DWG. NO:

NORTHWEST SHELF, CENTRAL BASIN PLATFORM

Age		Strata		Oil Plays
Triassic		Chinle		
		Santa Rosa		
Permian	Ochoan	Dewey Lake		
		Rustler		
		Salado		
	Guadalupian	Artesia Group	Tansill	Artesia Platform Sandstone
			Yates	
			Seven Rivers	
			Queen	
			Grayburg	Upper San Andres and Grayburg Platform - Artesia Vacuum Trend
		San Andres		Upper San Andres and Grayburg Platform - Central Basin Platform Trend
		Glorieta		Leonardian Restricted Platform Carbonate
		Yeso	Paddock	
			Blinebry	
			Tubb	
			Drinkard	
	Leonardian	Abo		Abo Platform Carbonate
	Wolfcampian	Hueco ("Wolfcamp")		Wolfcamp Platform Carbonate
Pennsylvanian	Virgilian	Cisco	Bough	Northwest Shelf Upper Pennsylvanian Carbonate
	Missourian	Canyon		
	Des Moinesian	Strawn		Northwest Shelf Strawn Patch Reef
	Atokan	Atoka		
	Morrowan	Morrow		
Miss.		undivided		
Dev.	Upper	Woodford		
	Middle			
	Lower	Thirtyone		Devonian Thirtyone Deepwater Chert
Sil.	Upper	Wristen		Wristen Buildups and Platform Carbonate
	Middle			
	Lower	Fusselman		Fusselman Shallow Platform Carbonate
Ord.	Upper	Montoya		
	Middle	Simpson		Simpson Cratonic Sandstone
	Lower	Ellenburger		Ellenburger Karst-Modified Restricted Ramp Carbonate
Cambrian		Bliss		
Precambrian		Igneous, metamorphics volcanics		

FIGURE 6

STRATIGRAPHIC COLUMN



SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 7

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

REGIONAL GEOLOGIC FEATURES

DATE: 01/07/13	CHECKED BY:	JOB NO: 6006894
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NAVAJO REFINING
WDW #1

LOGAN DRAW, 17
(SAN ANDRES WOLFCAMP CISCO ATOKA MORROW)

LOGAN DRAW W, 94
(MORROW)

RED LAKE NW, 01
(PADDOCK)

CHALK BLUFF, 82
(WOLFCAMP)

EMPIRE, 24
(YATES, SEVEN RIVERS, QUEEN, GRAYBURG, PADDOCK, ABO, WOLFCAMP, STRAWN, ATOKA, PENN, BARNETT)

LOGAN DRAW SE, 39

GRAYBURG-JACKSON
(SEVEN RIVERS, QUEEN, GRAYBURG, SAN ANDRES)

RED LAKES S, 64
(SEVEN RIVERS)

AID, 41
(YATES, SEVEN RIVERS, QUEEN, GRAYBURG, SAN ANDRES, GLORIETA, TUBB, DRINKARD, ABO, WOLFCAMP, MORROW)

RED LAKE NE, 98
(GLORIETA, YESO)

ARTESIA LAKE, 03

SKAGGIN DRAW, 72
(STRAWN, ATOKA, MORROW)

EMPIRE S, 71
(WOLFCAMP, STRAWN, MORROW)

ILLINOIS CAMP H, 68
(MORROW, ATOKA, CHESTER)

TRAVIS, 78
(YATES, BONE SPRING, WOLFCAMP, UPPER PE

ILLINOIS CAMP, 77

22N 34W

T18S R28E

Pecos River

2000

1700

1600

1500

1400

104°15'00"

32°45'00"

SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 8

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

PUBLISHED STRUCTURE MAP
TOP OF SAN ANDRES FORMATION

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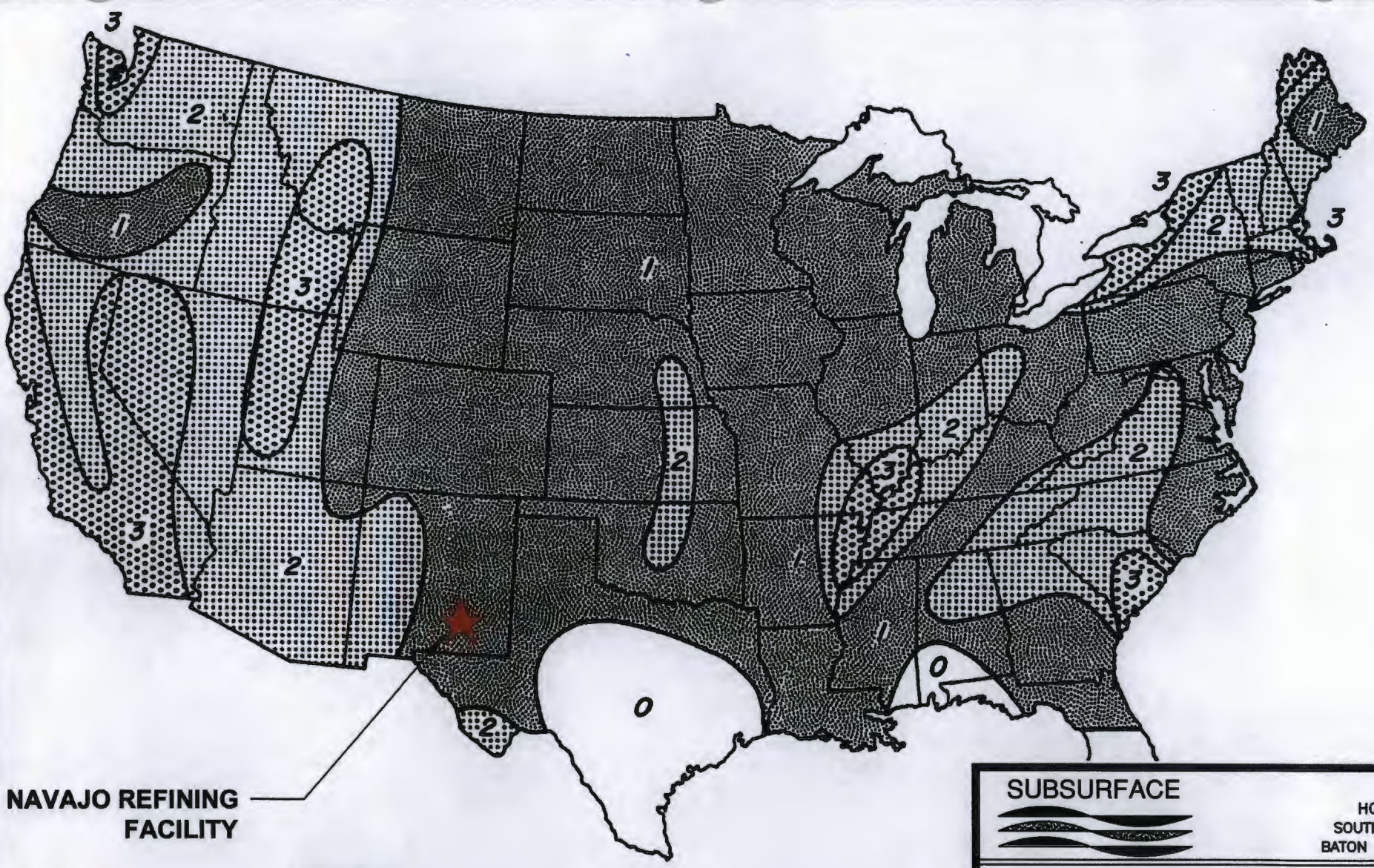

LEGEND

Zone 0 - no damage.
Zone 1 - minor damage; corresponds to intensities V and VI of the M.M.* Scale.
Zone 2 - moderate damage; corresponds to intensity VII of the M.M.* Scale.
Zone 3 - major damage; corresponds to intensity VIII and higher of the M.M.* Scale.
(* - M.M. Refers to the Modified Mercalli Intensity Scale.)

SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 9

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

SEISMIC RISK MAP

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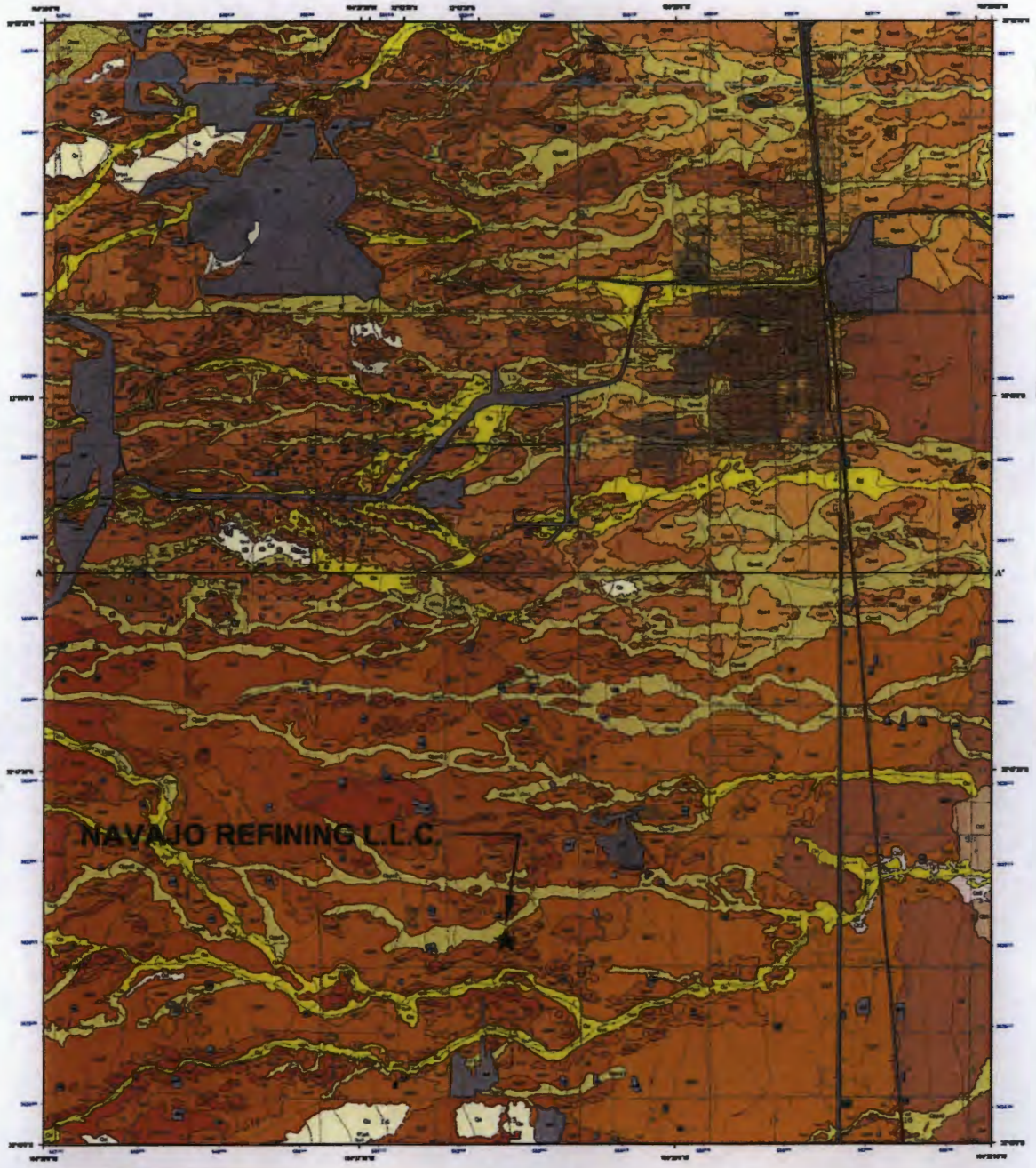
NMBGMR Open-file Geologic Map 169
Last Modified June 2011



DESCRIPTION OF MAP UNITS

CENOZOIC

NEOGENE

Alluvium, lacustrine, and anthropogenic deposits

Disturbed land and/or artificial fill (Historic) — Dumped fill and areas affected by human disturbance, mapped where deposits or structures are readily extensive. Especially notable are the numerous constructed oil and gas well pads. Also includes the U.S. Bureau of Reclamation's Keiser Channel of the Pecos River, as well as other unmapped canal reaches.

Qa **Quaternary alluvium, undifferentiated (Historic to uppermost Pleistocene)** — Brown (7.5YR4/2) to light brown (7.5YR6/3), unconsolidated, moderately sorted, pebbly sand, silt, and clay. Comprises primarily carbonate gravels and pebbles. Varies considerably in thickness from <1 to 3 m in tributaries and up to 10-12 m in the floodplain.

Pecos Valley alluvial terrace complex

Alluvial terraces of the Pecos River and its tributaries were first described in the classic study of Fiedler and Nye (1933). They recognized 3 terraces: (from lowest to highest) the Lakewood, the Orchard Park, and the Blackdom. On the Artesia quad, south of the higher Eagle Creek and Rio Peñasco piedmont alluvial complex is erroneously mapped by Fiedler and Nye (1933) as Blackdom terrace. These materials, however, are all derived from mixed volcanic tributaries, not the Pecos River.

Lakewood terrace alluvial deposits (upper to middle Pleistocene) — Following McCraw, *et al.* (2007) and McCraw and Land (2008), three shallow, low-lying (upper to uppermost middle(?) Pleistocene) "Lakewood terrace" are recognized. Fiedler and Nye's original Lakewood terrace, mapped here to Q_{lt}, lies an elevation of 6 to 9 m above the floodplain and is located on the eastern edge of the quad. The lowest and youngest, Q_{lt_1} is <1-2 m above the floodplain and extends up Tumbleweed Draw. These are comprised of occasional gravels and pebbles, brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine- grained sand, silty sand, silt and sandy clay. Pedogenic carbonate increases from stage I to stage II+ (occasionally III) from Q_{lt} to Q_{lt_1}. Mostly non-gypsiferous.

Qltu **Younger Lakewood terrace alluvial deposits (upper Pleistocene)** — Thickness <1 to 1 m.

Qlto **Older Lakewood terrace alluvial deposits (upper to middle Pleistocene)** — Thickness ~2 to 9 m.

Orchard Park terrace alluvial deposits (upper Pliocene (?) to upper Pleistocene) — According to Fiedler and Nye (1933), the Orchard Park terrace rises 1.5-3 m above the Lakewood terrace and 10.5-20 m above the Pecos floodplain. It is comprised of gravels and pebbles of dolomite, limestone, sandstone, chert, and quartzite in a very pale brown (10YR7/4) to reddish brown (5YR4/4), unconsolidated, moderately sorted, coarse- to fine- grained sand, silty sand, silt, and sandy clay. Pedogenic carbonate is a strong stage III. Thickness ranges from 3 to 15 m.

Rio Peñasco alluvial piedmont complex

Rio Peñasco alluvial piedmont deposits (Upper Pleistocene to Late Miocene(?)) — The headwaters of the Rio Peñasco are located high in the Sacramento Mountains in predominantly carbonate rocks of the San Andres formation (Psa) and clastic sediments of the Yeso Formation (Pzy). Where it leaves the Permian highlands, it has built a large piedmont alluvial complex, which extends west to Eagle Creek to the north and the Seven Rivers to the south. These piedmont deposits grade to and onto the Pecos Valley alluvial terraces on the easternmost edge in the Artesia west. Oldest, highest remnant surfaces (Qpp_1 and Qpp_2) are Pliocene or older, and likely graded to a river system which forms Gatuña formation deposits today. Middle to upper Pleistocene piedmont deposits (Qpp_3) are inset into these and grade to Qae. The youngest, (Qpp_4, grades to Qlt_1, Seward channels (*e.g.*, Tumbleweed Draw) on this piedmont surface were likely former Rio Peñasco channels.

Lithologically, the Rio Peñasco piedmont deposits are distinctly different than those of Eagle Creek to the north and Seven Rivers to the south. While gravels are dominated by limestone clasts, dolomitic, chert, yellow-brown sandstone, conglomerate, and quartzite are common. The matrix consists of dark yellowish brown (10YR3/4) to light brown (7.5YR6/3), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt, and sandy clay. Stage V-VI pedogenic carbonate can be found in the oldest deposits, while middle to upper Pleistocene deposits range from stages I+ to III. Degree of pedogenic carbonate development can be the main distinguishing characteristic between the youngest deposits.

Qpe **Younger Quaternary piedmont alluvium (Holocene to upper Pleistocene)** — Thickness 1 to 3 m.

Qpm **Younger Quaternary piedmont alluvium (Upper Pleistocene)** — Thickness 2 to 4 m.

Qpo **Old Quaternary piedmont alluvium (Upper to middle Pleistocene)** — Most extensive deposit. Thickness 2 to 4 m.

Qpo **Older piedmont alluvium (Middle Pleistocene to late Pliocene)** — Thickness 2 to 6 m.

Contact beneath conglomeratic boulder between (Tf)pp and a (Qpp_3) channel, incised into the old Rio Peñasco piedmont alluvium. The boulder is *not in situ* and its' matrix is actually stage V pedogenic carbonate

Rio Peñasco piedmont channel deposits (Historic to upper Pleistocene) — Numerous, thin alluvial channels, swales, and occasional small playa depressions fill deposits that drain the piedmont alluvial complex. They usually consist of light brown (7.5YR6/4) to pinkish gray (7.5YR6/2), unconsolidated, poorly sorted, fine-grained sand, silt, and clay sediments. They were often mapped primarily by soil moisture increases in lower areas relative to adjacent piedmont deposits noted on photography. Eolian input often resembles the "v-shaped" contours associated with stream channels and in some areas sand sheets and dunes can fill these channels (Qae). On the Rio Peñasco, on the Dayton quad immediately to the south, older channels (Qpe_o) are mapped on Qpe surfaces, similar and stratigraphically equivalent as those on Eagle Creek (Qpe, deposits.

Qpe **Young Quaternary piedmont channels (Holocene to upper Pleistocene)** — Thickness <1 to 3 m.

Qpm **Young Quaternary piedmont channels filled with eolian sands, occasionally forming dunes (Holocene to upper Pleistocene)** — Thickness ≤1 m.

Eagle Creek alluvial piedmont complex

Eagle Creek alluvial piedmont deposits (Upper to middle Pleistocene) — Eagle Creek (or Eagle Draw further west) heads on the easternmost flank of the southern Sacramento Mountains in San Andres Formation (Psa) rocks and flows east to the Pecos River. Where it leaves the Permian highlands, it has built a large piedmont alluvial complex, which coalesces with the Rio Peñasco to the north and the Rio Peñasco to the south. This piedmont complex grades to and onto the Pecos Valley alluvial terraces. Oldest, highest remnant surfaces are correlative to Quaternary – Tertiary piedmont deposits of the Rio Peñasco (Qpp_1). Collectively, these are comprised of gravels that are almost exclusively limestone derived from Psa, supported in a matrix of light brown (7.5YR6/3), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt (largely calcareous), and sandy clay. Topographic expression between the youngest deposits are often to subtle to practically non-existent. Distinction is often based upon a stronger developed pedogenic carbonate (Qae_o = stage III+ – II+, Qae_y = stage II) (Qae, grades to Qlt_1.

Qaey **Youngest Quaternary piedmont alluvium (Holocene to upper Pleistocene)** — Thickness 1 to 3 m.

Qaem **Younger Quaternary piedmont alluvium (Upper Pleistocene)** — Thickness 2 to 4 m.

Qaeo **Older Quaternary piedmont alluvium (Upper to middle Pleistocene)** — Most extensive deposit. Thickness 2 to 4 m.

Qaeo **Oldest piedmont alluvium (Middle Pleistocene to late Pliocene)** — Thickness 2 to 6 m.

Eagle Creek piedmont channel deposits (Historic to upper Pleistocene) — Up until the mid 20th Century, prior to channelization through town, Eagle Creek flowed primarily south of the town of Artesia. These abandoned channels (2-3 m thick) are now similar to the numerous, thin alluvial channels, swales, and occasional coalescing depression fill deposits that only drain the local piedmont alluvial complex. These channels usually consist of light brown (7.5YR6/4) to pinkish gray (7.5YR6/2), unconsolidated, poorly sorted, fine-grained sand, silt, and clay sediments. They were often mapped primarily by soil moisture increases in lower areas relative to adjacent piedmont deposits noted on photography. Eolian input often resembles the "v-shaped" contours associated with stream channels and in some areas sand sheets and dunes can fill these channels (Qae_o). Older channels (Qae_o) are mapped on Qae_o surfaces above modern Eagle Creek in the vicinity of the Eagle Creek remining dam on the northwestern edge of the quad.

Qaem **Young Quaternary piedmont channels (Holocene to upper Pleistocene)** — Thickness <1 to 2 m.

Qaeo **Older Quaternary piedmont channels (Upper Pleistocene)** — Thickness <1 to 2 m.

Qaey **Young Quaternary piedmont channels filled with eolian sands, occasionally forming dunes (Holocene to upper Pleistocene)** — Thickness ≤ 1 m.

Quaternary depression fill and sinkhole deposits

Qdp **Quaternary depression fill, undifferentiated (Holocene to middle Pleistocene)** — Unconsolidated, well-sorted, fine-grained (less sands to clay) complexes of alluvial, colluvial, eolian, and occasional lacustrine deposits within closed depressions. Colors variable. Depressions are created by either gradual subsidence or sudden collapse followed by gradual subsidence of underlying gypsiferous carbonate terrane. These complexes are often superficially modified by stream erosion and deposition, playa deposition, deflation, and mass wasting. Depression fills have been active since the middle Pleistocene and are usually 1-3 m thick but can reach thicknesses in excess of 30 m.

Qds **Quaternary sinkhole deposits, primarily caused by collapse (Historic to middle Pleistocene)** — Complexes of unconsolidated, well- to poorly-sorted, coarse- to fine-grained sands to clay, alluvial, colluvial, eolian, and occasional lacustrine deposits within closed depressions. Colors variable. Thickness <1 to 3 m.

PALEOZOIC

Permian Artesia Group

Pqg **Queen and Grayburg formations, undifferentiated (Guadalupian)** — Cross section only

Lower Permian Formations

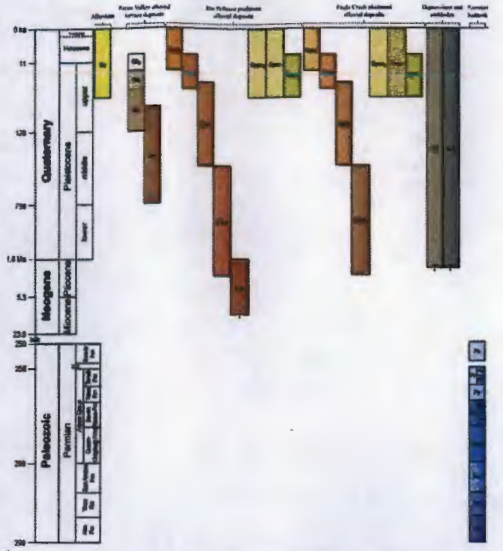
Psa **San Andres formation** — Cross section only.

Pgl **Glorieta sandstone tongue** — Cross section only

Pyu **Yeso formation, undifferentiated** — Cross section only.

Pa **Abo formation, undifferentiated** — Cross section only

CORRELATION OF MAP UNITS



View looking north-northwest with Tumbleweed Draw in the foreground (Qa). Younger Rio Peñasco piedmont deposits (Qpe_y) below the storage tank are inset into old piedmont deposits (Qpp_3). The hill on the distant skyline is Qdp_y.

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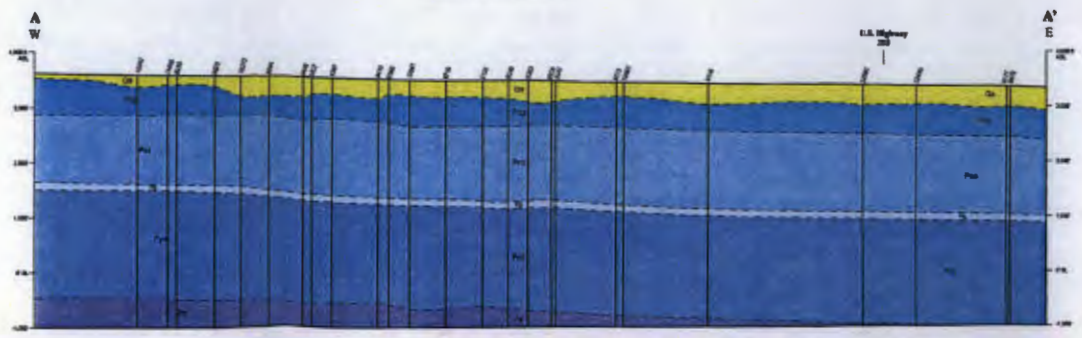
GEOLOGIC CROSS SECTION



QUADRANGLE LOCATION

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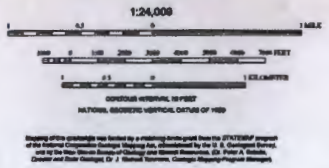

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 169

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
801 Leroy Place
Socorro, New Mexico
87801-4796

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This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

Geologic map of the Artesia quadrangle, Eddy County, New Mexico.

May 2011

by

David J. McCraw and Shannon Williams

New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801

EXPLANATION OF MAP SYMBOLS

- A—A' Location of geologic cross section
- Geologic contact. Solid where exposed or known, dashed where approximately known, dotted where concealed or inferred.
- Arrow showing mean direction of paleoflow, based upon pebble imbrication, n ≥ 20 each arrow.
- Soil pit.
- Oil & gas exploration well used in cross section construction.

COMMENTS TO MAP USERS

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrences of structural features. Geologic and fault contacts are irregular ovoiform that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: nonreconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map. Therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the photography. Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not for the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

This map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

FIGURE 10

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

SURFACE GEOLOGIC MAP

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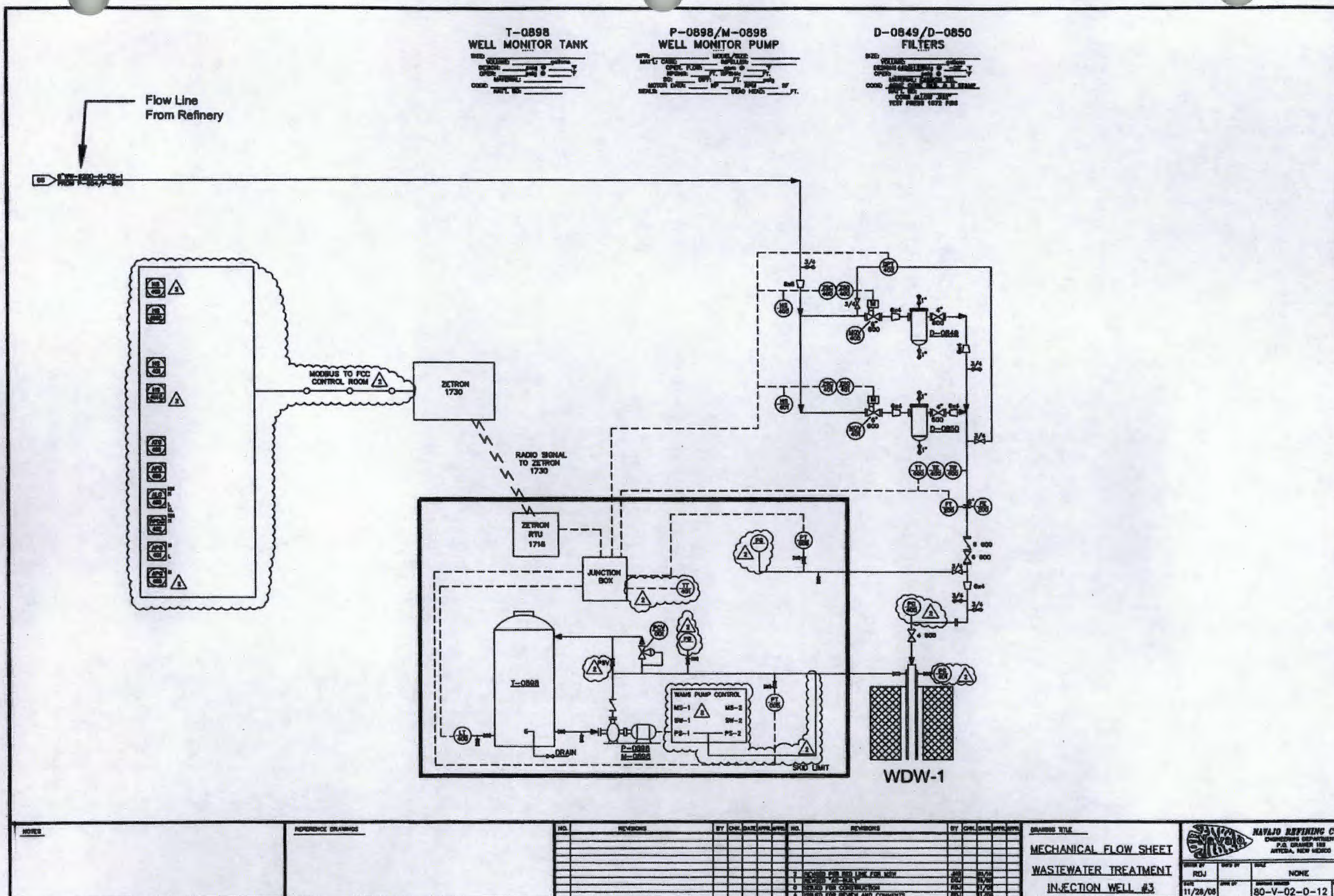
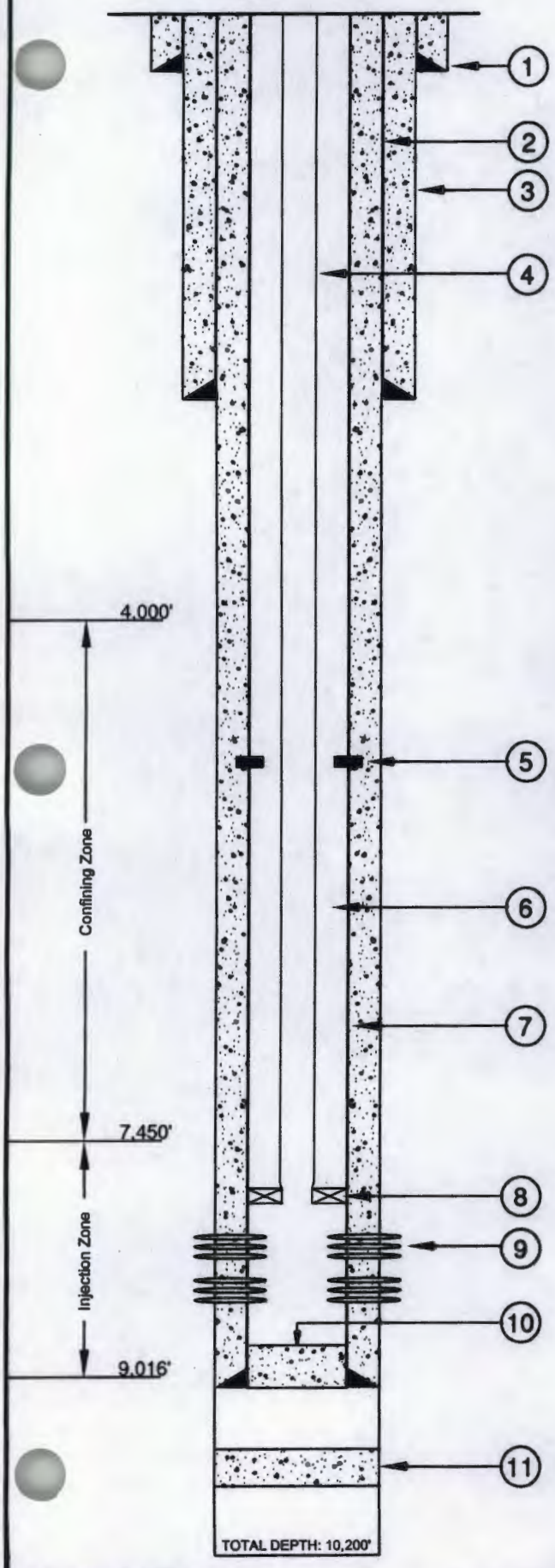


FIGURE 11
PRE-INJECTION SURFACE FACILITIES
NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO



BELOW GROUND DETAILS

All depths are referenced to the Kelly bushing elevation of 12.5' above ground level. Ground level elevation is 3,678' above mean sea level.

1. Surface Casing: 13 ⅜", 48 lb/ft, J-55, ST&C set at 390' in a 17 ½" hole. Cemented with 150 sx Class C with 3% calcium chloride, 375 sx Class C Litewate w/3% calcium chloride and ½ lb/sx flocele. Circulated 86 sx to surface.

2. Intermediate Casing: 9 ⅝", 36 lb/ft, J-55, ST&C set at 2,555' in a 12¼" hole. Cemented w/800 sx of Class C Lite w/½ lb/sx flocele and 2 lb/sx Gilsonite and 12% salt. Followed by 200 sx of Class C w/2% calcium chloride. Circulated 133 sx to surface.

3. Base of the USDW at 493'.

4. Injection Tubing: 4 ½", 11.6 lb/ft, N-80, SMLS, R3, LT&C set at 7,879'.

5. DV Tool: at 5,498'.

6. Annulus Fluid: 8.7 lb/gal brine water mixed w/UniChem Techni-Hib 370 corrosion inhibitor.

7. Protection Casing: 7", 29 lb/ft, N-80, LT&C: 9094' to 7031'. 7", 29 lb/ft, P-110, LT&C: 7031' to 5845'. 7", 26 lb/ft, P-110, LT&C; 5,845' to surface. Casing set in 8 ¾" hole and cemented in two stages as follows:

   First Stage - 600 sx modified Class H w/0.4% CFR-3, 5 lb/sx Gilsonite, 0.5% Halad-344, and 1 lb/sx salt mixed at 13.0 ppg. Opened DV tool at 5,498' and circulated 142 sx to surface.

   Second Stage - Lead Slurry: 220 sx Interfill "C" (35:65:6) mixed at 11.7 ppg. Tail Slurry: 550 sx modified Class H w/0.4% CFR-3, 5 lb/sx, Gilsonite, 0.5% Halad-344, 0.1% HR-7, and 1 lb/sx mixed at 13.0 ppg. Circulated 75 sx to surface. Topped out w/20 sx premium plus 3% calcium chloride.

8. Packer: 7" x 3.5" EVI Oil Tools (Arrow), Model X-1 retrievable packer set at 7,879'. Minimum I.D. is 3.0". Wireline re-entry guide on bottom. To release: turn ¼ turn to the right and pick up.

9. Perforations (2 SPF):

   Upper Zone - 7,924 - 7,942', 7,974 - 8,030', 8,050 - 8,056', 8,066 - 8,080', 8,118 - 8,127', 8,132 - 8,140', 8,160 - 8,164', 8,170 - 8,188'.

   Lower Zone - 8,220 - 8,254', 8,260 - 8,270', 8,280 - 8,302', 8,360 - 8,366', 8,370 - 8,378', 8,400 - 8,410', 8,419 - 8,423', 8,430 - 8,446', 8,460 - 8,464', 8,470 - 8,476'.

10. PBTD: 9,004'.

11. Cement Plug: 45 sx Class H from 9624' to 9734'.

SUBSURFACE

HOUSTON, TX.
SOUTH BEND, IN.
BATON ROUGE, LA.

FIGURE 12

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

BELOW GROUND WELL SCHEMATIC
WASTE DISPOSAL WELL NO. 1

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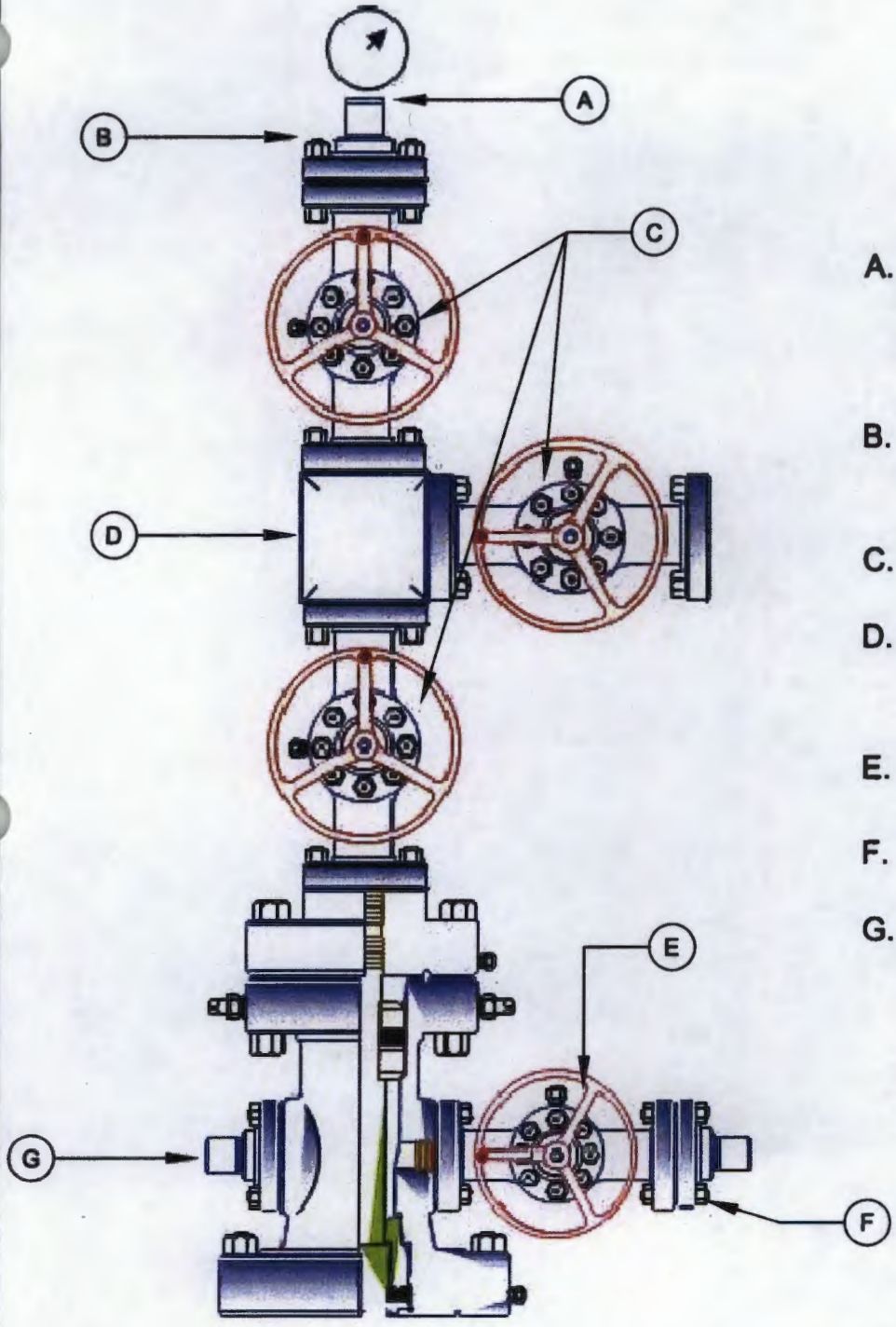

WELLHEAD DETAILS

A. Top Connection: 4 $\frac{1}{2}$" EUE, 2 $\frac{7}{8}$" 8rd, 2 $\frac{7}{8}$" bull plug, $\frac{1}{2}$" NPT 5000 lb gauge.

B. Flange: 4 $\frac{1}{16}$" 3K x 4 $\frac{1}{2}$" UPTBG 3K

C. Tree Gate Valves: 4 $\frac{1}{16}$" 3K

D. Upper Tree Assembly: A5PP, 4 $\frac{1}{2}$", 7 $\frac{1}{16}$" 3K x 4 $\frac{1}{16}$" 3K

E. Annulus Valve: 2 $\frac{1}{16}$" 5K

F. Flange: 2 $\frac{1}{16}$" 5K x 2" LP 5K

G. Annulus Valve: 2" ball valve 3K

SUBSURFACE

HOUSTON, TX
SOUTH BEND, IN
BATON ROUGE, LA

FIGURE 13

NAVAJO REFINING COMPANY, L.L.C.
ARTESIA, NEW MEXICO

WELLHEAD SCHEMATIC
WASTE DISPOSAL WELL NO. 1

DATE: 01/08/13	CHECKED BY:	JOB NO: 60D6894
DRAWN BY: WDD	APPROVED BY:	DWG. NO: